FOOD ADDITIVES DATA BOOK

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SECOND EDITION

Edited by

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How to Use This Book

The prudent use of approved food additives continues to be important in the food industry in order to provide safe, convenient, quality food products with useful shelf-lives. Developments in processing technologies will minimise the use of additives but their advantages continue in certain product formats.

The *Food Additives Data Book* contains practical information about a wide range of food additives. They are organised by functional category such as acidulants, antioxidants, colourings, etc. The priority is to provide useful information for the practising food technologist and student. The 'function in foods' and 'technology of use in foods' sections are likely to be the most useful ones for each additive in the data book. These illustrate why the additive finds application in certain food products and how it is used from a practical point of view. Chemical and physical data are provided to help the food technologist in using the additives. Some brief information on legislation is also provided.

To find information about a certain additive, it can be searched for in the table of contents (if the functional category is known) or in the index. The index is extensive and can be used to locate information about certain foods, synonyms, alternative additives and other topics of interest.

For this, the Second Edition, the list of additives has been extended and all entries updated with current information to mid-2010. Some aspects are timeless but others (legislation in particular) may need to be checked for up-to-dateness. References are included to help with this.

Part 1

Acidulants

Stephanie Doores

Food Additives Data Book, Second Edition. Edited by Jim Smith and Lily Hong-Shum.

NAME:	Acetic acid
CATEGORY:	Emulsifiers/Stabilisers/Chelating agents/pH control agents/Preservatives/Flavour enhancers and modifiers/ Solvents/Firming agents
FOOD USE:	Baked goods/Cereals and cereal products/Dairy products/Edible oils and fats/Fish, seafoods and products/Meat, poultry and eggs and products/Fruits, vegetables and nuts and products/Sugars, sugar preserves, and confectionery/Vinegar, pickles and sauces
SYNONYMS:	Ethanoic acid/Ethylic acid/Glacial acetic acid/Methane carboxylic acid/Monocarboxylic acid/Vinegar/ CAS 64-19-7/DOT 2789/2790/FEMA No. 2006
FORMULA:	CH_3COOH
MOLECULAR MASS IN Daltons:	60.05
ALTERNATIVE FORMS:	Calcium acetate; hydroxyacetic acid; manganese acetate; methyl acetate; potassium acetate; sodium acetate; zinc acetate
PROPERTIES AND APPEARANCE:	Clear, colourless liquid
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	117.9
MELTING RANGE IN °C:	16.6
FLASH POINT IN °C:	43 (closed cup), 57 (open cup)
IONISATION CONSTANT AT 25°C:	1.76×10^{-5}
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.0492 @ 20°/4°C
HEAT OF COMBUSTION AT 25°C:	209.02 kcal/gram molecular weight
VAPOUR PRESSURE AT VARIOUS TEMPERATURES:	−17.2°C (1 mmHg) 17.5°C (10 mmHg) 43°C (40 mmHg) 63°C (100 mmHg) 99°C (400 mmHg) 118.1°C (760 mmHg)

PURITY %:	≥99.5 by weight	
HEAVY METAL CONTENT MAXIMUM IN ppm:	10	
ARSENIC CONTENT MAXIMUM IN ppm:	3	
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:		
in water:	**@ 25°C**	Acid and its salts are freely soluble
in ethanol solution:	**@ 25°C**	Freely soluble
	@ 25°C	Potassium and sodium salts are freely soluble
	@ 25°C	Calcium salt is slightly soluble

FUNCTION IN FOODS:

Acetic acid is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Acetic acid can be used as an acidifier and flavouring agent in condiments such as mustard, catsup, salad dressings, sauces, canned fruits, and mayonnaise. It can be used to alter the acidity of acidified milk, acidified low-fat milk, acidified skim milk, meat and poultry products. It can also be used to alter the acidity of cold pack cheese food such that the pH does not exceed 4.5, and pasteurised process cheese (pH 5.3), cheese food (pH 5.0) and cheese spread (pH 4.0). It is a pickling agent in products such as sausages and pigs' feet, sweet and sour pickles, marinades and vinaigrettes. It is used to separate fatty acids and glycerol in rendered fats at a level sufficient for purpose. It assists in caramelisation. It is used as an emulsifier in the manufacture of hydroxylated lecithin. It can also be used to sanitise equipment and as a boiler water additive. Maximum levels recommended in foods are 0.25% for baked goods and baking mixes, 0.5% for chewing gum, fats and oils, 0.6% for meat products, 0.8% for cheese and dairy product analogues, 3.0% for gravies and sauces, 9.0% for condiments and relishes, and 0.15% for all other food categories when used in accordance with good manufacturing practices.

Calcium acetate is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Calcium acetate can be used as a firming agent, pH control agent, processing aid, an acidity regulator, sequestrant, texturiser, thickener, and as an antirope agent in bakery products. It can also be a source of calcium. It acts as a stabiliser in sausage casings and as a stabiliser when salt migrates from food-packaging materials. Maximum levels recommended are 0.02% in cheese, 0.15% in sweet sauces, toppings and syrups, 0.2% in baked goods, baking mixes, gelatins, puddings and fillings, and 0.0001% in all other foods in accordance with good manufacturing practices.

Ethyl acetate can be used in accordance with good manufacturing practice as a solvent in the decaffeination of coffee and tea and in inks for marking fruits and vegetables.

	Potassium acetate is used as a synthetic flavouring. It is also an acidity regulator and buffer. Sodium acetate is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Sodium acetate can be used as a pH control agent, flavouring agent and adjuvant, stabiliser and buffer in certain milk and meat products, and as a boiler additive for food-grade steam. Maximum levels recommended in foods are 0.007% in breakfast cereal, 0.05% in snack foods, soup mixes and sweet sauces, 0.12% in meat products and jams and jellies, 0.15% in hard candy, 0.2% in soft candy, 0.5% in fats and oils, 0.6% in grain products and snack foods. Sodium acetate is limited to 56 g per 45 kg (2oz per 100lb) to acidify artificially flavoured fruit jelly, preserves and jams. Hydroxyacetic acid, manganese acetate, methyl acetate, and zinc acetate can be used as a component of adhesives.
TECHNOLOGY OF USE IN FOODS:	Acetic acid $pK_1 = 4.75$ Calcium and sodium acetate are hygroscopic. Acetic acid is more effective in limiting bacterial and yeast growth than mould growth.
FOOD SAFETY ISSUES:	LD_{50} (mg/kg body weight) acetic acid: Mouse 4960 oral route; 525 intravenous route. Rat 3310–3530 oral route. Rabbit 1200 oral route; 1200 subcutaneous route; 1200 rectal route. LD_{50} (mg/kg body weight) calcium acetate: Mouse 52 intravenous route. Rat 147 intravenous route. LD_{50} (mg/kg body weight) sodium acetate: Mouse 3310 oral route; 380 intravenous route. Rat 3530–4960 oral route. Acceptable daily intake for humans of acetic acid and its calcium, potassium and sodium salts is not limited.
LEGISLATION:	**USA:** Acetic acid: 9 CFR 318.7, 381.147; 21 CFR 73.85, 131.111, 131.136, 131.144, 133.123, 133.124, 133.169, 133.173, 133.178,133.179, Part 145, 172.814, 178.1010, 184.1005 Calcium acetate: 21 CFR 181.29, 184.1185 Ethyl acetate: 21 CFR 73.1, 173.228 Hydroxyacetic acid: 21 CFR 175.105 Manganese acetate: 21 CFR 175.105 Methyl acetate: 21 CFR 175.105 Potassium acetate: 21 CFR 172.515 Sodium acetate: 21 CFR 150.141, 150.161, 173.310, 182.70, 184.1721 Zinc acetate: 21 CFR 175.105
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NAME:	Adipic acid
CATEGORY:	Chelating agents/pH control agents/Preservatives/Flavour enhancers and modifiers/Flour and baking additives
FOOD USE:	Baked goods/Dairy products/Edible oils and fats/Fish and seafoods and products/Meat, poultry and eggs and products/Fruit, vegetables and nuts and products/Beverages/Vinegar, pickles and sauces
SYNONYMS:	Acifloctin/Acinetten/Adilactetten/Adipinic acid/Hexanedioic acid/Molten adipic acid/1,4-Butanedicarboxylic acid/1,6-Hexanedioic acid/CAS 124-04-9/DOT 9077/FEMA No. 2011
FORMULA:	$HOOC(CH_2)_4COOH$
MOLECULAR MASS IN Daltons:	146.14
ALTERNATIVE FORMS:	Calcium adipate; magnesium adipate
PROPERTIES AND APPEARANCE:	White crystals or crystalline, non-hygroscopic powder
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	337.5 (closed cup)
MELTING RANGE IN °C:	151.5–154
FLASH POINT IN °C:	196
IONISATION CONSTANT AT 25°C:	3.71×10^{-5} 3.87×10^{-6}
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.360 @ 25°/4°C
HEAT OF COMBUSTION AT 25°C:	668.29 kcal/gram molecular weight
VAPOUR PRESSURE AT VARIOUS TEMPERATURES:	159.5°C (1 mmHg) 191°C (5 mmHg) 205.5°C (10 mmHg) 222°C (20 mmHg) 240.5°C (40 mmHg) 265°C (100 mmHg) 337.5°C (760 mmHg)

PURITY %:	≥99.6
WATER CONTENT MAXIMUM IN %:	0.2
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ARSENIC CONTENT MAXIMUM IN ppm:	3
ASH MAXIMUM IN %:	≤0.002–0.02
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 100°C** 160
	@ 20°C 1.4
in ethanol solution:	Freely soluble
FUNCTION IN FOODS:	Adipic acid is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Adipic acid can be used as a pH control agent, neutralising agent, leavening agent and flavouring agent. It can be used to alter the acidity of acidified milk, acidified low-fat milk and acidified skim milk, margarine or oleomargarine. It can be used as a sequestrant in oils and improves melting characteristics and texture of process cheese and cheese spreads. It is used in puddings and gelatin to improve set and maintain acidities within the range of pH 2.5–3.0. It is an excellent slow-acting leavening agent that supports the even release of carbon dioxide in baked goods. It increases the whipping quality of products containing egg white. It can be used in the production of resinous and polymeric coatings. Maximum levels recommended are 0.0004% for frozen dairy desserts, 0.005% for non-alcoholic beverages, 0.05% for baked goods and baking mixes, 0.1% for gravies, 0.3% for fats, oils and meat products, 0.45% for dairy product analogues, 0.55% for gelatin, puddings, and fillings, 1.3% for snack foods, 5% for condiments and relishes and 0.02% for other food categories when used in accordance with good manufacturing practices. Diisobutyl adipate can be used as a component of adhesives and a plasticiser for food packaging materials at levels not to exceed good manufacturing practices. Pentaerythritol adipate-stearate may be safely used as a lubricant in the fabrication of rigid and semi-rigid polyvinyl chloride and/or vinyl chloride–propylene copolymers used as articles or components of articles that contact food.
ALTERNATIVES:	Adipic acid is used as an acidulant in commercial baking powders to replace tartaric acid and cream of tartar and phosphates because adipic acid is non-hygroscopic.

TECHNOLOGY OF USE IN FOODS:

Adipic acid $pK_1 = 4.43$; $pK_2 = 5.41$

Adipic acid is four to five times more soluble than fumaric acid at room temperature and has the lowest acidity of any of the food acids. It imparts a slowly developing, smooth, mildly acid flavour and is essential in supplementing foods with delicate flavours. It is practically non-hygroscopic which is an advantage in prolonging the shelf-life of powdered products.

SYNERGISTS:

Adipic acid combined with sodium metabisulphite can be used in the preservation of sausages and other meat products.

FOOD SAFETY ISSUES:

LD_{50} (mg/kg body weight) adipic acid: Mouse 1900 oral route; 680 intravenous route; 275 intraperitoneal route. Rat 3600 oral route. Rabbit 2430–4860 oral route; 2430 intravenous route.

Acceptable daily intake for humans of adipic acid is limited conditionally up to 5 mg/kg body weight.

LEGISLATION:

USA:

Adipic acid: 9 CFR 318.7; 21 CFR 75.85, 131.111, 131.136, 131.144, 166.110, 175.300, 175.320, 177.1210, 177.2420, 177.2600, 178.3690, 184.1009

Diisobutyl adipate: 21 CFR 175.105, 181.27

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NAME:	Caprylic acid
CATEGORY:	Emulsifiers/Stabilisers/pH control agents/Preservatives/Flavour enhancers and modifiers/Anti-caking agents/ Antifoaming agent/Foaming agents/Glazing and coating agents
FOOD USE:	Baked goods/Dairy products/Edible oils and fats/Meat, poultry and eggs and products/Fruit, vegetables and nuts and products/Sugars, sugar preserves and confectionery
SYNONYMS:	C-8 acid/Hexacid 898/*n*-Caprylic acid/*n*-Octoic acid/*n*-Octylic acid/neo-fat 8/Octanoic acid/Octic acid/ 1-Heptanecarboxylic acid/CAS 124-07-2
FORMULA:	$CH_3(CH_2)_6COOH$
MOLECULAR MASS IN Daltons:	144.22
ALTERNATIVE FORMS:	Aluminum caprylate; calcium caprylate; cobalt caprylate; iron caprylate; magnesium caprylate; manganese caprylate; potassium caprylate; sodium caprylate
PROPERTIES AND APPEARANCE:	Colourless oily liquid
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	239.3
MELTING RANGE IN °C:	16.5–16.7
IONISATION CONSTANT AT 25°C:	1.28×10^{-5}
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	0.9088 @ 20°/4°C
VAPOUR PRESSURE AT VARIOUS TEMPERATURES:	92.3°C (1 mmHg) 124°C (10 mmHg) 150.6°C (40 mmHg) 172.2°C (100 mmHg) 213.9°C (400 mmHg) 237.5°C (760 mmHg)
PURITY %:	99.6

WATER CONTENT MAXIMUM IN %:	10
HEAVY METAL CONTENT MAXIMUM IN ppm:	3
ARSENIC CONTENT MAXIMUM IN ppm:	0.1
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 0.068
in ethanol solution:	Freely soluble
FUNCTION IN FOODS:	Caprylic acid is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Caprylic acid can be used as a flavouring agent and adjuvant, lubricant, binder and defoaming agent. It can be used indirectly as an antimicrobial agent in cheese wrappers and as a coatingon fresh citrus fruits. It can also be used to assist in lye peeling. It is an indirect antimicrobial food additive when migrating to food from paper and paperboard products. It can be used as a sanitising solution on food processing equipment. Maximum levels recommended for specific products are 0.005% for fats and oils, frozen dairy desserts, gelatins, puddings, meat products and soft candy, 0.013% for baked goods and baking mixes, 0.016% for snack foods, 0.04% for cheeses, and 0.001% or less for other food categories. Aluminium, calcium, magnesium, potassium or sodium caprylate can be used as a binder, emulsifier and anti-caking agent when used in accordance with good manufacturing practices. The salts of caprylic acid can also be used in the production of resinous and polymeric coatings. Cobalt, iron or manganese caprylate can be used as a drier when migrating from food packaging material, with no limitation other than good manufacturing practices.
TECHNOLOGY OF USE IN FOODS:	Caprylic acid $pK_1 = 4.89$ Caprylic acid imparts a `sweat-like' or cheesy odour and buttery taste to foods. It is more inhibitory to a broad group of microorganisms at a lower concentration at around neutral pH than other acidulants.
FOOD SAFETY ISSUES:	LD_{50} (mg/kg body weight). Mouse 600 intravenous route. Acceptable intake for humans of caprylic acid is not limited.
LEGISLATION:	**USA:** Caprylic acid: 21 CFR 172.210, 172.860, 173.315, 173.340, 178.1010, 182.90, 184.1025 Cobalt caprylate: 21 CFR 181.25 Iron caprylate: 21 CFR 181.25 Manganese caprylate: 21 CFR 181.25

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NAME:	Citric acid
CATEGORY:	Emulsifiers/Stabilisers/Chelating agents/Nutritive additives/Antioxidants/pH control agents/Preservatives/ Flavour enhancers and modifiers/Solvents/Flour and baking additives/Anti-caking agents/Firming agents/ Glazing and coating agents
FOOD USE:	Baked goods/Dairy products/Edible oils and fats/Fish and seafoods and products/Meat, poultry and eggs and products/Fruit, vegetables and nuts and products/Beverages/Soft drinks/Sugar, sugar preserves and confectionery/Alcoholic drinks/Vinegar, pickles and sauces
SYNONYMS:	Aciletten/Boxylic acid/Citretten/Citro/2-Hydroxy-1,2,3-propanetricarboxylic acid/β-Hydroxytricarballyic acid/β-Hydroxytricarboxylic acid/CAS 77-92-9/FEMA No. 2306
FORMULA:	CH_2-(COOH)-C-(OH)(COOH)-CH_2-COOH
MOLECULAR MASS IN Daltons:	192.14
ALTERNATIVE FORMS:	Ammonium citrate; calcium citrate; dipotassium citrate; disodium citrate; ferric ammonium citrate; ferric citrate; ferrous citrate; iron ammonium citrate; isopropyl citrate; magnesium citrate; manganese citrate; monoglyceride citrate; monopotassium citrate; monosodium citrate; stearyl citrate; stearyl monoglyceridyl citrate; triethyl citrate; tripotassium citrate; trisodium citrate
PROPERTIES AND APPEARANCE:	Colourless, odourless, translucent crystals or as a white granular to fine crystalline powder
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	Decomposition
MELTING RANGE IN °C:	153 (anhydrous form) 100 (monohydrate)
FLASH POINT IN °C:	100
IONISATION CONSTANT AT 25°C:	7.10×10^{-4} 1.68×10^{-5} 4.10×10^{-7}
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.665 (anhydrous form) 20°/4°C 1.542 (monohydrate) 20°/4°C

HEAT OF COMBUSTION AT 25°C IN J/kg:	468.6 (anhydrous form)
PURITY %:	≥99.5
WATER CONTENT MAXIMUM IN %:	0.5 (anhydrous form) 8.8 (hydrous form)
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ARSENIC CONTENT MAXIMUM IN ppm:	3
ASH MAXIMUM IN %:	0.05

SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:

in water:	**@ 10°C**	54.0	**@ 20°C**	59.2	**@ 30°C**	64.3	**@ 40°C**	68.6	**@ 50°C**	70.9
	@ 60°C	73.5	**@ 70°C**	76.2	**@ 80°C**	78.8	**@ 90°C**	81.4	**@ 100°C**	84.0
in ethanol solution:	**@ 25°C**	1 g/2 mL								

FUNCTION IN FOODS: Citric acid is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Citric acid is used as a curing accelerator, dispersing agent, sequestrant, and synergist for antioxidants. Citric acid can be used to alter the acidity of acidified milk, acidified low-fat milk, acidified skim milk, cultured milk, cultured low-fat milk, acidified skim milk, cultured skim milk, margarine and oleomargarine. It can also be used to alter the acidity of cold pack cheese food such that the pH does not exceed 4.5, pasteurised process cheese (pH 5.3), cheese food (pH 5.0), cheese spread (pH 4.0), and dry curd cottage cheese (pH 4.5–4.7). It can be used to alter the acidity of canned fruits, corn, artificially sweetened canned figs, canned peaches, and canned prune juice, artificially sweetened fruit jelly, fruit preserves, jams, meat and meat food products, and poultry. It controls acidity in pectin and alginate gels and reduces heat processing requirements by lowering pH. It enhances the flavour of citrus-based foods including canned sweetened apricots, cherries, pears, and chili con carne. Citric acid is a precursor to diacetyl and indirectly improves the flavour and aroma of a variety of cultured dairy products. It is limited to 0.15% by weight of the milk used or equivalent amount of sodium citrate as a flavour precursor or at 0.1% in sour cream and sour half-and-half. It assists in caramelisation. It can be used a plasticiser and an emulsifying agent to provide texture and improve melting characteristics in pasteurised processed cheese at a level not to exceed 3%. Citric acid is limited at 0.01% alone or in combination with antioxidants for any product containing antioxidants. It is approved for use in ice cream, sherbet and ices, beverages, and salad dressings. Citric acid singly or in combination with sodium acetate

can delay discoloration on fresh cuts of beef, lamb and pork at levels not to exceed 250 ppm or 0.14 mg/cm^2 (0.9 mg/sq inch) of product surface or exceed 500 ppm or 0.28 mg/cm^2 (1.8 mg/sq inch) of surface when in combination with ascorbic acid, erythorbic acid or sodium ascorbate. Citric acid may be used in cured products or in 10% solution used to spray surfaces of cured meats and meat food products prior to packaging to replace up to 50% of the ascorbic acid, erythorbic acid, sodium ascorbate or sodium erythorbate that is used. It is used to preserve cured colour of pork cuts during storage at a level not to exceed 30% in water solution used to spray surfaces of cured cuts prior to packaging. It can be used at levels not to exceed 0.001% in dry sausage, 0.01% in fresh pork sausage, and 0.01% in dried meats. Its use is limited at 0.003% for dry sausage in combination with antioxidants. Citric acid may be used to replace up to 50% of the ascorbic acid or sodium ascorbate in poultry to accelerate colour fixing and is limited at 0.01% alone or in combination with antioxidants in poultry fats to increase effectiveness of antioxidants. Its use is limited for French dressing, mayonnaise and salad dressing at 25% or less of the weight of the acids of the vinegar or diluted vinegar calculated as acetic acid. Citric acid can be added to grapes after fermentation or in combination with other acids after fermentation to correct deficiencies at a level not to exceed 9 g/L of finished wine. It may be added to adjust the acidity of citrus fruit juice or wine at a level not to exceed 9 g/L finished wine. It prevents cloudy precipitates and inhibits oxidation. Citric acid can be used to stabilise wine at a level not to exceed 5.8 lb per 1000 gallons ($\sim$ 120 mg/L).

Ammonium citrate is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Ammonium citrate can be used as a stabiliser when migrating from food packaging material. It is used in the manufacture of adhesives and in the production of resinous and polymeric coatings. It can be used as a flavour enhancer, pH control agent and is used in non-alcoholic beverages and cheeses.

Calcium citrate is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Calcium citrate can be used as a nutrient and dietary supplement, pH control agent, buffer, firming agent, and sequestrant. It improves the baking properties of flour. It can be used in infant formula. It can be used as an emulsifying agent in pasteurised process cheese, cheese food, and cheese spread at a limit of 3.0% and a gelling agent in artificially sweetened jelly, fruit preserves and jam. It is limited at 0.1% as a flavour precursor in sour cream and sour half-and-half.

Ferric ammonium citrate, ferric citrate and ferrous citrate are used as a nutrient supplement at levels not to exceed good manufacturing practices. It may also be used in infant formula.

Iron ammonium citrate is used as an anti-caking agent in salt for human consumption at a level not to exceed 25 ppm (0.0025%) in finished salt.

Isopropyl citrate is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Isopropyl citrate can be used as a sequestrant, solvent and vehicle. It is used to protect flavour in margarine at a level of 0.02%, in non-alcoholic beverages, fats and oils at levels not to

exceed good manufacturing practices. It can be used to increase effectiveness of antioxidants in lard, shortening, oleomargarine, fresh pork sausage, and dried meats at a level of 0.02%.

Magnesium citrate is used in the production of resinous and polymeric coatings.

Manganese citrate is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Manganese citrate can be used as a dietary supplement in baked goods, non-alcoholic beverages, dairy product analogues, fish products, meat products, milk products, poultry products, and infant formula. Monoglyceride citrate is used to increase effectiveness in lard, shortening, fresh pork sausage, and dried meats at a level not to exceed 0.02%. It is used to increase effectiveness of antioxidants in poultry fats at a level of 0.02%.

Monopotassium, dipotassium and tripotassium citrate, and monosodium, disodium and trisodium citrate are classified as stabilisers when migrating from food-packaging materials.

Potassium citrate is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Potassium citrate can be used as sufficient for purpose in jelly, margarine, meat products, milk and wine. It can be used to acidify margarine or oleomargarine at a level sufficient for purpose. It is used in the production of resinous and polymeric coatings. It can be used as an emulsifying agent in pasteurised process cheese, cheese food and cheese spread at a limit of 3.0%. Its use is limited to 1.4 mg/kg (2 oz per 100 lb) in artificially sweetened fruit jelly, fruit preserves and jam. It is used as a pH control agent and sequestrant in the treatment of citrus wines at a level not to exceed 25 lb per 1000 gallons of wine (~50 mg/L).

Sodium citrate is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Sodium citrate is used as a chelating agent in conjunction with phosphate buffers to prepare non-caking meat-salt mixtures and to provide heat and storage stability in condensed, evaporated and sterile concentrated milks. It can be used to accelerate colour fixing in cured and comminuted poultry or poultry products to replace up to 50% ascorbic acid or sodium ascorbate that is used. It can be used as an emulsifying agent in pasteurised process cheese, cheese food, and cheese spread at a limit of 3.0%. It can be used to acidify margarine or oleomargarine. It is a denuding agent in tripe. It is used in the production of resinous and polymeric coatings. Sodium citrate is limited at a concentration of 10% in solution to spray on the surface of cured cuts of meat prior to packaging. It is limited at 0.1% as a flavour precursor in sour cream and sour half-and-half. Its use is limited to 2oz/100lb (1.4 mg/kg) of artificially sweetened fruit jelly, fruit preserves and jams.

Stearyl citrate is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Stearyl citrate can be used to protect flavour in margarine at 0.15%.

Stearyl monoglyceridyl citrate can be used as an emulsion or stabiliser in or with shortenings containing emulsifiers at a level sufficient for purpose.

Triethyl citrate is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practice. It is used as a flavouring agent, solvent and vehicle and surface-active agent.

TECHNOLOGY OF USE IN FOODS:	Citric acid $pK_1 = 3.14$; $pK_2 = 4.77$; $pK_3 = 6.39$ Citric acid is more hygroscopic than adipic or fumaric acid and can create storage problems in powdered products. Citric acid is compatible with fruit and berry flavours; it imparts a clean, tart taste in hard candies. The salts of citric acid are commonly used as sequestrants. Sodium citrate is added to carbonated beverages to reduce the sharpness of acid taste and it imparts a cool, saline taste and aids in the retention of carbonation.
SYNERGISTS:	Citric acid acts with antioxidants to prevent rancidity by chelating metal ions. Sodium citrate in conjunction with phosphate buffers is used to prepare non-caking meat/salt mixtures.
FOOD SAFETY ISSUES:	LD_{50} (mg/kg body weight) citric acid. Mouse 5040–5790 oral route; 42–960 intravenous route; 961 intraperitoneal route; 2700 subcutaneous route. Rat 11 700 oral route; 725–884 intraperitoneal route; 5500 subcutaneous route. Rabbit 330 intravenous route. LD_{50} (mg/kg body weight) potassium citrate. Dog 167 intravenous route. LD_{50} (mg/kg body weight) sodium citrate. Mouse 44, intravenous route; 1460 intraperitoneal route. Rat 1210 intraperitoneal route. Rabbit 338 intravenous route. Acceptable daily intake for humans of citric acid and its calcium, potassium and sodium salts is not limited.
LEGISLATION:	**USA:** Citric acid: 21 CFR 73.85, 131.111, 131.112, 133.124, 133.125, 133.129, 133.147, 133.169, 133.170, 133.171, 133.173, 133.174, 133.176, 133.178, 133.179, 133.180, Part 145, 146.187, 150.141, 150.161, 161.190, 169.115, 169.140, 169.150, 173.165, 173.280, 184.1033 Ammonium citrate: 21 CFR 175.105, 175.300, 181.29, 184.1140 Calcium citrate: 21 CFR 133.169, 133.173, 133.179, 150.141, 150.161, 155.131 Dipotassium citrate: 21 CFR 181.29 Disodium citrate: 21 CFR 181.29 Ferric ammonium citrate: 21 CFR 184.1296 Ferric citrate: 21 CFR 184.1298 Ferrous citrate: 21 CFR 184.1307c Iron ammonium citrate: 21 CFR 172.430 Isopropyl citrate: 21 CFR 166.110, 184.1386 Magnesium citrate: 21 CFR 175.300 Manganese citrate: 184.1449 Monoglyceride citrate: 21 CFR 172.832

Monopotassium citrate: 21 CFR 133.169, 133.173, 133.179, 150.141, 150.161, 181.29, 184.1625;
Monosodium citrate: 21 CFR 131.112, 131.160, 133.179, 150.141, 150.161, 175.300, 181.29, 184.1751
Potassium citrate: 21 CFR 184.1625
Stearyl citrate: 21 CFR 166.110, 184.1851
Stearyl monoglyceridyl citrate: 21 CFR 172.755
Triethyl citrate: 21 CFR 175.300, 184.1911
Tripotassium phosphate: 21 CFR 181.29
Trisodium phosphate: 21 CFR 181.29

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NAME:	Dehydroacetic acid	
CATEGORY:	pH control agent/Preservatives	
FOOD USE:	Dairy products/Fruit, vegetables and nuts and products	
SYNONYMS:	DHA/DHS/Dehydracetic acid/Methylacetopyronone/Δ lactone/2-Acetyl-5-hydroxy-3-oxo-4-hexenoic acid/ 3-Acetyl-6-methyl-l, 2-pyran-2,4-dione/3-Acetyl-6-methyl-2,4-pyrandione/3-Acetyl-6-methyl-2*H*-pyran-2,4 (3*H*)-dione/3-Acetyl-6-methyl-pyrandione-2,4/CAS 520-45-6	
FORMULA:	$C_8H_8O_4$ (cyclic structure)	
MOLECULAR MASS IN Daltons:	168.16	
ALTERNATIVES FORMS:	Sodium dehydroacetate	
PROPERTIES AND APPEARANCE:	White or nearly white crystalline powder	
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	269.9	
MELTING RANGE IN °C:	109–111	
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	5.8	
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	91.7°C (1 mm)	
PURITY %:	≥98.0	
HEAVY METAL CONTENT MAXIMUM IN ppm:	10	
ARSENIC CONTENT MAXIMUM IN ppm:	3	
ASH MAXIMUM IN %:	0.1	
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:		
in water:	**@ 25°C**	<0.1

in vegetable oil:	**@ 25°C (olive oil)**	1.6
in propylene glycol:	**@ 25°C**	1 g/35 mL

FUNCTION IN FOODS:

Dehydroacetic acid and its sodium salt are GRAS when used in accordance with good manufacturing practices. Dehydroacetic acid is approved as a preservative for cut or peeled squash at levels not to exceed 65 ppm expressed as dehydroacetic acid remaining in or on squash. It is bacteriostatic at concentrations of 0.1–0.4% and fungistatic at concentrations of 0.005–0.1%. It can be used as a component of adhesives with no limitation other than good manufacturing practices. It can also be used as a fungistatic agent in cheese wrappers.

TECHNOLOGY OF USE IN FOODS:

Dehydroacetic acid $pK_1 = 5.27$

Dehydroacetic acid has one of the highest dissociation constants of the organic acids and remains effective at higher pH ranges than other acids.

It is twice as effective as sodium benzoate at pH 5.0 against *Saccharomyces cerevisiae*, and 25 times more effective against *Penicillium glaucum* and *Aspergillus niger*.

FOOD SAFETY ISSUES:

LD_{50} (mg/kg body weight). Rat 1000 oral route.

LEGISLATION:

USA:

Dehydroacetic acid: 21 CFR 172.130, 175.105

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NAME:	Fumaric acid
CATEGORY:	Emulsifiers/Stabilisers/Nutritive additives/Antioxidants/pH control agents/Preservatives/Flavour enhancers and modifiers/Flour and baking additives/Firming agent
FOOD USE:	Baked goods/Dairy products/Edible oils and fats/Meat, poultry and eggs and products/Fruit, vegetables and nuts and products/Beverages/Sugars, sugar preserves and confectionery/Alcoholic drinks
SYNONYMS:	Allomaleic acid/Boletic acid/2-butenedioc acid/Butenedioic acid/Lichenic acid/*trans*-Butenedioic acid/*trans*-1,2-ethylenedicarboxylic acid/(E)-butenedioic acid/(E)-1,2-ethylenedicarboxylic acid/CAS 110-17-8/DOT 9126/NSC-2752/U-1149/USAF EK-P-583
FORMULA:	$HOOC\text{-}(CH)_2\text{-}COOH$
MOLECULAR MASS IN Daltons:	116.07
ALTERNATIVES:	Calcium fumarate; ferrous fumarate; magnesium fumarate; potassium fumarate; sodium fumarate; sodium stearyl fumarate
PROPERTIES AND APPEARANCE:	White granules or crystalline powder
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	290 (sublimes)
MELTING RANGE IN °C:	287
IONISATION CONSTANT AT 25°C:	9.30×10^{-4} 3.62×10^{-5}
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.635 @ 20°/4°C
HEAT OF COMBUSTION AT 25°C:	318.99 kcal/gram molecular weight
PURITY %:	≥99.5
WATER CONTENT MAXIMUM IN %:	0.5
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ARSENIC CONTENT MAXIMUM IN ppm:	3

ASH MAXIMUM IN %:	0.1						
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:							
in water:	**@ 25°C**	0.63	**@ 40°C**	1.07	**@ 60°C**	2.4	**@ 100°C** 9.8
in vegetable oil (olive oil):	**@ 25°C**	Almost insoluble					
in ethanol solution (95%):	**@ 30°C**	5.76					

FUNCTION IN FOODS:

Fumaric acid is used at a level not in excess of the amount reasonably required to accomplish the intended effect. It can be found in pie fillings, refrigerated biscuit doughs, and maraschino cherries. Fumaric acid can be used as a pH control agent to alter the acidity of acidified milk, acidified low-fat milk, acidified skim milk, canned fruit, artificially sweetened fruit jelly, fruit preserves and jam. It increases the strength of gelatin gels and displays some antioxidant properties in fat-containing foods. It blends with certain flavouring compounds to intensify after-taste of a flavour in fruit juices. It is used as a component of adhesives and in the production of resinous and polymeric coatings at levels not to exceed good manufacturing practices. It can be used to accelerate colour fixing in cured, comminuted poultry, poultry products, meat or meat food products at a level of 0.065% (or 1oz/100lb) of the weight of the poultry, poultry by-products, meat or meat by-products before processing. Fumaric acid can be added to grapes after fermentation or in combination with other acids after fermentation to correct deficiencies at levels not to exceed 9 g/L finished wine. The fumaric acid can be added to stabilise wine at levels not to exceed 25 lb per 1000 gallons (~50 mg/L) and acid content of finished wine shall not exceed 3 g/L.

Calcium, ferrous, magnesium, potassium and sodium fumarates are a source of iron in foods and nutrient supplement in infant formula at levels consistent with good nutrition practice.

Sodium stearyl fumarate can be used as a dough conditioner in yeast-leavened bakery products at a level not to exceed 0.5% by weight of flour. It is used as a conditioning agent in dehydrated potatoes and processed cereals for cooking at levels not to exceed 1% by weight, and as a conditioning agent in starch-thickened or flour-thickened foods at levels not to exceed 0.2% by weight of the food. It is used as a stabilising agent in non-yeast-leavened bakery products at a level not to exceed 1% by weight of flour used.

ALTERNATIVES:

Fumaric acid can substitute for tartaric acid in beverages and baking powders and partially replace citric acid in fruit drinks.

TECHNOLOGY OF USE IN FOODS:

Fumaric acid $pK_1 = 3.03$; $pK_2 = 4.44$

Fumaric acid is one of the most acidic of the solid acids. Its low solubility in water limits its widespread use. Its slow rate of moisture absorption aids in extending the shelf-life of powdered products. It can eliminate excessive hardening and rubbery texture in alginate-based desserts.

It is compatible with fruit and berry flavour; imparts a tart metallic taste, and blends well with other acidulants without imparting a `burst' in flavour.

SYNERGISTS: Complements sodium benzoate as a preservative in green foods and fish products.

FOOD SAFETY ISSUES: LD_{50} (mg/kg body weight) fumaric acid. Rat 10 700 oral route.
LD_{50} (mg/kg body weight) disodium fumarate. Rat 3600–4800 oral route.
LD_{50} (mg/kg body weight) sodium fumarate. Rat 8000 oral route.
Acceptable daily intake for humans is limited unconditionally at 0–6 mg/kg body weight and conditionally at 6–10 mg/kg body weight.

LEGISLATION: **USA:**
Fumaric acid: 381.147; 21 CFR 131.111, 150.141, 150.161, 172.350, 175.105, 175.300, 175.320; 176.180; 177.2420
Calcium fumarate: 21 CFR 172.350
Ferrous fumarate: 21 CFR 172.350, 184.1307d
Magnesium fumarate: 21 CFR 172.350
Potassium fumarate: 21 CFR 172.350
Sodium fumarate: 21 CFR 172.350
Sodium stearyl fumarate: 21 CFR 172.826

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NAME:	Glucono-delta-lactone
CATEGORY:	Chelating agents/pH control agents/Preservatives/Flour and baking additives
FOOD USE:	Baked goods/Dairy products/Meat, poultry and eggs and products/Fruit, vegetables and nuts and products
SYNONYMS:	D-gluconic acid-δ-lactone/D-gluconolactone/D-glucono-1,5-lactone
FORMULA:	$C_6H_{10}O_6$ (cyclic structure)
MOLECULAR MASS IN Daltons:	178.14
PROPERTIES AND APPEARANCE:	Fine, white, crystalline powder
MELTING RANGE IN °C:	153 (decomposition)
HEAVY METAL CONTENT MAXIMUM IN ppm:	<0.002
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	59
in ethanol solution:	1
FUNCTION IN FOODS:	Glucono-δ-lactone is GRAS in the USA with no limitation other than good manufacturing practices. Glucono-δ-lactone can be used as a curing and pickling agent, leavening agent, pH control agent, and sequestrant and a binder. It can be used to alter the acidity of acidified milk, acidified low-fat milk, and acidified skim milk, meat and poultry products. It is used as a curing accelerator in cured, comminuted meat or meat food products at a level of 8 oz per 100 lb (~5 mg/kg) of meat or meat by-product where slowly lowered pH will increase the curing rate without shorting the emulsion. It serves as a replacement for bacterial starter cultures in fermented sausages. It is also used as a leavening agent and as a cleaning agent. It can be used as an ingredient in canned green beans and canned wax beans.
TECHNOLOGY OF USE IN FOODS:	Glucono-δ-lactone must undergo hydrolysis to gluconic acid before it can lower pH. Therefore, when used in the manufacture of cheese products the rate of pH is slowed.
FOOD SAFETY ISSUES:	LD_{50} (mg/kg body weight) glucono-δ-lactone. Rabbit 7630 intravenous route.

LEGISLATION:

USA:

Glucono-δ-lactone: 21 CFR 131.111, 155.120, 184.1318

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NAME:	Lactic acid
CATEGORY:	Emulsifiers/Stabilisers/Nutritive additives/pH control agents/Preservatives/Flavour enhancers and modifiers/ Solvents/Flour and baking additives/Humectants
FOOD USE:	Dairy products/Edible oils and fats/Fish and seafood and products/Meat, poultry and eggs and products/ Fruit, vegetables and nuts and products/Sugars, sugar preserves and confectionery/Alcoholic drinks/Vinegar, pickles and sauces
SYNONYMS:	Acetonic acid/Ethylidenelactic acid/Milk acid/1-Hydroxyethane 1-carbonylic acid/1-Hydroxyethane 1-carboxylic acid/2-Hydroxypropanoic acid/2-Hydroxypropionic acid/α-Hydroxypropionic acid/DL mixture CAS 598-82-3/L isomer CAS 79-33-4/D isomer CAS 10326-41-7
FORMULA:	$COOH\text{-}CHOH\text{-}CH_3$
MOLECULAR MASS IN Daltons:	90.08
ALTERNATIVE FORMS:	Butyl lactate; calcium lactate; ferrous lactate; potassium lactate; sodium lactate
PROPERTIES AND APPEARANCE:	Colourless or yellowish, syrupy, non-volatile, hygroscopic liquid
BOILING POINT IN °C AT VARIOUS	122 DL-lactic acid @ 15 mmHg
PRESSURES (INCLUDING 760 mmHg):	103 D-lactic acid @ 15 mmHg
MELTING RANGE IN °C:	52.8 D-lactic acid 16.8 DL-lactic acid 53 L-lactic acid
IONISATION CONSTANT AT 25°C:	8.4×10^{-4} @ 100°C
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.249 @ 15°C 1.2060 @ 21°/4°C (DL-lactic acid)
HEAT OF COMBUSTION AT 25°C:	326.8 kcal/gram molecular weight DL lactic acid
PURITY %:	≥95

HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ARSENIC CONTENT MAXIMUM IN ppm:	3
ASH MAXIMUM IN %:	0.1%
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 25°C** Soluble **@ 100°C** Quickly soluble
in ethanol solution (95%)	**@ 25°C** Almost insoluble
in propylene glycol:	**@ 25°C** Soluble
FUNCTION IN FOODS:	Lactic acid is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Lactic acid is used as an antimicrobial agent, curing and pickling agent, flavouring agent and flavour enhancer, pH control agent, solvent and vehicle, dough conditioner, thickener, and yeast food in bread. It has been used in the manufacture of angel food cake, canned fruits, meat food sticks, meringues, dry milk powders, sausage, canned vegetables, imitation sausages, jams, jellies, sherbets, confectionery products and whipped toppings. Lactic acid can be used to alter the acidity of acidified milk, acidified low-fat milk, acidified skim milk, margarine, oleomargarine, artificially sweetened fruit jelly, fruit preserves and jam, meat products and in brines for pickles and olives at a level sufficient for use. It can also be used to alter the acidity of cold pack cheese food such that the pH does not exceed 4.5, pasteurised process cheese (pH 5.3), cheese food (pH 5.0), cheese spread (pH 4.0), and dry curd cottage cheese (pH 4.5–4.7). It can be used as a sanitising agent on food processing equipment and as an antimicrobial spray on meat carcasses. A mixture of sodium alginate, calcium carbonate, lactic acid and calcium lactate can be used to bind ground and formed raw or cooked poultry pieces at a level not to exceed 1.55% of the product with the combination of lactic acid and calcium lactate at a level not to exceed 0.6% of product. Lactic acid and calcium lactate can be used in a mixture as a binder for restructured meat food products not to exceed a level of 0.3% of the product formulation. Lactic acid is used in the manufacture of hydroxylated lecithin used as an emulsifier. Lactic acid can be added to grapes after fermentation or in combination with other acids after fermentation to correct deficiencies at a level not to exceed 9 g/L in finished wine. It can be added to correct natural acid deficiencies in juice grape wine. Butyl lactate is used as a component of adhesives at levels not to exceed good manufacturing practices. Calcium lactate is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Calcium lactate is a flavour enhancer, flavour agent or adjuvant, leavening agent, nutrient supplement, stabiliser and thickener. It can be used as a firming agent for apple slices and canned grapefruit at a level not to exceed 0.035% calcium by weight of the finished product, and to prevent discoloration

of fruit prior to thermal processing. It is used as a gelling agent in artificially sweetened fruit jelly, preserves, and jam. It ensures clarity in the brine of Spanish olives. It is used in salad dressings and marinades and in baking products. A mixture of sodium alginate, calcium carbonate, lactic acid and calcium lactate can be used to bind ground and formed raw or cooked poultry pieces at a level not to exceed 1.55% of the product with the combination of lactic acid and calcium lactate at a level not to exceed 0.6% of product. It can be used to bind and extend poultry products and is required at a rate of 10% of the binder if rennet-treated, calcium-reduced dried skim milk used or 25% of binder if rennet-treated sodium caseinate is used. Calcium lactate is used to protect flavour in cooked semi-dry and dry products including sausages, imitation sausage and non-specific meat food sticks at a level of 0.6% in product formulation.

Ferrous lactate is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Ferrous lactate can be used as a dietary and nutrient supplement.

Potassium lactate is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Potassium lactate is used as a flavour enhancer, flavouring agent or adjuvant, humectant and pH control agent. It can be used to acidify margarine and oleomargarine at a level sufficient for purpose. It can be used to flavour various poultry and poultry food products at a level not to exceed 2% of formulation.

Sodium lactate is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Sodium lactate is used as a flavour enhancer, flavouring agent or adjuvant, pH control agent, denuding agent, emulsifier, hog scald agent, humectant, lye peeling agent, washing agent and cooked-out juices retention agent. It is used in biscuits, fruits, hog carcasses, meat products, nuts, sponge cake, Swiss roll, vegetables, and bottled water. It can be used to acidify margarine and oleomargarine at a level sufficient for purpose. It is limited in meat products where allowed to 5% of phosphate in pickle at a 10% pump level; and 0.5% of phosphate in product. It is used to flavour various poultry and poultry food products, meat and meat food products at a level not to exceed 2% of the formulation.

TECHNOLOGY OF USE IN FOODS:

Lactic acid $pK_1 = 3.08$

Manufactured in technical, food and USP grade in two concentrations: 50% and 88%.

SYNERGISTS:

Lactic acid acts synergistically with acetic acid as an antimicrobial preservative.

FOOD SAFETY ISSUES:

LD_{50} (mg/kg body weight) lactic acid. Mouse 4875 oral route. Rat 3730 oral route. Guinea pig 1810 oral route.

LD_{50} (mg/kg body weight) ferrous lactate. Mouse 147 oral route.

LD_{50} (mg/kg body weight) sodium lactate. Rat 2000 intraperitoneal route.

Acceptable daily intake for humans of lactic acid is not limited for lactic acid and its calcium, potassium, ammonium and sodium salts and is limited up to 100 mg/kg body weight for DL lactic acid.

Lactic acid and the calcium, potassium and sodium salt should not be used in infant foods and formulas in either the D(−) or DL form; acetic acid may be substituted.

LEGISLATION:

USA:

Lactic acid: 9 CFR 381.129; 21 CFR 131.111, 133.123,133.124, 133.125, 133.129, 133.169, 133.171, 133.173, 133.174, 133.176, 133.178, 133.179, 133.180, 150.141, 150.161, 172.814, 178.1010, 184.1061

Butyl lactate: 21 CFR 175.105

Calcium lactate: 9 CFR 381.129; 21 CFR 145.145, 150.141, 150.161, 184.1207

Ferrous lactate: 21 CFR 184.1311

Potassium lactate: 21 CFR 184.1639

Sodium lactate: 21 CFR 184.1768

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NAME:	Malic acid
CATEGORY:	Antioxidants/pH control agents/Preservatives/Flavour enhancers and modifiers
FOOD USE:	Baked good/Dairy products/Edible oils and fats/Meat, poultry and eggs and products/Fruit, vegetables and nuts and products/Beverages/Soft drinks/Sugars, sugar preserves and confectionery/Alcoholic drinks
SYNONYMS:	Hydroxybutanedioic acid/Hydroxysuccinic acid/Pomalous acid/1-Hydroxy-1,2-ethanedicarboxylic acid/L form CAS 97-67-6/DL form CAS 617-48-1
FORMULA:	HO-CH-(COOH)-CH_2-COOH
MOLECULAR MASS IN Daltons:	134.09
PROPERTIES AND APPEARANCE:	White or nearly white, crystalline powder or granules
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	150 DL-malic acid 140 D- or L-malic acid
MELTING RANGE IN °C:	128 DL-malic acid 100 D- or L-malic acid
IONISATION CONSTANT AT 25°C:	3.9×10^{-4} 7.8×10^{-6}
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.601 (DL-malic acid) 1.595 (D- or L-malic acid) @ 20°/4°C
HEAT OF COMBUSTION AT 25°C IN J/kg:	317.37 (L malic acid)
PURITY %:	≥99
HEAVY METAL CONTENT MAXIMUM IN ppm:	20
ARSENIC CONTENT MAXIMUM IN ppm:	3
ASH MAXIMUM IN %:	0.1

SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:

in water:	**@ 20°C**	55.8 (DL), 36.3 (L)	**@ 25°C**	Very soluble
in ethanol solution (95%)	**@ 20°C**	45.53 DL malic acid	**@ 20°C**	86.60 L malic acid

FUNCTION IN FOODS:

Malic acid is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Malic acid may be used as a flavour enhancer, flavouring agent and adjuvant, and pH control agent. It can be used in sherbets and ices, candies, baked goods, canned fruits, fat, lard, shortening, fruit preserves, jams, jellies, gelatins, puddings, and beverages primarily for flavouring and acidification. Malic acid can be used to alter the acidity of acidified milk, acidified low-fat milk, acidified skim milk, and artificially sweetened fruit jelly, fruit preserves and jam. Maximum levels recommended are 0.8% in gelatin, pudding and fillings, 2.6% in jams and jellies, 3.0% in chewing gum and soft candy, 3.4% in non-alcoholic beverages, 3.5% in processed fruits and fruit juice, 6.9% in hard candy and 0.7% in all other foods to be used in accordance with good manufacturing practices. It is used to increase the effectiveness of antioxidants in poultry fats at a level of 0.01%. It is limited at 0.01% based on total weight in combination with antioxidants in lard and shortening. It can be used in French dressing, mayonnaise and salad dressing at a level not to exceed 25% of the weight of the acids of the vinegar or diluted vinegar calculated as acetic acid. It can be added to grapes prior to fermentation or in combination with other acids to correct deficiencies after fermentation at a level not to exceed 9 g/L. It can also be added to adjust the acidity in apples, apple juice or wine at a level not to exceed 9 g/L of finished wine. It can be used to correct natural acid deficiencies in juice or wine.

ALTERNATIVES:

Malic acid imparts the same degree of acidity as citric acid, but in lower amounts.

TECHNOLOGY OF USE IN FOODS:

Malic acid $pK_1 = 3.4$; $pK_2 = 5.11$

Malic acid does not have the same build-up of acid taste as other acids. It imparts a smooth tart taste with no burst of flavour and is compatible with fruit and berry flavour in hard candies. It provides excellent anti-browning properties in fruits.

The US Internal Revenue Service has specified the addition of malic acid to volatile fruit flavour concentrates containing 6–15% alcohol to render these products non-potable during transportation from manufacturer to winery.

SYNERGISTS:

Malic acid acts synergistically with antioxidants to prevent rancidity.

FOOD SAFETY ISSUES:

LD_{50} (mg/kg body weight) L malic acid. Rat 1600 oral route. Rabbit 5000 oral route.

LD_{50} (mg/kg body weight) sodium malate. Dog 1000 oral route.

Acceptable daily intake for humans of malic acid is not limited for malic acid but is limited at 100 mg/kg for DL malic acid. D and DL malic acids are not to be used in baby foods.

LEGISLATION:

USA:

Malic acid: 21 CFR 131.111, 150.141, 150.161, 169.115, 169.140, 169.150, 184.1069

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NAME:	Phosphoric acid
CATEGORY:	Emulsifiers/Stabilisers/Chelating agents/Nutritive additives/Antioxidants/pH control agents/Preservatives/ Flavour enhancers and modifiers/Flour and baking additives/Anti-caking agents/Firming agents
FOOD USE:	Baked goods/Cereals and cereal products/Dairy products/Edible oils and fats/Fish and seafood and products/ Meat, poultry and eggs and products/Beverages/Soft drinks/Sugars, sugar preserves and confectionery/ Alcoholic drinks/Vinegar, pickles and sauces
SYNONYMS:	Orthophosphoric acid/CAS 7664-38-2/DOT 1805
FORMULA:	$P(OH)_2$-OOH
MOLECULAR MASS IN Daltons:	98.0
ALTERNATIVE FORMS:	Phosphoric acid; ammonium phosphate, dibasic; ammonium phosphate, monobasic; ammonium potassium hydrogen phosphate; ammonium potassium phosphate; calcium glycerophosphate; calcium hexametaphosphate; calcium phosphate, dibasic; calcium phosphate, monobasic; calcium phosphate, tribasic; calcium pyrophosphate; ferric phosphate; ferric pyrophosphate; ferric sodium pyrophosphate; magnesium glycerophosphate; magnesium phosphate, dibasic; magnesium phosphate, monobasic; magnesium phosphate, tribasic; manganese glycerophosphate; potassium glycerophosphate; potassium phosphate, dibasic; potassium phosphate, monobasic; potassium pyrophosphate; potassium tripolyphosphate; sodium acid pyrophosphate; sodium aluminum phosphate; sodium metaphosphate; sodium phosphate, dibasic; sodium phosphate, monobasic; sodium phosphate, tribasic; sodium polyphosphate; sodium pyrophosphate; sodium tripolyphosphate; tetrasodium pyrophosphate
PROPERTIES AND APPEARANCE:	Colourless solution
MELTING POINT IN °C:	42.35
FLASH POINT IN °C	42.4
IONISATION CONSTANT AT 25°C:	7.52×10^{-3} 6.23×10^{-8} 2.2×10^{-13} (@ 18°C)

DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.8741 (100% solution) 1.6850 (85% solution) 1.334 (50% solution) 1.0523 (10% solution)
VAPOUR PRESSURE AT VARIOUS TEMPERATURES:	0.0285 mmHg @ 20°C
PURITY %:	75–85%
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ARSENIC CONTENT MAXIMUM IN ppm:	2
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	Soluble
in ethanol solution:	Soluble
FUNCTION IN FOODS:	Phosphoric acid is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Phosphoric acid can be used to alter the acidity of acidified milk, acidified low-fat milk, and acidified skim milk, margarine and oleomargarine, poultry, meat, and meat food products. It can be used to acidify cold pack cheese food such that the pH of the finished products is not below pH 4.5, pasteurised process cheese food (pH 5.3), pasteurised process cheese food (pH 5.0), pasteurised process cheese spread (pH 4.0) and dry-curd cottage cheese (4.5–4.7). It can be used as a synergist in combination with antioxidants in lard, shortening and poultry fat at a limit of 0.01%. It assists in caramelisation. It can be used as a sanitiser on food processing equipment. Ammonium phosphate, dibasic is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Ammonium phosphate, dibasic can be used as a pH control agent, processing aid, firming agent, and leavening agent. It is found in baked goods, alcoholic beverages, condiments, and puddings. It is used as a yeast nutrient in wine production and to start secondary fermentation of sparkling wines at a level not to exceed 8 lb per 1000 gallons (~16 mg/L). Ammonium phosphate, monobasic is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Ammonium phosphate, monobasic can be used as a pH control agent, and dough strengthener. It is found in baked goods, baking powder, frozen desserts, margarine,

whipped toppings and yeast food. It is used as a yeast nutrient in wine production and to start secondary fermentation of sparkling wines at a level not to exceed 8 lb per 1000 gallons (16 mg/L).

Ammonium potassium hydrogen phosphate can be used as an indirect additive as a component of adhesives intended for use in packaging and in the production of resinous and polymeric coatings in packaging materials.

Ammonium potassium phosphate can be used as an indirect additive in the production of resinous and polymeric coatings in packaging materials.

Calcium glycerophosphate is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Calcium glycerophosphate can be used as a dietary and nutrient supplement. It is found in gelatins, puddings and fillings. It can be used as an indirect additive in the production of resinous and polymeric coatings in packaging materials.

Calcium hexametaphosphate is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Calcium hexametaphosphate is used as a sequestrant.

Calcium phosphate, dibasic is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Calcium phosphate, dibasic is used as a dietary and nutrient supplement, dough conditioner, stabiliser, yeast food in baked foods, cereal products, and dessert gels. It can be used as an indirect additive in the production of resinous and polymeric coatings in packaging materials.

Calcium phosphate, monobasic is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Calcium phosphate, monobasic is used as a dietary and nutrient supplement, dough conditioner, firming agent, leavening agent, sequestrant, stabiliser, yeast food in cereals, and dough. It can be used as an acidulant in baking powders and wheat flours or as a mineral supplement for foods. It can be used in artificially sweetened fruit jelly, fruit preserves and jams as a gelling agent. It is limited in bread, rolls and buns to not more than 0.75 part for each 100 parts by weight of flour used. It can be used as an indirect additive in the production of resinous and polymeric coatings in packaging materials.

Calcium phosphate, tribasic is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Calcium phosphate, tribasic can be used as a dietary supplement, nutrient, stabiliser in cereals, desserts, flour, lard, and dry vinegar. It can be used in clarifying sugar syrups and as an anti-caking agent in table salt. It can be used to preserve colour during dehydration processing in mechanically deboned chicken to be dehydrated at a level not to exceed 2% of the mechanically deboned chicken prior to dehydration. It can be used as an aid in rendering animal fats. It can be used as an indirect additive in the production of resinous and polymeric coatings in packaging materials.

Calcium pyrophosphate is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Calcium pyrophosphate can be used as a dietary and nutrient supplement.

Ferric phosphate is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. It is used as a dietary and nutrient supplement.

Ferric pyrophosphate is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Ferric pyrophosphate can be used as a dietary and nutrient supplement.

Ferric sodium pyrophosphate is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Ferric sodium pyrophosphate is used as a dietary supplement.

Magnesium glycerophosphate can be used as a stabiliser when migrating from food packaging material. It can be used as an indirect additive in the production of resinous and polymeric coatings in packaging materials.

Magnesium phosphate, dibasic is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Magnesium phosphate, dibasic is used as a pH control agent and a dietary and nutrient supplement. It can be used as an indirect additive in the production of resinous and polymeric coatings in packaging materials.

Magnesium phosphate, monobasic can be used as an indirect additive in the production of resinous and polymeric coatings in packaging materials.

Magnesium phosphate, tribasic is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Magnesium phosphate, tribasic is used as a pH control agent, stabiliser and nutrient supplement. It can be used as an indirect additive in the production of resinous and polymeric coatings in packaging materials.

Manganese glycerophosphate is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Manganese glycerophosphate can be used as a dietary supplement.

Potassium glycerophosphate is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Potassium glycerophosphate can be used as a dietary supplement and as a stabiliser when migrating from food packaging material.

Potassium phosphate, dibasic is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Potassium phosphate, dibasic can be used as a sequestrant in the preparation of non-dairy powdered coffee creamers. It is used as an emulsifier in pasteurised process cheese, cheese food, and cheese spread at a level not to exceed 3.0% of the weight of the finished products. It can be used to decrease the amount of cooked-out juices in meat food products at a level of 5% of phosphate in pickle, at 10% in pump level, and 0.5% of phosphate in product only (clear solution may be injected into product) or in poultry at a limit of 0.5% of total poultry product. It can be used to remove feathers from poultry carcasses.

Potassium phosphate, monobasic is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Potassium phosphate, monobasic can be used to decrease the amount of cooked-out juices in meat food products at a level of 5% of phosphate in pickle, at 10% in pump level, and 0.5% of phosphate in product only (clear solution may be injected into product) or in poultry at a limit of 0.5% of total poultry product.

Potassium pyrophosphate can be used to decrease the amount of cooked-out juices in meat food products at a level of 5% of phosphate in pickle, at 10% in pump level, and 0.5% of phosphate in product only (clear solution may be injected into product) or in poultry at a limit of 0.5% of total poultry product.

Potassium tripolyphosphate is used as a boiler water additive. It can be used to decrease the amount of cooked-out juices in meat food products at a level of 5% of phosphate in pickle, at 10% in pump level, and 0.5% of phosphate in product only (clear solution may be injected into product) or in poultry at a limit of 0.5% of total poultry product.

Sodium acid pyrophosphate is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Sodium acid pyrophosphate is used as an emulsifier in pasteurised process cheese, cheese food, and cheese spread at a level not to exceed 3.0% of the weight of the finished products. It can be used as a sequestrant. It can be used as a curing accelerator to accelerate colour fixing in frankfurters, wieners, Vienna, bologna, garlic bologna, knockwurst and similar products not to exceed alone or in combination with other curing accelerators 8 oz per 100 lb (~5 mg/kg) of meat or meat and meat by-products nor 0.5% in finished product. It can be used to decrease the amount of cooked-out juices in meat food products at a level of 5% of phosphate in pickle, at 10% in pump level, and 0.5% of phosphate in product only (clear solution may be injected into product) or in poultry at a limit of 0.5% of total poultry product. It can be used to remove hair from hog carcasses and feathers from poultry carcasses.

Sodium aluminum phosphate is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Sodium aluminum phosphate can be used as an emulsifier in pasteurised process cheese, cheese food, and cheese spread at a level not to exceed 3.0% of the weight of the finished products.

Sodium metaphosphate (hexametaphosphate) is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Sodium metaphosphate is used as a starch modifying agent, sequestrant and texturiser. It is used in fish, lima beans, peanuts and canned peas. It is used as an emulsifier in pasteurised process cheese, cheese food, and cheese spread at a level not to exceed 3.0% of the weight of the finished products. It is used as a stabiliser and thickener in French dressing. It can be used in artificially sweetened fruit jelly, fruit preserves and jam at a level not to exceed 8 oz per 100 lb (~5 mg/kg) of the finished food. In meat food products it can be used in combination with sodium tripolyphosphate to protect flavour in fresh beef, beef for further cooking, cooked beef, beef patties, meat loaves, meat toppings and similar products derived from pork, lamb, veal, mutton and goat meat which are cooked or frozen after processing at a level not to exceed 0.5% of total product. It can be used to decrease the amount of cooked-out juices in meat food products at a level of 5% of phosphate in pickle, at 10% in pump level, and 0.5% of phosphate in product only (clear solution may be injected into product) or in poultry at a limit of 0.5% of total poultry product. It can be used to remove hair from hog carcasses. It is an indirect additive when migrating to food from paper and paperboard products.

Sodium phosphate, dibasic is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Sodium phosphate, dibasic can be used as a boiler water additive, sequestrant, texturiser, a dietary and nutrient supplement and buffer in coffee whiteners, cream sauce, evaporated milk, instant pudding and whipped products. It is used as an emulsifier in pasteurised process cheese, cheese food, and cheese spread at a level not to exceed 3.0% of the weight of the finished products. It can be used in artificially sweetened fruit jelly, fruit preserves and jam at a level not to exceed 2 oz per 100 lb (~1 mg/kg) of the finished food. It can be used to decrease the amount of cooked-out juices in meat food products at a level of 5% of phosphate in pickle, at 10% in pump level, and 0.5% of phosphate in product only (clear solution may be injected into product) or in poultry at a limit of 0.5% of total poultry product. It can be used to remove hair from hog carcasses and feathers from poultry carcasses. It can be used as an indirect additive in the production of resinous and polymeric coatings in packaging materials.

Sodium phosphate, monobasic is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Sodium phosphate, monobasic can be used as a boiler water additive, a sequestrant, dietary and nutrient supplement. It is used as an emulsifier in pasteurised process cheese at a level not to exceed 3.0% of the weight of finished products. It can be used in artificially sweetened fruit jelly, fruit preserves and jam at a level not to exceed 2 oz per 100 lb (~1 mg/kg) of the finished food. It can be used to decrease the amount of cooked-out juices in meat food products at a level of 5% of phosphate in pickle, at 10% in pump level, and 0.5% of phosphate in product only (clear solution may be injected into product) or in poultry at a limit of 0.5% of total poultry product. It can be used to remove feathers from poultry carcasses at a level sufficient for use. It can be used in the production of resinous and polymeric coatings and as a stabiliser when migrating from packaging materials.

Sodium phosphate, tribasic is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Sodium phosphate, tribasic is used as a boiler water additive, sequestrant, buffer, and dietary and nutrient supplement. It is used in cereals and evaporated milk. It is used as an emulsifier in pasteurised process cheese, cheese food, and cheese spread at a level not to exceed 3.0% of the weight of the finished products. It can be used in artificially sweetened fruit jelly, fruit preserves and jam at a level not to exceed 2 oz per 100 lb (~1 mg/kg) of the finished food. It is a denuding agent in tripe at a level sufficient for purpose. It can be used to remove hair from hog carcasses and feathers from poultry carcasses. It can be used in the production of resinous and polymeric coatings and as a stabiliser when migrating from packaging materials. It can be used as an aid in rendering animal fats.

Sodium polyphosphate can be used in combination with sodium tripolyphosphate and sodium metaphosphate to protect flavour in fresh beef, beef for further cooking, cooked beef, beef patties, meat loaves, meat toppings and similar products derived from pork, lamb, veal, mutton and goat meat which are cooked or frozen after processing at a level not to exceed 0.5% of total product. It can be used to decrease the amount of cooked-out juices

in meat food products at a level of 5% of phosphate in pickle, at 10% in pump level, and 0.5% of phosphate in product only (clear solution may be injected into product) or in poultry at a limit of 0.5% of total poultry product.

Sodium pyrophosphate is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Sodium pyrophosphate can be used as a sequestrant. It can be used to decrease the amount of cooked-out juices in meat food products at a level of 5% of phosphate in pickle, at 10% in pump level, and 0.5% of phosphate in product only (clear solution may be injected into product) or in poultry at a limit of 0.5% of total poultry product. It can be used to remove hair from hog carcasses and feathers from poultry carcasses. It can be used as an indirect additive in the production of resinous and polymeric coatings in packaging materials.

Sodium tripolyphosphate is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Sodium tripolyphosphate is used as a sequestrant, texturiser used in angel food cake mix, desserts, gelling juices, canned ham, lima beans, meringues and canned peas. In meat food products it can be used alone or in combination with sodium metaphosphate and sodium polyphosphate to protect flavour in fresh beef, beef for further cooking, cooked beef, beef patties, meat loaves, meat toppings and similar products derived from pork, lamb, veal, mutton and goat meat which are cooked or frozen after processing at a level not to exceed 0.5% of total product. It can be used to decrease the amount of cooked-out juices in meat food products at a level of 5% of phosphate in pickle, at 10% in pump level, and 0.5% of phosphate in product only (clear solution may be injected into product) or in poultry at a limit of 0.5% of total poultry product. It can be used to remove hair from hog carcasses and feathers from poultry. It can be used as a substance migrating to food from paper and paperboard products.

Tetrasodium pyrophosphate is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Tetrasodium pyrophosphate can be used as a sequestrant and boiler water additive. It is used as an emulsifier in pasteurised process cheese, cheese food, and cheese spread at a level not to exceed 3.0% of the weight of the finished products. It can be used to remove feathers from poultry carcasses at a level sufficient for use. It is used as a substance when migrating to food from cotton and cotton fabrics used in dry packaging and can be used as an indirect additive in the production of resinous and polymeric coatings in packaging materials.

TECHNOLOGY OF USE IN FOODS: Phosphoric acid $pK_1 = 2.12$; $pK_2 = 7.21$; $pK_3 = 12.67$

SYNERGISTS: Phosphoric acid increases the effectiveness of antioxidants in lard and shortening.

FOOD SAFETY ISSUES: LD_{50} (mg/kg body weight) phosphoric acid. Rat 1530 oral route.

Acceptable daily intake for humans of phosphoric acid is up to 70 mg/kg body weight.

LEGISLATION:

USA:

Phosphoric acid: 21 CFR 131.111, 133.124, 133.129, 133.169, 133.173, 133.179, 178.1010, 182.1073
Ammonium phosphate, dibasic: 21 CFR 184.1141b
Ammonium phosphate, monobasic: 21 CFR 184.1141a
Ammonium potassium hydrogen phosphate: 21 CFR 175.105, 175.300, 181.29
Ammonium potassium phosphate: 21 CFR 175.300
Calcium glycerophosphate: 21 CFR 175.300, 181.29, 184.1201
Calcium hexametaphosphate: 21 CFR 182.6203
Calcium phosphate, dibasic: 21 CFR 175.300, 181.29, 182.1217, 182.8217
Calcium phosphate, monobasic: 21 CFR 150.141, 150.161, 175.300, 181.29, 182.1217, 182.6215, 182.8217
Calcium phosphate, tribasic: 21 CFR 175.300, 182.1217, 182.8217
Calcium pyrophosphate: 21 CFR 182.8223
Ferric phosphate: 21 CFR 184.1301
Ferric pyrophosphate: 21 CFR 184.1304
Magnesium glycerophosphate: 21 CFR 175.300, 181.29
Magnesium phosphate, dibasic: 21 CFR 175.300, 181.29, 184.1434
Magnesium phosphate, monobasic: 21 CFR 175.300, 181.29,
Magnesium phosphate tribasic: 21 CFR 175.300, 184.1434
Potassium phosphate, dibasic: 21 CFR 133.169, 133.173, 133.179, 182.6285
Potassium tripolyphosphate: 21 CFR 173.310
Sodium acid pyrophosphate: 21 CFR 133.169, 133.173, 133.179, 182.1087
Sodium aluminum phosphate: 21 CFR 133.169, 133.173, 133.179, 182.1781
Sodium metaphosphate: 21 CFR 133.169, 133.173, 133.179, 150.141, 150.161, 169.115, 182.90, 182.6760, 182.6769
Sodium phosphate, dibasic: 21 CFR 133.169, 133.173, 133.179, 150.141, 150.161, 173.310, 175.300, 182.1778, 182.6290, 182.6778, 182.8778
Sodium phosphate, monobasic: 21 CFR 133.169, 133.173, 133.179, 150.141, 150.161, 173.310, 182.1778, 182.6085, 182.8778
Sodium phosphate, tribasic: 21 CFR 133.169, 133.173, 133.179, 150.141, 150.161, 173.310, 182.1778, 182.6778, 182.8778
Sodium tripolyphosphate: 21 CFR 173.310, 182.1810, 182.90, 182.6810
Tetrasodium pyrophosphate: 21 CFR 133.169, 133.173, 133.179, 173.310, 181.29, 182.70, 182.6787, 182.6789

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NAME:	Propionic acid
CATEGORY:	Antioxidants/pH control agents/Preservatives/Flavour enhancers and modifiers
FOOD USE:	Baked goods/Dairy products/Meat, poultry and eggs and products/Beverages/Sugars, sugar preserves and confectionery
SYNONYMS:	Carboxyethane/Ethane carboxylic acid/Ethylformic acid/Metacetonic acid/Methylacetic acid/Propanoic acid/Prozoin/Pseudoacetic acid/CAS 79-09-4/DOT 1848
FORMULA:	CH_3-CH_2-COOH
MOLECULAR MASS IN Daltons:	74.08
ALTERNATIVE FORMS:	Calcium propionate; dilauryl thiopropionic acid; potassium propionate; sodium propionate; thiopropionic acid
PROPERTIES AND APPEARANCE:	Oily liquid (propionic acid) White, free-flowing powder (salts)
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	4.6 (1 mmHg) 85.8 (100 mmHg) 122.0 (400 mmHg) 141.1 (760 mmHg)
MELTING POINT IN °C:	−21.5
FLASH POINT IN °C:	58
IONISATION CONSTANT AT 25°C:	1.34×10^{-5}
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	0.99336 @ 20°/4°C 0.998 @ 15°/4°C
HEAT OF COMBUSTION AT 25°C:	365.03 kcal/gram molecular weight
VAPOUR PRESSURE AT VARIOUS TEMPERATURES:	4.6°C (1 mmHg) 39.7°C (10 mmHg) 65.8°C (40 mmHg) 85.8°C (100 mmHg)

	122.0°C (400 mmHg) 141.1°C (760 mmHg)
PURITY %:	≥99.5
WATER CONTENT MAXIMUM IN %:	0.15
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ARSENIC CONTENT MAXIMUM IN ppm:	3
ASH MAXIMUM IN %:	0.01
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 100°C** Sodium salt, 150 **@ 100°C** Calcium salt, 58.8
in vegetable oil:	**@ 25°C** Soluble
in ethanol solution (95%)	**@ 25°C** Sodium propionate, 4 **@ 25°C** Calcium propionate, insoluble
FUNCTION IN FOODS:	Propionic acid is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Propionic acid can be used as a flavouring agent and as an antifungal agent to control mould growth on the surface of cheese and buffer and inhibits rope formation in baked goods. Maximum levels recommended are 0.3% in cheese products, 0.32% in flour and in white bread and rolls, 0.38% in whole wheat products. Calcium propionate is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Calcium propionate can be used as an antimycotic agent when migrating from food packaging material for cold-pack cheese or cheese food, pasteurised process cheese or cheese food, and pasteurised process cheese spread at a level not to exceed 0.3% alone or in combination with sodium propionate. It is used as an antifungal agent to control mould growth on the surface of cheese and butter and inhibits rope formation in baked goods. It can be used in confections and frostings, gelatins, puddings fillings, jams and jellies. Maximum levels recommended for use as a preservative are 0.3% alone or in combination with sodium propionate based on the weight of the flour used in the fresh pie dough, cold pack cheese, pasteurised process cheese food, pasteurised process cheese spread, 0.32% alone or in combination with sodium propionate based on the weight of the flour in pizza crust, and 0.1% by weight of artificially sweetened fruit jelly, fruit preserves and jams. It is not limited in bread, rolls or buns. It can be used as a yeast nutrient.

Dilauryl thiopropionic acid is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Dilauryl thiopropionic acid is used as a chemical preservative when the total content of antioxidants does not exceed 0.02% of the fat or oil content.

Potassium propionate is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Potassium propionate is used as an antifungal agent to control mould growth on the surface of cheese and butter and inhibits rope formation in baked goods. It can be used in baked goods, non-alcoholic beverages, soft candy, cheese, frostings, confections, fresh pie, fillings, gelatins, jams, jellies, meat products, pizza crust, and puddings.

Sodium propionate is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Sodium propionate can be used as a flavouring agent and an antimycotic agent when migrating from food packaging material for cold-pack cheese or cheese food, pasteurised process cheese or cheese food, and pasteurised process cheese spread at a level not to exceed 0.3% alone or in combination with calcium propionate. It is used as an antifungal agent to control mould growth on the surface of cheese and butter and inhibits rope formation in baked goods. It can be used in baked goods, non-alcoholic beverages, cheeses, confections and frostings, gelatins, puddings, fillings, jams and jellies, meat products and soft candy. Maximum levels recommended for use as a preservative are 0.3% alone or in combination with calcium propionate based on the weight of the flour used in the fresh pie dough, cold pack cheese, pasteurised process cheese food, and pasteurised process cheese spread, 0.32% alone or in combination with calcium propionate based on the weight of the flour in pizza crust, 0.1% by weight of artificially sweetened fruit jelly, preserves and jams. It is not limited in bread, rolls or buns.

Thiodipropionic acid is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Thiodipropionic acid is used as a chemical preservative when the total content of antioxidants does not exceed 0.02% of the fat or oil content.

TECHNOLOGY OF USE IN FOODS:

Propionic acid $pK_1 = 4.87$

Propionic acid has a pungent sour odour and taste, and is limited in use by its sensory properties.

The salts of propionic acid have a slight cheese-like flavour. The sodium salt is more soluble than the calcium form. The salts are readily incorporated into powdered mixes.

Propionates may be added to bread dough without interfering with leavening since there is little or no effect on yeast growth. Sodium propionate is recommended for use in chemically leavened products since calcium interferes in the leavening action. Calcium propionate is preferred for use in bread and rolls because calcium propionate contributes to the enrichment of the product.

FOOD SAFETY ISSUES:

LD_{50} (mg/kg body weight) of propionic acid. Mouse 625 intravenous route. Rat 2600–3500 oral route.

LD_{50} (mg/kg body weight) calcium propionate. Rat 3340 oral route; 580–1020 intravenous route.

LD_{50} (mg/kg body weight) sodium propionate. Mouse 2100 subcutaneous route. Rat 5100 oral route; 1380–3200 intravenous route. Rabbit 1640 cutaneous route.

Acceptable daily intake for humans of propionic acid and its calcium, potassium and sodium salts is not limited.

LEGISLATION:

USA:

Propionic acid: 21 CFR 172.515, 184.1081

Calcium propionate: 9 CFR 318.7, 381.147; 21 CFR 133.123, 133.124, 133.169, 133.173, 133.179, 136.110, 136.115, 136.130, 136.160, 136.180, 150.141, 150.161, 181.23, 184.1081, 184.1221

Dilauryl thiopropionic acid: 21 CFR 182.3109, 182.3280

Potassium propionate: 9 CFR 318.7, 381.147

Sodium propionate: 9 CFR 318.7; 21 CFR 133.123, 133.124, 133.169, 133.173, 133.179, 150.141, 150.161, 181.23, 184.1784

Thiodipropionic acid: 21 CFR 181.24, 182.3109

Thiopropionic acid: 21 CFR 182.3280

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NAME:	Sodium diacetate
CATEGORY:	Chelating agents/pH control agents/Preservatives/Flavour enhancers and modifiers
FOOD USE:	Baked goods/Dairy products/Edible oils and fats/Meat, poultry and eggs and products/Sugars, sugar preserves and confectionery
SYNONYMS:	Dykon/Sodium acid acetate/Sodium hydrogen diacetate/CAS 126-96-5
FORMULA:	CH_3-COONa-CH_3-COOH · xH_2O
MOLECULAR MASS IN Daltons:	142.09, anhydrous
ALTERNATIVE FORMS:	Calcium diacetate
PROPERTIES AND APPEARANCE:	White, hygroscopic crystalline solid
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	235
MELTING POINT IN °C:	58
PURITY %:	≥39 to ≤41 acetic acid; ≥58 to ≤60 sodium acetate
WATER CONTENT MAXIMUM IN %:	≤2
HEAVY METAL CONTENT MAXIMUM IN ppm:	≤10
ARSENIC CONTENT MAXIMUM IN ppm:	≤3
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 25°C** 100
FUNCTION IN FOODS:	Sodium diacetate is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Sodium diacetate can be used as a preservative in butter and wrapping materials, pH control agent, flavouring agent and adjuvant. It inhibits bread mould and rope-forming bacteria in bakery products and has little effect on baker's yeast. It delays mould growth in cheese spreads at concentrations

of 0.1–2% and in malt syrups at 0.5%. Maximum levels recommended are 0.05% in snack foods, soup, and soup mixes (commercial), 0.1% in fats, oils, soft candy, and meat products, 0.25% in gravies and sauces, and up to 0.4% in baked goods and baking mixes.

Calcium diacetate is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. It is used as a sequestrant, preservative, pH control agent, flavouring agent and adjuvant.

TECHNOLOGY OF USE IN FOODS:

Sodium diacetate $pK_1 = 4.75$

Effective at pH of 3.5–4.5 to control mould growth in animal feed and silage.

FOOD SAFETY ISSUES:

Acceptable daily intake for humans of sodium diacetate is limited conditionally up to 15 mg/kg body weight.

LEGISLATION:

USA:
Sodium diacetate: 21 CFR 184.1754
Calcium diacetate: 21 CFR 182.6197

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NAME:	Succinic acid
CATEGORY:	pH control agents/Preservatives/Flavour enhancers and modifiers/Flour and baking additives
FOOD USE:	Baked goods/Dairy products/Edible oils and fats/Meat, poultry and eggs and products/Beverages/Sugars, sugar preserves and confectionery/Vinegar, pickles and sauces
SYNONYMS:	Amber acid/Butanedioic acid/Ethylenesuccinic acid/1,2-Ethanedicarboxylic acid/1,4-Butanedioic acid/CAS 110-15-6
FORMULA:	$HOOC\text{-}(CH_2)_2\text{-}COOH$
MOLECULAR MASS IN Daltons:	118.09
ALTERNATIVE FORMS:	Succinic acid, diethyl ester; succinic anhydride
PROPERTIES AND APPEARANCE:	Colourless or white crystals
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	235 (decomposition)
MELTING RANGE IN °C:	185–190
IONISATION CONSTANT AT 25°C:	6.89×10^{-5} 2.47×10^{-6}
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.564 @ 20°/4°C 1.572 @ 25°/4°C
HEAT OF COMBUSTION AT 25°C:	356.36 kcal/gram molecular weight
PURITY %:	$\geq$90.0
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ARSENIC CONTENT MAXIMUM IN ppm:	3

ASH MAXIMUM IN %:	0.025
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 25°C** 7.7 **@ 100°C** 100
in ethanol solution:	1 g/100 mL
in propylene glycol:	1 g/18.5 mL
FUNCTION IN FOODS:	Succinic acid is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Succinic acid is a flavour enhancer and pH control agent. It can be used to alter the acidity of acidified milk, acidified low-fat milk, and acidified skim milk. It readily combines with proteins in modifying the plasticity of doughs and aids in the production of edible fats with desired thermal properties. It is used in gelatin desserts and cake flavourings. It is also used as a component of polymeric resins. Maximum levels recommended are 0.0061% in meat, 0.084% in condiments and relishes, and 2.6% in jams and jellies. Succinic acid, diethyl ester is used as a flavouring agent with no limitation other than good manufacturing practices. Succinic anhydride is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Succinic anhydride is used as a dehydrating agent for the removal of moisture from foods and it imparts stability to dry mixes. It also aids in the controlled release of carbon dioxide during leavening. It is used in the esterification of food starch at a level not to exceed 4%. Sodium dioctyl sulphosuccinate can be used as a flavouring agent in dry beverage mixes not to exceed 75 parts per million of the finished beverage. It can also be used as a stabiliser in evaporated milk, cottage cheese, cream cheese, pasteurised Neufchatel. It can also be used as a wetting agent and in paper and paperboard used in food grade packaging.
TECHNOLOGY OF USE IN FOODS:	Succinic acid $pK_1 = 4.16$; $pK_2 = 5.61$ Succinic acid is odourless and has a slightly bitter and acid taste. It is non-hygroscopic with a slow taste build-up. It can extend the shelf-life of dessert powders, without damaging flavour.
FOOD SAFETY ISSUES:	LD_{50} (mg/kg body weight) succinic acid. Rat 2260 oral route. Acceptable daily intake for humans of succinic acid is not limited.
LEGISLATION:	**USA:** Succinic acid: 21 CFR 131.111, 184.1091 Succinic acid, diethyl ester: 21 CFR 172.515 Succinic anhydride: 21 CFR 175.300 Dioctyl sodium sulfosuccinate: 21 CFR 131.130, 133.133, 133.162, 133.178, 172.83, 172.520, 172.810, 176.170, 176.180

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NAME:	Tartaric acid
CATEGORY:	Emulsifiers/Stabilisers/Chelating agents/pH control agents/Preservatives/Flavour enhancers and modifiers/ Flour and baking additives/Anti-caking agents/Firming agents/Humectants
FOOD USE:	Baked goods/Dairy products/Edible oils and fats/Fish and seafoods and products/Meat, poultry and eggs and products/Fruit, vegetables and nuts and products/Beverages/Soft drinks/Sugars, sugar preserves and confectionery/Alcoholic drinks
SYNONYMS:	Dihydroxybutanedioic acid/2,3-Dihydroxybutanedioic acid/2,3-Dihydroxysuccinic acid/ *d*-α,β-Dihydroxysuccinic acid/L form CAS 87-69-4
FORMULA:	$HOOC\text{-}(CHOH)_2\text{-}COOH$
MOLECULAR MASS IN Daltons:	150.09
ALTERNATIVE FORMS:	Diethyl tartrate; potassium acid tartrate; potassium bitartrate; sodium potassium tartrate; sodium tartrate
PROPERTIES AND APPEARANCE:	Colourless to translucent crystals, or a white, fine to granular crystalline powder
MELTING RANGE IN °C:	168–170
IONISATION CONSTANT AT 25°C:	1.04×10^{-3} 4.55×10^{-5}
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.7598 @ 20°/4°C
HEAT OF COMBUSTION AT 25°C:	275.1 kcal/gram molecular weight 274.7 kcal/gram molecular weight (L form) 272.6 kcal/gram molecular weight (D, L anhydrous form)
PURITY %:	≥99.7
WATER CONTENT MAXIMUM IN %:	0.5
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ARSENIC CONTENT MAXIMUM IN ppm:	3

ASH MAXIMUM IN %: 0.05

SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:

in water: **@ 0°C** 115 **@ 10°C** 126 **@ 20°C** 139 **@ 30°C** 156 **@ 40°C** 176 **@ 50°C** 195
@ 60°C 217 **@ 70°C** 244 **@ 80°C** 273 **@ 90°C** 307 **@ 100°C** 343

in ethanol solution: 1 g/3 mL

FUNCTION IN FOODS: Tartaric acid is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. Tartaric acid is used as a firming agent, flavour enhancer, flavouring agent, humectant, sequestrant, and pH control agent. It is used to alter the acidity of acidified milk, acidified low-fat milk, acidified skim milk, margarine, oleomargarine, meat and poultry products, artificially sweetened fruit jelly, fruit preserves and jams. It can be used in fruit jams, jellies, preserves, sherbets, grape-flavoured beverages, and canned fruits. It can be used as a dip (1–3%) for meat carcasses to lower microbial populations. Tartaric acid salts are used to control the degree of acidity in soft drinks and as a flavour enhancer, particularly in lime and grape-flavoured beverages. Tartaric acid can be used to reduce the pH of wine or juice, but not below pH 3.0. It can be added prior to fermentation of grapes or in combination with other acids after fermentations to correct deficiencies at a level not to exceed 9 g/L finished wine. It can be used to correct natural acid deficiencies in grape juice/wine and to reduce the pH value where ameliorating material is used in the production of grape wine.

Potassium acid tartrate (cream of tartar) is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. It can be used as an anti-caking and leavening agent, antimicrobial or pH control agent, formulation and processing aid, humectant, stabiliser and thickener and surface-active agent. It is used in baked goods, candy, crackers, confections and frostings, gelatins and puddings, jams, jellies, and margarine. Its use is limited in wine at 25 lb/1000 gallons (*ca*. 50 mg/kg). It is limited at 2 oz/100 lb (*ca*. 1 mg/kg) of finished product or artificial sweetened fruit jelly, preserves and jam.

Potassium bitartrate can be used to stabilise grape wine at a level not to exceed 35lb/1000 gallons (*ca*. 70 mg/kg) of grape wine.

Sodium potassium tartrate is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. It acts as a pH control agent, and sequestrant in cheese, jams, jellies and margarine. It is limited as an emulsifier at a level not to exceed 3.0% of pasteurised process cheese, cheese food and cheese spread. It is limited at 2 oz/100 lb (*ca*. 1 mg/kg) of finished product or artificial sweetened fruit jelly, preserves and jam.

Sodium tartrate is GRAS for miscellaneous and general-purpose usage in the USA with no limitation other than good manufacturing practices. It functions as a pH control agent in fats, oils, jams and jellies. It is limited as

an emulsifier at a level not to exceed 3.0% of pasteurised process cheese, cheese food and cheese spread. It is limited at 2 oz/100 lb (*ca*. 1 mg/kg) of finished product of artificial sweetened fruit jelly, fruit preserves and jam.

TECHNOLOGY OF USE IN FOODS:

Tartaric acid $pK_1 = 2.98$; $pK_2 = 4.34$

Tartaric acid has a sharp or bitter tart taste and is the most soluble of all acidulants.

When blended with citric acid, tartaric acid contributes tartness to sour apple and wild cherry flavours.

SYNERGISTS:

Tartaric acid acts with antioxidants to prevent rancidity.

FOOD SAFETY ISSUES:

LD_{50} (mg/kg body weight) tartaric acid. Mouse 4960 oral route; 485 intravenous route. Rat 3310–3530 oral route. Dog 5000 oral route.

Acceptable daily intake for humans of L tartaric acid and its potassium and sodium salt is limited conditionally up to 30 mg/kg body weight.

LEGISLATION:

USA:
Tartaric acid: 21 CFR 131.111, 150.141, 150.161, 184.1099
Potassium acid tartrate: 21 CFR 150.141, 150.161, 184.1077
Potassium bitartrate: 21 CFR 184.1077
Sodium potassium tartrate: 21 CFR 133.169, 133.173, 133.179, 150.141, 150.161, 184.1804
Sodium tartrate: 21 CFR 133.169, 133.173, 133.179, 150.141, 150.161, 184.1801

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Part 2

Antioxidants

Fereidoon Shahidi and P.K.J.P.D. (Janitha) Wanasundara

Food Additives Data Book, Second Edition. Edited by Jim Smith and Lily Hong-Shum.

NAME:	Ascorbic acid and isomers (L-ascorbic acid and erythorbic acid)	
CATEGORY:	Antioxidant/Sequestrant/Reducing agent	
FOOD USE:	Fruit juices/Carbonated beverages/Wine/Beer/Frozen fruits/Canned fruits and vegetables/Sausages/Cured meats/Milk powder/Citrus oils	
SYNONYMS:	L-Ascorbic acid: Ascorbic acid (INCI)/1-Ascorbic acid/Cetivamin/Cevitamic acid/3-Keto-L-gulofuranolactone/1-3-Ketothreohexuronic/acid lactone/L-Lyxoascorbic acid/3-Oxo-1-gulofuranolactone/Vitamin C/1-Xyloascorbic acid Erythorbic acid: Araboascorbic acid/D-Araboascorbic acid/D-2,3-Didehydroerythro-hexono-1,4-lactone/Erycorbin/D-Erythorbic acid/D-Erythro-ascorbic acid/D-Erythro-hex-2-enonic acid, γ-lactone/D-Erythro-3-ketohexonic acid lactone	
FORMULA:	$C_6H_8O_6$	
MOLECULAR MASS IN Daltons:	176.13	
ALTERNATIVE FORMS:	L-Ascorbic acid: sodium ascorbate; calcium ascorbate Erythorbic acid: sodium erythorbate	
PROPERTIES AND APPEARANCE:	Both are white or slightly yellow crystalline powders	
MELTING RANGE IN °C:	L-Ascorbic acid: 190–192, with decomposition Erythorbic acid: 164–171, with decomposition	
	L-Ascorbic acid	Erythorbic acid
PURITY %:	>99	>99
WATER CONTENT MAXIMUM IN %:	0.4	0.4
HEAVY METAL CONTENT MAXIMUM IN ppm:	10	10
ARSENIC CONTENT MAXIMUM IN ppm:	3	3
ASH MAXIMUM IN %:	0.1	0.3

SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:

		L-Ascorbic acid	Erythorbic acid
in water:	**@ 20°C**	33	40
in vegetable oil:	**@ 20°C**	Insoluble	Insoluble
in ethanol solution (100%):		2	–

FUNCTION IN FOODS: L-Ascorbic acid: antioxidant activity is due to quenching of various forms of oxygen (singlet oxygen, hydroxyl radicals as well as superoxide), reduction of free radicals, thus terminating radical reaction. Acts as a synergist. Functions as vitamin C, colour fixing, flavouring, raising agent, oxidant and a reducing agent. Prevents enzymatic browning of fruits and vegetables.

Erythorbic acid: weaker antioxidant than L-ascorbic acid, enhances curing action of nitrites on meat pigments, stabilises colour of meat, meat products and fruits, inhibits growth of microorganisms and formation of N-nitrosamines in cured meats.

TECHNOLOGY OF USE IN FOODS: Apply to surfaces of cured meat cuts, easily oxidised on exposure to air in aqueous solutions.

SYNERGISTS: α-Tocopherol; citric acid; BHA; BHT

FOOD SAFETY ISSUES: Avoid acrid smoke and irritating fumes when heated.

LEGISLATION:

L-Ascorbic acid:

USA:	**UK and EUROPE:**	**AUSTRALIA/PACIFIC RIM:**
FDA and USDA: approved	Approved	Japan: approved

Erythorbic acid:

USA:	**AUSTRALIA/PACIFIC RIM:**
USDA and FDA: approved	Japan: restricted for purpose as antioxidant

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NAME:	Ascorbyl palmitate
CATEGORY:	Antioxidant
FOOD USE:	Baked goods/Soft drinks/Margarine/Sausages/Vegetable oils/Shortening
SYNONYMS:	L-Ascorbic acid, 6-hexadecanoate/Ascorbic acid palmitate/L-Ascorbic acid palmitate/L-Ascorbic acid 6-palmitate/6-*O*-Palmitoylascorbic acid/Palmitoyl L-ascorbic acid
FORMULA:	$C_{22}H_{38}O_7$
MOLECULAR MASS IN Daltons:	414.54
ALTERNATIVE FORMS:	Ascorbyl stearate
PROPERTIES AND APPEARANCE:	White or yellow white powder with a soapy taste and citrus-like odour
MELTING RANGE IN °C:	107–117 (113°C with decomposition in the presence of oxygen; 180°C with decomposition in the absence of oxygen)
PURITY %:	>95
WATER CONTENT MAXIMUM IN %:	2
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ARSENIC CONTENT MAXIMUM IN ppm:	3
ASH MAXIMUM %:	0.1
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 25°C** (pH = 7.0) 0.002 **@ 50°C** (pH = 8.1) 0.01 **@ 60°C** (pH = 8.1) 60.0 **@ 70°C** (pH = 7.0) 2.0 **@ 100°C** 10.0

in vegetable oil:						
Coconut oil	**@ 25°C**	1.2	**@ 100°C**	50.0		
Olive oil	**@ 25°C**	0.30				
Peanut oil	**@ 25°C**	0.30	**@ 70°C**	1.60	**@ 100°C**	9.00
Sunflower oil	**@ 25°C**	0.28				
in ethanol solution:						
50%	**@ 25°C**	0.4				
95%	**@ 25°C**	108.0				
100%	**@ 25°C**	125.0				
100%	**@ 0°C**	45.0				
in propylene glycol:	**@ 25°C**	48.0				

FUNCTION IN FOODS: Antioxidant that prevents oxidative rancidity development by quenching singlet oxygen. A sequestrant, emulsifier, stabiliser, source of vitamin C and a colour preservative.

TECHNOLOGY OF USE IN FOODS: Decomposition starts at 113°C in the presence of oxygen; unstable in alkaline pH.

SYNERGISTS: α-Tocopherol

LEGISLATION:

USA:	**UK:**	**AUSTRALIA/PACIFIC RIM:**
FDA and USDA: approved 0.02% maximum in margarine	Approved	Japan: approved

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NAME:	Beta-carotene
CATEGORY:	Antioxidant/Nutrient
FOOD USE:	Orange beverages/Cheese/Dairy products/Butter/Ice-cream/Fats and oils/Fruit juices/Infant formula as vitamin A
SYNONYMS:	Provitamin A/Food Orange 5/Natural Yellow 26/C140800/C175130/E160a/*trans*-Beta-Carotene/Provatene/Provitamin A/NaturalYellow26/á,á-caroteno (Spanish)/β,β-carotene/1,1′-(3,7,12,16-tetramethyl-1,3,5,7,9,11,13,15,17-Octadecanonaene-1,18-diyl) Bis(2,6,6-trimethyl-, (All-e)-Cyclohexene
FORMULA:	$C_{40}H_{56}$
MOLECULAR MASS IN Daltons:	536.90
PROPERTIES AND APPEARANCE:	Purple hexagonal prisms or red leaflets
MELTING RANGE IN °C:	178–179
FUNCTION IN FOODS:	Singlet oxygen quencher, thereby acts as an antioxidant. Colorant and functions as provitamin A in foods.
REFERENCE:	Committee on Food Chemicals Codex (1981) *Food Chemicals Codex*, 3rd edn. Food and Nutrition Board, Institute of Medicine, National Academy of Sciences, National Academy Press, Washington, DC.

NAME:	Butylated hydroxyanisole (BHA)
CATEGORY:	Antioxidant
FOOD USE:	Bakery products/Meat products/Spices/Cereals/Dehydrated mashed potatoes/Beverage mixes/Dessert mixes/Nuts/Vitamins/Yeast/Vegetable oils/Animal fats/Processed cheeses/Margarine/Essential oils/Chewing gum base
SYNONYMS:	Butylated hydroxyanisole/Butylhydroxyanisole/2(3)-*tert*-Butyl-4-hydroxyanisole/*tert*-Butylhydroxyanisole/*tert*-Butyl-4-hydroxyanisole/*tert*-Butyl-4-methoxyphenol/(1,1-Dimethylethyl)-4-methoxyphenol/Hydroxyanisole, butylated
FORMULA:	$C_{11}H_{16}O_2$
MOLECULAR MASS IN Daltons:	180.27
PROPERTIES AND APPEARANCE:	White or slightly yellow crystals or waxy solid with aromatic odour
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	264–270 (at 733 mmHg); 270 (at 760 mmHg)
MELTING RANGE IN °C:	48–55 (decomposed)
FLASH POINT IN °C:	130
PURITY %:	Not less than 98.5 of 2-isomer and not less than 85 of 3-isomer
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ARSENIC CONTENT MAXIMUM IN ppm:	3
ASH MAXIMUM IN %:	0.05
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** Insoluble
in vegetable oil:	**@ 25°C** 30 in cottonseed oil 40 in coconut, corn, peanut oils 50 in soybean oil

in ethanol solution (100%)	**@ 25°C**	>25
in propylene glycol:	**@ 20°C**	70

FUNCTION IN FOODS:

Antioxidant preservative by terminating free radicals formed during autoxidation of unsaturated lipids. It also possesses antimicrobial activity as a phenolic compound.

ALTERNATIVES:

BHT; PG; TBHQ

TECHNOLOGY OF USE IN FOODS:

Direct application: dissolves in lipid heated to 60°C, continue mild agitation for additional 20 min to ensure uniform distribution.

Concentration method: prepare an antioxidant concentrate solution by dissolving the antioxidant in a small quantity of heated lipid (93–121°C). This hot concentrate can be introduced into fat directly, or by metering.

Spray method: a dilute antioxidant solution can be directly sprayed onto food products such as nuts.

Other methods: antioxidants should be mixed with the seasonings for meat products such as sausages. For cereal products, antioxidants can be incorporated into the wax liner of the packages.

Usually applied with BHT for better efficiency than alone.

Should be protected from light and exposure to air.

SYNERGISTS:

BHT; propyl gallate; methionine; lecithin; thiodipropionic acid; citric acid; phosphoric acid

FOOD SAFETY ISSUES:

This antioxidant has not been subjected to great criticism of safety. However, suspected of tumour formation in animals with forestomach (Malaspina, 1987).

LEGISLATION:

USA:

Maximum usage level approved for general use:
FDA 0.02% and USDA 0.01% of weight of fat

Special applications include:
- Chewing gum base: 0.01% by weight of chewing gum base
- Active dry yeast or dry material
- Emulsion stabilisers: 0.02% by weight of emulsion, shortenings, stabiliser
- Potato flakes, sweet potato flakes: 0.005% by weight, dry breakfast cereal, of food material, packaging material
- Potato granules: 0.001% by weight of potato granules
- Dry mixes for beverages: 0.009% of material and desserts
- Beverages and desserts, prepared from dry mixes: 0.0002%

UK and EUROPE:

Approved

CANADA:

Approved

AUSTRALIA/PACIFIC RIM:

Japan: approved

(*USA: contd*)
Dry diced glazed fruits: 0.0032%
Flavour substances: 0.5% of essential oil content

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Tenox® *Food-Grade Antioxidants*. Eastman Chemical Company, Kingsport, TN. Publication ZG262B, March 1995.

NAME:	Butylated hydroxytoluene (BHT)	
CATEGORY:	Antioxidant	
FOOD USE:	Breakfast cereals/Baked goods/Potato chips/Vegetable oils/Snack foods/Butter/Margarine/Frozen seafoods/Chewing gum base	
SYNONYMS:	2,6-Bis-(1,1-dimethylethyl)-4-methylphenol/BHT/2,6-*tert*-butyl-4-methylphenol/DBPC/2,6-Di-*tert*-butyl-*p*-cresol/Di-*tert*-butyl-*p*-cresol/2,6-Di-*tert*-butyl-4-methylphenol/Hydroxytoluene, butylated/4-Methyl-2,6-di-*tert*-butylphenol/Methyl di-*tert*-butylphenol	
FORMULA:	$[(CH_3)_3C]_2$-C_6H_2-CH_3OH	
MOLECULAR MASS IN Daltons:	220.39	
PROPERTIES AND APPEARANCE:	White granular crystals with slight odour	
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	265	
MELTING RANGE IN °C:	69–72	
FLASH POINT IN °C:	118	
PURITY %:	Not less than 99	
HEAVY METAL CONTENT MAXIMUM IN ppm:	10	
ARSENIC CONTENT MAXIMUM IN ppm:	0.0001	
ASH MAXIMUM IN %:	0.05	
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:		
in water:	**@ 20°C**	Insoluble
in vegetable oil:	**@ 25°C**	30 in coconut, cottonseed, corn, peanut and soybean oils
in ethanol solution (100%):	25	
in propylene glycol:	**@ 20°C**	Insoluble

FUNCTION IN FOODS: Antioxidant preservative; prevents oxidative rancidity development in oil-containing foods by terminating free radicals formed during autoxidation of unsaturated lipids. It possesses antimicrobial activity as a phenolic compound.

ALTERNATIVES: BHA; PG; TBHQ

TECHNOLOGY OF USE IN FOODS: Similar to BHA

SYNERGISTS: BHA

FOOD SAFETY ISSUES: This has not been subjected to great criticism over safety.

LEGISLATION:

USA:
Maximum general usage level approved by USDA is 0.01% and FDA 0.02% of weight of lipids

Special applications include:
- Enriched rice: 0.0033%
- Non-alcoholic beverages, frozen raw breaded shrimp, mixed nuts and margarine: 0.02% based on oil content
- Dry sausages: 0.003%
- Fresh pork sausages, brown-and-serve sausages, pre-grilled beef patties, pizza toppings, meatballs, dried meats: 0.01%
- Rendered animal fat or combination with vegetable fat, poultry fat or various poultry products: 0.01%
- Dry breakfast cereals: 0.005%
- Emulsion stabilised for shortening: 0.02%
- Potato granules: 0.001%
- Potato flakes, sweet potato flakes, dehydrated potato shreds: 0.005%

EUROPE and UK:
Approved

CANADA:
Approved

AUSTRALIA/PACIFIC RIM:
Japan: approved

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Tenox® *Food-Grade Antioxidants*. Eastman Chemical Company, Kingsport, TN. Publication ZG262B, March 1995.

NAME:	*Tert*-Butylhydroquinone (TBHQ)
CATEGORY:	Antioxidant
FOOD USE:	Dry cereals/Edible fats/Margarine/Pizza toppings/Potato chips/Poultry/Dried meats/Sausages/Beef patties/ Vegetable oils
SYNONYMS:	2-(1,1-Dimethylethyl)-1,4-Benzenediol/Mono-*tert*-butyl hydroquinone/Mono-tertiarybutylhydroquinone/ MTBHQ/TBHQ
FORMULA:	$(CH_3)_3CC_6H_3(OH)_2$
MOLECULAR MASS IN Daltons:	166.24
PROPERTIES AND APPEARANCE:	White to tan colour solid crystals, having a characteristic odour
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	295
MELTING RANGE IN °C:	126.5–128.5
FLASH POINT IN °C:	171
PURITY %:	99
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ARSENIC CONTENT MAXIMUM IN ppm:	3
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** <1 **@ 100°C** 5
in vegetable oil:	**@ 20°C** 10 in corn, cottonseed, and soybean oils
in ethanol solution (100%):	25
in propylene glycol:	**@ 20°C** 30
FUNCTION IN FOODS:	Prevents oxidative rancidity development in foods by terminating free radical formation.

ALTERNATIVES: BHA; BHT

TECHNOLOGY OF USE IN FOODS: Similar to BHA. Some discoloration may occur in the presence of alkaline pH, certain proteins and sodium salts. It can be used as an antioxidant in frying oils.

SYNERGISTS: BHA; citric acid

FOOD SAFETY ISSUES: Has shown mutagenicity *in vivo*; therefore some countries consider that TBHQ does not meet current standards of toxicity testing.

LEGISLATION:

USA:
Not allowed to use in combination with PG. For general usage:
FDA 0.02%, USDA 0.01%, based on lipid content of food

Specific food use:
- Non-alcoholic beverages
- Margarine, mixed nuts: 0.02% alone or in combination based on lipid content
- Dried meats
- Fresh pork or beef sausages
- Pre-grilled beef patties
- Pizza toppings
- Meatballs: 0.01% based on weight of finished product
- Rendered animal fats

EUROPE, UK, NORWAY, DENMARK, SWEDEN, SWITZERLAND:
Not allowed for food use

CANADA:
Not allowed for food use

AUSTRALIA/PACIFIC RIM: AUSTRALIA, NEW ZEALAND:
Allowed for food use
Japan: not allowed for food use

REFERENCES:

Ash, M. and Ash, I. (2008) *Handbook of Food Additives*, 3rd edn. Synapse Information Resources, Inc. Available at http://Knovel.com/web/portal/browse/display_EXT_KNOVEL_DISPLAY_bookid=2192&VerticalID=0.

Sustane® *Food-Grade Antioxidants*. Universal Oil Products Company, Food Antioxidants Department, Des Plaines, IL, 1994.

Tenox® *Food-Grade Antioxidants*. Eastman Chemical Company, Kingsport, TN. Publication ZG262B, March 1995.

NAME:	Calcium ascorbate
CATEGORY:	Antioxidant
FOOD USE:	Meat products/Concentrated dairy products
SYNONYMS:	Ascorbic acid calcium salt
FORMULA:	$C_{12}H_{14}CaO_{12} \cdot 2H_2O$(dihydrate)/$C_{12}H_{14}CaO_{12}$ (anhydrous)
MOLECULAR MASS IN Daltons:	426.35 (dihydrate)/390.31 (anhydrous)
PROPERTIES AND APPEARANCE:	White to slight yellow odourless crystalline powder
PURITY %:	Not less than 98
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ARSENIC METAL MAXIMUM IN ppm:	3
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 25°C** 55
in vegetable oil:	**@ 25°C** Insoluble
in ethanol solution:	**@ 25°C** Insoluble
FUNCTION IN FOODS:	Antioxidant, vitamin C source and functions as a meat colour preservative.
FOOD SAFETY ISSUES:	When heated to decomposition, it emits acrid smoke and irritating fumes.
LEGISLATION:	**USA:** FDA approved; **UK:** Approved; **EUROPE:** Listed
REFERENCES:	Ash, M. and Ash, I. (2008) *Handbook of Food Additives*, 3rd edn. Synapse Information Resources, Inc. Available at http://Knovel.com/web/portal/browse/display_EXT_KNOVEL_DISPLAY_bookid=2192&VerticalID=0. Committee on Food Chemicals Codex (1981) *Food Chemicals Codex*, 3rd edn. Food and Nutrition Board, Institute of Medicine, National Academy of Sciences, National Academy Press, Washington, DC.

NAME:	Citric acid and its salts
CATEGORY:	Sequestrant/Synergist for antioxidant/Dispersing agent/Acidifier/Flavouring agent
FOOD USE:	Beverages/Canned vegetables/Baby foods/Confectionery/Ice-cream/Baked products
SYNONYMS:	2-Hydroxy-1,2,3-propanetricarboxylic acid, β-Hydroxytricarballylic acid/E330/Cap-Shure® C-140E-75/ Citrostabil® NEU/Citrostabil® – S/Citrocoat® A1000HP/Citrocoat® A2000HP/Citrocoat® A4000TP/ Citrocoat® A4000TT/Descote® Citric Acid 50%/Liquinat®
FORMULA:	$CH_2(COOH)C(OH)(COOH)CH_2COOH$
MOLECULAR MASS IN Daltons:	192.43
ALTERNATIVE FORMS:	Isopropylcitrate; triethylcitrate; ammonium citrate; mono-, di-, tri-sodium citrate; mono-, di-, tri-potassium citrate; calcium citrate; citric acid monohydrate
PROPERTIES AND APPEARANCE:	Colourless translucent crystals or powder with tart taste
MELTING RANGE IN °C:	152–154 (anhydrous); 135–153 (hydrated)
IONISATION CONSTANT AT 20°C:	$K_1 = 7.10 \times 10^{-4}$, $pK_a = 3.14$ $K_2 = 1.68 \times 10^{-5}$, $pK_a = 4.77$ $K_3 = 6.4 \times 10^{-5}$, $pK_a = 6.39$
PURITY %:	Not less than 99.5 of $C_6H_8O_7$ calculated on the anhydrous basis
WATER CONTENT MAXIMUM IN %:	0.5 in the anhydrous form; 8.8 in hydrous form
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ARSENIC CONTENT MAXIMUM IN ppm:	3
ASH MAXIMUM IN %:	0.05
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 200 g/100 mL
in ethanol solution:	50 g/100 mL

FUNCTION IN FOODS:

Control of pH in food, mainly an acidulant in beverages. Sequestrant of metal ions. Collects and deactivates metal ions, thus preventing the participation of metal ions in the initiation of autoxidation of unsaturated food lipids. Curing accelerator. Dispersant. As a flavour enhancer, it imparts tartness. Calcium citrate is a firming agent and a nutrient in baby foods.

TECHNOLOGY OF USE IN FOODS:

Readily soluble in water, and releases free acid. Therefore, it can be added directly to water-containing foods. Decomposes when heated.

FOOD SAFETY ISSUES:

Accelerates tooth decay. Moderate skin irritant and some allergic properties.

LEGISLATION:

USA:
FDA and USDA approved
Non-alcoholic beverages: 2500 ppm
Ice-cream and ices: 1600 ppm
Candy: 4300 ppm
Baked products: 1200 ppm
Chewing gum: 3600 ppm

UK:
Approved

EUROPE:
Listed

AUSTRALIA/PACIFIC RIM:
Japan: approved

REFERENCES:

Ash, M. and Ash, I. (2008) *Handbook of Food Additives*, 3rd edn. Synapse Information Resources, Inc. Available at http://Knovel.com/web/portal/browse/display_EXT_KNOVEL_DISPLAY_bookid=2192&VerticalID=0.

Committee on Food Chemicals Codex (1981) *Food Chemicals Codex*, 3rd edn. Food and Nutrition Board, Institute of Medicine, National Academy of Sciences, National Academy Press, Washington, DC.

de la Teja, P. (1991) pH control agents. In: Smith, J. (ed.) *Food Additive User's Handbook*. Van Nostrand Reinhold, New York, pp. 214–222.

Freydberg, N. and Gortner, W.A. (1982) *The Food Additive Book*. Bantam Books, New York.

NAME:	Ethoxyquin
CATEGORY:	Antioxidant/Stabiliser
FOOD USE:	Apples/Pears/Chilli powder/Paprika powder
SYNONYMS:	6-Ethoxy-1,2-dihydro-2,2,4-trimethylquinoline/1,2-Dihydro-6-ethoxy-2,2,4-trimethylquinoline/1,2-Dihydro-2,2,4-trimethyl-6-ethoxyquinoline/EMQ/EQ/Ethoxyquine/6-Ethoxy-2,2,4-trimethyl-1,2-dihydroquinoline/ETMQ/Santoquine/2,2,4-Trimethyl-6-ethoxy-1,2-dihydroquinoline
FORMULA:	$C_{14}H_{19}NO$
MOLECULAR MASS IN Daltons:	217.34
PROPERTIES AND APPEARANCE:	Yellow-coloured liquid
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	125
FUNCTION IN FOODS:	Prevents brown spot formation (scald) in apples and pears during storage. Preserves the colour in ground chilli and paprika. Used as antioxidant in animal feed.
LEGISLATION:	**USA:** FDA approved: 100 ppm in chilli powder; 100 ppm in paprika; 5 ppm in uncooked meat fat; 3 ppm in uncooked poultry fat; 0.5 ppm in eggs
REFERENCE:	Ash, M. and Ash, I. (2008) *Handbook of Food Additives*, 3rd edn. Synapse Information Resources, Inc. Available at http://Knovel.com/web/portal/browse/display_EXT_KNOVEL_DISPLAY_bookid=2192&VerticalID=0.

NAME:	Ethylenediaminetetraacetic acid (EDTA)
CATEGORY:	Chelator/Antioxidant
FOOD USE:	Margarine/Mayonnaise/Salad dressings/Fish and fish products/Beer/Fruit drinks/Vegetable juices/Condiments
SYNONYMS:	Edetic acid/Ethylenedinitrilotetraacetic acid/EDTA, free base/EDTA free acid/Ethylenediamine-*N*,*N*,*N*′,*N*′-tetraacetic acid/Hampene/Versene/*N*,*N*′-1,2-Ethanediylbis-(*N*-(carboxymethyl)glycine)/Ethylenediamine tetra-acetic acid
FORMULA:	$(HOOC\text{-}CH_2)_2\text{-}NCH_2\text{-}CH_2N(CH_2COOH)_2$
MOLECULAR MASS IN Daltons:	292.24
ALTERNATIVE FORMS:	Calcium disodium EDTA; sodium dihydrogen EDTA; disodium EDTA
PROPERTIES AND APPEARANCE:	White powder
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	238
MELTING RANGE IN °C:	36.4; decomposes at 245°C
FLASH POINT IN °C:	160
HEAVY METAL CONTENT MAXIMUM IN ppm:	20
ARSENIC CONTENT MAXIMUM IN ppm:	3
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	Freely soluble
in ethanol solution:	Insoluble
FUNCTION IN FOODS:	Chelation of transition metal ions such as copper and iron, thus preventing initiation of autoxidation of unsaturated lipids. EDTA salts improve the stability of foods.
SYNERGISTS:	BHT; PG

LEGISLATION:	GMP
REFERENCES:	Ash, M. and Ash, I. (2008) *Handbook of Food Additives*, 3rd edn. Synapse Information Resources, Inc. Available at http://Knovel.com/web/portal/browse/display_EXT_KNOVEL_DISPLAY_bookid=2192&VerticalID=0. Dean, J.A. (1992) *Lange's Handbook of Chemistry*, 14th edn. McGraw-Hill, New York. Freydberg, N. and Gortner, W.A. (1982) *The Food Additives Book*. Bantam Books, New York.

NAME:	Propyl gallate (PG)
CATEGORY:	Antioxidant
FOOD USE:	Chewing gum base/Non-alcoholic beverages/Margarine/Mixed nuts/Fresh or dry sausages/Pre-grilled beef patties/Rendered animal fat/Pizza toppings and meatballs
SYNONYMS:	Gallic acid propyl ester/PG; *n*-Propyl gallate/Propyl-3,4,5-Trihydroxybenzoate/*n*-Propyl-3,4,5-trihydroxybenzoate/3,4,5-Trihydroxybenzene-1-propylcarboxylate/3,4,5-Trihydroxybenzoic acid propyl ester/3,4,5-Trihydroxybenzoic acid, *n*-propylester
FORMULA:	$(HO)_3C_6H_2$-$COOCH_2$-CH_2-CH_3
MOLECULAR MASS IN Daltons:	212.22
ALTERNATIVE FORMS:	Octyl gallate; dodecyl gallate
PROPERTIES AND APPEARANCE:	Ivory fine powder or crystals, odourless with slight bitter taste
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	Decomposes at about 148
MELTING RANGE IN °C:	147–149
FLASH POINT IN °C:	187
PURITY %:	Not less than 98 and not more than 102.5 on the dried basis
WATER CONTENT MAXIMUM IN %:	0.5
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ARSENIC CONTENT MAXIMUM IN ppm:	3
ASH MAXIMUM IN %:	0.1

SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:

in water:	**@ 20°C**	<1
in vegetable oil:	**@ 20°C**	1 in cottonseed oil 2 in soybean oil insoluble in corn oil
in ethanol solution (100%):		>60

FUNCTION IN FOODS: Prevents oxidative rancidity development in lipid-containing foods by terminating free radical formation during autoxidation of unsaturated lipids.

ALTERNATIVES: BHA; BHT; TBHQ; octyl gallate; dodecyl gallate

TECHNOLOGY OF USE IN FOODS: Heat-sensitive and decomposes at 148°C, therefore not good for foods subjected to heat treatment. Also poorly soluble in lipids and water. Can form coloured complexes with metal ions, and affect the appearance of food.

SYNERGISTS: BHA; BHT

FOOD SAFETY ISSUES: Not subjected to great criticism over safety.

LEGISLATION:

USA:
Not allowed to use in combination with TBHQ
For general use: FDA 0.02% and USDA 0.01% alone or in combination with BHT or BHA by weight of lipid portion of food

Special applications include:
- Chewing gum base: 0.1%
- Non-alcoholic beverages: 0.1%
- Margarine: 0.02%
- Mixed nuts: 0.02% based on oil content
- French beef or pork sausages, brown-and-serve sausages, pre-grilled beef patties, pizza toppings and meatballs: for all these 0.01% based on weight of finished product
- Rendered animal fats or combination of such fat with vegetable fat: 0.01% based on lipid content

UK:
Approved

EUROPE:
Listed

CANADA:
Approved

AUSTRALIA/PACIFIC RIM:
Japan: approved

REFERENCES:

Ash, M. and Ash, I. (2008) *Handbook of Food Additives*, 3rd edn. Synapse Information Resources, Inc. Available at http://Knovel.com/web/portal/browse/display_EXT_KNOVEL_DISPLAY_bookid=2192&VerticalID=0.

Sustane® *Food-Grade Antioxidants*. Universal Oil Products Company, Food Antioxidants Department, Des Plaines, IL, 1994.

Tenox® *Food-Grade Antioxidants*. Eastman Chemical Company, Kingsport, TN. Publication ZG262B, March 1995.

NAME:	Rosemary extract; natural spice extract
CATEGORY:	Antioxidant/Natural
FOOD USE:	Edible fats and oils/Processed meats and poultry/Fresh and frozen sausages/Salad dressings/Mayonnaise/Seasonings/Snacks and nuts/Soup bases/Chewing gum/Peanut butter/Citrus oils
SYNONYMS:	Pristene® RO/Pristene® RW/Stabex®/Herbalox®/Freeze-Grad®-FP-15/Flav-R-Keep® FP-51
PROPERTIES AND APPEARANCE:	Yellowish powder or oil- or water-dispersible liquid
DENSITY:	0.36 g/mL
PURITY %:	16–24.8 carnosic acid
WATER CONTENT MAXIMUM %:	5
HEAVY METAL CONTENT MAXIMUM IN ppm:	Lead 20 Cadmium 0.2 Mercury 0.1
FUNCTION IN FOODS:	Retards development of oxidative rancidity by terminating free radicals. Used as a natural antioxidant.
TECHNOLOGY OF USE IN FOODS:	Direct addition or metering into fat. Concentrated suspension can be dosed into bulk fat or food material. It can be used by dry-mixing in powdered food.
SYNERGISTS:	Ascorbic acid; ascorbyl palmitate
LEGISLATION:	**USA:** 200–1000 ppm depending on the carnosic acid content and intended shelf-life and specific food product
REFERENCES:	Pristene® *Natural Based Food-Grade Antioxidants and Flavors*. Universal Oil Products Company, UOP2341-2, Food Antioxidant Department, Des Plaines, IL (1995). Schuler, P. (1990) Natural antioxidants exploited commercially. In: Hudson, B.J.F. (ed.) *Food Antioxidants*. Elsevier Science Publishers, London, pp. 99–170. Stabex® SKW Chemicals. Product Data, Marietta, GA.

NAME:	Sodium ascorbate
CATEGORY:	Antioxidant/Colour preservative
FOOD USE:	Canned meat products/Bottled baby food/Frozen fish
SYNONYMS:	L-Ascorbic acid monosodium salt/L(+)-Ascorbic acid sodium salt/Monosodium ascorbate/Monosodium L-ascorbate/Sodium L-ascorbate/Vitamin C sodium salt
FORMULA:	$C_6H_7NaO_6$
MOLECULAR MASS IN Daltons:	198.11
ALTERNATIVE FORMS:	Calcium ascorbate/L-ascorbic acid
PROPERTIES AND APPEARANCE:	White to yellowish crystalline solid, odourless, soapy taste
MELTING RANGE IN °C	200 (decomposes at 218)
PURITY %:	>99 (and not more than the equivalent of 101.0 of $C_6H_7NaO_6$ after drying)
WATER CONTENT MAXIMUM IN %:	0.25
HEAVY METAL CONTENT MAXIMUM IN ppm:	20
ARSENIC CONTENT MAXIMUM IN ppm:	3
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	@ 25°C 62
in vegetable oil:	@ 25°C Insoluble
in ethanol solution:	@ 25°C Insoluble
FUNCTION IN FOODS:	Functions as an antioxidant, colour preservative, dietary supplement of vitamin C, nutrient supplement in foods and curing of meat.
ALTERNATIVES:	L-ascorbic acid; calcium ascorbate
FOOD SAFETY ISSUES:	When heated to decomposition, it emits toxic fumes of Na_2O that have been shown to be mutagenic in humans.

LEGISLATION:	USA:	UK:	AUSTRALIA/PACIFIC RIM:
	FDA and USDA approved: 87.5 oz/100 gallons of pickle 7–8 oz/100 lb of meat 500 ppm in meat alone or in combination with ascorbic acid or erythorbic acid	Approved	Japan: approved

REFERENCES:

Ash, M. and Ash, I. (2008) *Handbook of Food Additives*, 3rd edn. Synapse Information Resources, Inc. Available at http://Knovel.com/web/portal/browse/display_EXT_KNOVEL_DISPLAY_bookid=2192&VerticalID=0.

Committee on Food Chemicals Codex (1981) *Food Chemicals Codex*, 3rd edn. Food and Nutrition Board, Institute of Medicine, National Academy of Sciences, National Academy Press, Washington, DC.

NAME:	L-Tartaric acid
CATEGORY:	Sequestrant/Synergist of antioxidant
FOOD USE:	Non-alcoholic beverages/Ice-cream confectionery/Baked products/Desserts/Chewing gum/Condiments/Jam/Jelly/Canned vegetables and fruits
SYNONYMS:	Butanedioic acid, 2,3-dihydroxy-/2,3-Dihydrosuccinic acid/Dihydroxybutanedioic acid/2,3-Dihydroxybutanedioic acid/L-2,3-Dihydroxybutanedioic acid/Dihydroxysuccinic acid/α,β-Dihydroxysuccinic acid/3-Hydroxymalic acid/Malic acid, 3-hydroxy-/Succinic acid, 2,3-dihydroxy-/Tartaric acid (INCI); L(+)-Tartaric acid; Thearic acid
FORMULA:	COOH-CHOH-CHOH-COOH
MOLECULAR MASS IN Daltons:	150.09
ALTERNATIVE FORMS:	Sodium tartrate (L-tartaric acid disodium salt)
PROPERTIES AND APPEARANCE:	Colourless or translucent crystals or white crystalline powder, odourless with acid taste
MELTING RANGE IN °C:	168–170
IONISATION CONSTANT AT 25°C:	$K_1 = 1.04 \times 10^{-3}$, $pK_a = 2.98$ $K_2 = 4.55 \times 10^{-3}$, $pK_a = 4.34$
PURITY %:	99
WATER CONTENT MAXIMUM IN %:	0.5
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ARSENIC CONTENT MAXIMUM IN ppm:	2
ASH MAXIMUM IN %:	0.05

SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:

in water:	**@ 25°C** 139
in alcohol:	**@ 25°C** 33

FUNCTION IN FOODS: Augments fruit flavours in beverages and candies; prevents discoloration or flavour changes from occurring during oxidative rancidity as a stabilising agent; prevents fermentation in baked products; firming agent, humectant, acidulant, pH control agent, sequestrant.

TECHNOLOGY OF USE IN FOODS: Direct addition

LEGISLATION:

USA:
FDA and USDA approved:
Non-alcoholic beverages: 960 ppm
Ice-cream: 570 ppm
Candy: 5400 ppm
Baked products: 130 ppm
Gelatins and puddings: 60 ppm
Chewing gum: 3700 ppm
Condiments: 10 000 ppm

REFERENCES:

Ash, M. and Ash, I. (2008) *Handbook of Food Additives*, 3rd edn. Synapse Information Resources, Inc. Available at http://Knovel.com/web/portal/browse/display_EXT_KNOVEL_DISPLAY_bookid=2192&VerticalID=0.
Committee on Food Chemicals Codex (1981) *Food Chemicals Codex*, 3rd edn. Food and Nutrition Board, Institute of Medicine, National Academy of Sciences, National Academy Press, Washington, DC.

NAME:	Tea extract
CATEGORY:	Antioxidant/Natural
FOOD USE:	Salad oils/Bulk vegetable oils/Nuts and snacks (deep-fat fried)/Extruded snack foods/Seasoning mixes
SYNONYMS:	Teabalox® T-02/Teabalox® O/Green tea oleoresin
FORMULA:	Water-soluble catechins and gallates and oil-soluble oleoresin of green tea
PROPERTIES AND APPEARANCE:	Brown viscous liquid
FUNCTION IN FOODS:	Prevents oxidative rancidity development by terminating free radicals, and may chelate metal ions. Used as a natural antioxidant.
TECHNOLOGY OF USE IN FOODS:	Spray application to fried foods, extruded foods. At temperatures above 130°C, it can have reduced performance but thermal stable types (Herbalox O) are available. Migration of polyphenols from the oil phase to the water phase may occur in the presence of a significant quantity of unbound water, thereby reducing antioxidative activity.
LEGISLATION:	**USA:** Approved by FDA for use in foods: 0.025–0.15% of the fat
REFERENCE:	Kalsec Technical Data, Development Product Bulletin T-20, June 1993. Kalsec Inc., Kalamazoo, MI.

NAME:	Tocopherols, mixed α (DL), γ and δ (synthetic)
CATEGORY:	Antioxidant/Vitamin supplement
FOOD USE:	Infant foods/Milk fat/Mayonnaise/Salad dressings/Vegetable oils/Processed meats/Fresh and frozen sausages/Snacks and nuts/Dehydrated potatoes
SYNONYMS:	*d*-α-[2*R*,4′*R*,8′*R*]-2,5,7,8-tetramethyl-2-(4′,8′,12′-trimethyl-tridecyl)-6-chromanol; 5,7,8-trimethyltocol E307/γ-7,8-dimethyltocol, E308/δ-8-methyltocol, E309/Pristene® 180, 184, 185, 186, 198/Tenite1®
FORMULA:	α = $C_{29}H_{50}O_2$; γ = $C_{28}H_{48}O_2$; δ = $C_{27}H_{46}O_2$
MOLECULAR MASS IN Daltons:	α = 430.72; γ = 416.69; δ = 402.67
ALTERNATIVE FORMS:	Tocopheryl acetate
PROPERTIES AND APPEARANCE:	Yellow to brownish viscous oily liquid, odourless
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	α = 210; γ = 200–210; δ = 150
PURITY %:	α-Tocopherol content is not less than 96 and not more than 102.
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** Insoluble
in vegetable oil:	Soluble
in ethanol solution:	Soluble
FUNCTION IN FOODS:	Functions as a free-radical terminator in autoxidation reactions, and is considered as an antioxidant. It supplies vitamin E as a nutrient to foods. Some plant foods, particularly vegetable oils, oilseeds and nuts, naturally contain tocopherols, but during processing they are partly destroyed.
ALTERNATIVES:	Natural tocopherols
TECHNOLOGY OF USE IN FOODS:	Direct addition, spraying or dipping, can be used in frying oils.
SYNERGISTS:	Citric acid; ascorbyl palmitate; lecithin
FOOD SAFETY ISSUES:	Not subjected to safety criticism.

LEGISLATION:	USA:	UK and EUROPE:
	General manufacturing practices	Not to exceed 500 ppm

REFERENCES:

Committee on Food Chemicals Codex (1981) *Food Chemicals Codex*, 3rd edn. Food and Nutrition Board, Institute of Medicine, National Academy of Sciences, National Academy Press, Washington, DC.

Schuler, P. (1990) Natural antioxidants exploited commercially. In: Hudson, B.J.F. (ed.) *Food Antioxidants*. Elsevier Science Publishers, London, pp. 99–170.

Tenox® *Food-Grade Antioxidants*. Eastman Chemical Company, Kingsport, TN. Publication ZG262B, March 1995.

NAME:	Tocopherol, mixed natural concentrate
CATEGORY:	Antioxidant/Natural vitamin supplement
FOOD USE:	Dairy products/Cereal products/Green vegetables (frozen)/Margarine/Sausages/Vegetable oils/Soft drinks/Snacks and nuts/Salad dressings/Soup bases/Seasonings/Dehydrated potatoes/Fresh and frozen sausages/Processed meats and poultry/Baked products
SYNONYMS:	E306/Pristene® MT70/Prestene® MT-28/Pristene® MT-50/Vitamin E/Eisai® Natural Vitamin E/Tenox® GT-1/Tenox® GT-2
FORMULA:	Mixture of α, β, γ and δ tocopherol α = $C_{29}H_{50}O_2$; β and γ = $C_{28}H_{48}O_2$; δ = $C_{27}H_{46}O_2$
PROPERTIES AND APPEARANCE:	Golden brown colour, slightly viscous liquid with a characteristic odour. It may show a slight separation of wax-like constituents in microcrystalline form. It oxidises and darkens slowly in air and on exposure to light, particularly when in alkaline media.
PURITY %:	28–70% tocopherol in vegetable oil. High α type: not less than 50% of total tocopherols of which not less than 50% consists of *d*-α-tocopherol and not less than 20% consists of *d*-β + *d*-γ + *d*-δ-tocopherols. Low α type: not less than 50% of total tocopherols, of which not less than 80% consists of *d*-β + *d*-γ + *d*-δ-tocopherols.
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** Insoluble
in vegetable oil:	Soluble
in ethanol solution:	Soluble
in propylene glycol:	Soluble
FUNCTION IN FOODS:	Prevents oxidative rancidity development in lipid-containing foods by terminating free radicals. Dietary supplement of vitamin E. Inhibits *N*-nitrosamine formation in pump-cured bacon.
ALTERNATIVES:	Synthetic tocopherols

TECHNOLOGY OF USE IN FOODS:	Can be used in frying oils as tocopherols do not volatilise at 180°C. Spraying or dipping techniques for nuts (whole or broken) using 0.2% tocopherol solution in 96% ethanol. Should be stored in airtight light-proof containers.
SYNERGISTS:	Citric acid; ascorbic acid; ascorbyl palmitate; lecithin; amino acids; EDTA; BHA; BHT; PG
FOOD SAFETY ISSUES:	Has not been criticised over safety.
LEGISLATION:	**USA:** GMP for general use FDA: frozen raw breaded shrimp (amount required for intended technical effect), margarine, mixed nuts USDA: rendered animal fat or combination of such fat with vegetable fat: 0.03% (30% concentration of tocopherol should be used) Dry sausages, semi-dry sausages, dried meats, uncooked or cooked sausages from fresh beef and/or pork, uncooked or cooked meatballs, Italian sausages, meat pizza toppings, brown-and-serve sausages, pre-grilled beef patties and restructured meats; 0.03% based on fat content, may not be used in combination with other antioxidants Rendered poultry fat or various poultry products: 0.03% based on fat content; 0.02% in combination with BHA, BHT and PG
REFERENCES:	Committee on Food Chemicals Codex (1981) *Food Chemicals Codex*, 3rd edn. Food and Nutrition Board, Institute of Medicine, National Academy of Sciences, National Academy Press, Washington, DC. Schuler, P. (1990) Natural antioxidants exploited commercially. In: Hudson, B.J.F. (ed.) *Food Antioxidants*. Elsevier Science Publishers, London, pp. 99–170. Tenox® GT-1 and Tenox® GT-2. Eastman Chemical Company, Publication ZG-263D, Kingsport, TN, March 1996.

Part 3

Colourings

Bruce Henry

This Part is based upon the First Edition contribution of Paul Collins and the late Peter Rayner

Food Additives Data Book, Second Edition. Edited by Jim Smith and Lily Hong-Shum.

NAME:	Alkanet
CATEGORY:	Food colour
FOOD USE:	Alcoholic beverages/Confectionery/Ice-cream
SYNONYMS:	C.I. 75530 (Natural Red 20)/Alkannin
FORMULA:	$C_{16}H_{16}O_5$
MOLECULAR MASS IN Daltons:	288.13
ALTERNATIVE FORMS:	None known
PROPERTIES AND APPEARANCE:	A dark red/brown powder or paste
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	Not known
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	No data available
WATER CONTENT MAXIMUM IN %:	No data available
HEAVY METAL CONTENT MAXIMUM IN ppm:	50

ARSENIC CONTENT MAXIMUM IN ppm:	1					
ASH MAXIMUM IN %:	2					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	Slightly soluble	**@ 50°C**	Slightly soluble	**@ 100°C**	Slightly soluble
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in sucrose solution:						
10%	Very slightly soluble					
40%	Very slightly soluble					
60%	Very slightly soluble					
in sodium chloride solution:						
5%	Insoluble					
10%	Insoluble					
15%	Insoluble					
in ethanol solution:						
5%	Very slightly soluble					
20%	Very slightly soluble					
95%	Soluble					
100%	Soluble					
in propylene glycol:	**@ 20°C**	Not known	**@ 50°C**	Not known	**@ 100°C**	Not known
FUNCTION IN FOODS:	Red to purple/red food colour. Soluble in alcohol.					
ALTERNATIVES:	Other purple/red food colours, although not of exactly the same hue, include Beetroot, Anthocyanin, Allura Red, Ponceau 4R, Carmoisine					
TECHNOLOGY OF USE IN FOODS:	Alcohol soluble. Red to purple/red colour extracted from the roots of *Alkanna tinctoria* (*Anchusa tinctoria*). Red shade below pH 6, blue shade above. Used to colour alcoholic drinks and for confectionery. Only slightly soluble in water.					
SYNERGISTS:	None known					
ANTAGONISTS:	None known					

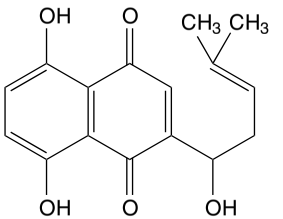
FOOD SAFETY ISSUES: The Joint FAO/WHO Expert Committee on Food Additives has insufficient data to evaluate and determine an allowable daily intake (ADI).

LEGISLATION:

USA:	**UK and EUROPE:**	**CANADA:**	**AUSTRALIA:**
Not permitted	Not permitted	Permitted	Permitted

REFERENCE: Smith, J. (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic and Professional, Glasgow.

STRUCTURE OF ALKANET:



NAME:	Allura Red AC
CATEGORY:	Food colour
FOOD USE:	Baked goods/Cereals and cereals products/Dairy products/Fish and seafood products/Meat and poultry products/Soft drinks/Fruit, vegetable and nut products/Beverages/Alcoholic drinks/Sugar and preserves/Confectionery/Edible ices/Vinegar, pickles and sauces/Decorations and coatings/Soups/Seasonings/Snacks/Desserts
SYNONYMS:	FD&C Red 40/E129/C.I. 16035 (Food Red 17)/Disodium 2-hydroxy-1-(2-methoxy-5-methyl-4-sulfonatophenylazo)-naphthalene-6-sulfonate
FORMULA:	$C_{18}H_{14}N_2Na_2O_8S_2$
MOLECULAR MASS IN Daltons:	496.42
ALTERNATIVE FORMS:	Calcium salt/Potassium salt/Aluminium lake (insoluble)
PROPERTIES AND APPEARANCE:	Dark red powder or granules
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	Not known
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	Not less than 85% total colouring matter, calculated as the sodium salt
WATER CONTENT MAXIMUM IN %:	15, but typically 3

HEAVY METAL CONTENT MAXIMUM IN ppm:	40					
ARSENIC CONTENT MAXIMUM IN ppm:	3					
ASH MAXIMUM IN %:	N/A					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	22	**@ 50°C**	25	**@ 100°C**	27
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in sucrose solution:						
10%	Soluble					
40%	Soluble					
60%	Soluble					
in sodium chloride solution:						
5%	Soluble					
10%	Insoluble					
15%	Insoluble					
in ethanol solution:						
5%	Soluble					
20%	**@ 25°C**	9.5	**@ 60°C**	22.0		
95%	**@ 25°C**	0.001	**@ 60°C**	0.05		
100%	**@ 25°C**	0.001	**@ 60°C**	0.05		
in propylene glycol:	**@ 25°C**	18	**@ 60°C**	22	**@ 100°C**	Not known

FUNCTION IN FOODS: Water-soluble red food colour or insoluble red food colour as the aluminium lake.

ALTERNATIVES: Other red food colours, although not of exactly the same hue, include Carmoisine; Ponceau 4R; Erythrosine; Carmine; Beet Red; Anthocyanins (in acid media); Red 2G (where permitted)

TECHNOLOGY OF USE IN FOODS: A very heat-stable, yellowish-red colour with excellent light stability. Becomes bluer in alkaline media. Some fade with ascorbic acid.

SYNERGISTS: None known

ANTAGONISTS: Ascorbic acid

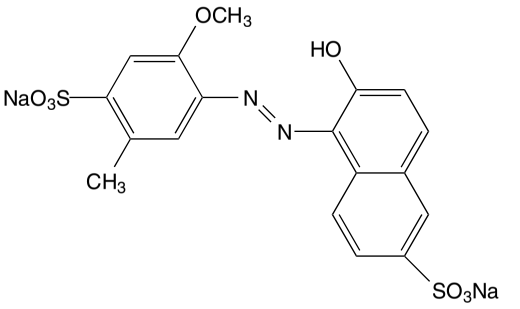
FOOD SAFETY ISSUES: None known

LEGISLATION:

USA:	**UK and EUROPE:**	**CANADA:**	**AUSTRALIA:**
FD&C Red 40 certified food colour: permitted	Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuff. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V Part 2 (of Directive 94/36/EC) for a list of food categories and maximum levels of colour use	Permitted when certified, but restrictions apply	Permitted, but restrictions apply

REFERENCE: Smith, J. (ed.) (1991) *Food Additive User's Handbook.* Blackie Academic and Professional, Glasgow.

STRUCTURE OF ALLURA RED:



NAME:	Aluminium
CATEGORY:	Food colour
FOOD USE:	Surface coating of sugar confectionery
SYNONYMS:	E173/C.I. 77000 (pigment metal 1)
FORMULA:	Al
MOLECULAR MASS IN Daltons:	26.98
ALTERNATIVE FORMS:	N/A
PROPERTIES AND APPEARANCE:	Silver-grey powder or thin sheets (leaf)
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	1800
MELTING RANGE IN °C:	659.8
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	Not less than 99
WATER CONTENT MAXIMUM IN %:	N/A
HEAVY METAL CONTENT MAXIMUM IN ppm:	40

ARSENIC CONTENT MAXIMUM IN ppm:	3					
ASH MAXIMUM IN %:	N/A					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in sucrose solution:						
10%	Insoluble					
40%	Insoluble					
60%	Insoluble					
in sodium chloride solution:						
5%	Insoluble					
10%	Insoluble					
15%	Insoluble					
in ethanol solution:						
5%	Insoluble					
20%	Insoluble					
95%	Insoluble					
100%	Insoluble					
in propylene glycol:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
FUNCTION IN FOODS:	Used as a dispersed powder or leaf to surface-colour sugar confectionery.					
ALTERNATIVES:	Silver powder or leaf					
TECHNOLOGY OF USE IN FOODS:	Applied as powder or leaf to the surface of hard sugar confectionery, then polished to a high gloss as a decoration. Other food colours can be mixed with the powder to achieve coloured coatings with a metallic sheen for hard sugar confectionery, known as dragees.					
SYNERGISTS:	None known					
ANTAGONISTS:	None known					

FOOD SAFETY ISSUES: Media attention on the role of dietary aluminium in Alzheimer's disease. However, contributions to the diet from the use of aluminium as a food colour are negligible.

LEGISLATION:

USA:	**UK and EUROPE:**	**CANADA:**	**AUSTRALIA:**
Not permitted	Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex IV for restrictions on use	Permitted	Not permitted

REFERENCE:

Smith, J. (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic and Professional, Glasgow.

NAME:	Amaranth
CATEGORY:	Food colour
FOOD USE:	Fish roe/Confectionery/Desserts/Alcoholic beverages/Edible ices/Dairy products/Canned products/ Decorations and coatings/Soft drinks/Sugar and preserves
SYNONYMS:	E123/C.I. 16185 (Food Red 9)/Trisodium 2-hydroxy-1-(4-sulfonato-1-naphthylazo)-naphthalene-3-6-disulfonate
FORMULA:	$C_{20}H_{11}N_2Na_3O_{10}S_3$
MOLECULAR MASS IN Daltons:	604.48
ALTERNATIVE FORMS:	Calcium salt/Potassium salt/Aluminium lake (insoluble)
PROPERTIES AND APPEARANCE:	Reddish brown powder or granules
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	Not known
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	Not less than 85% total colouring matter, calculated as the sodium salt
WATER CONTENT MAXIMUM IN %:	15, but typically 3
HEAVY METAL CONTENT MAXIMUM IN ppm:	40

ARSENIC CONTENT MAXIMUM IN ppm:	3					
ASH MAXIMUM IN %:	N/A					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	7	**@ 50°C**	8	**@ 100°C**	10
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in sucrose solution:						
10%	Soluble					
40%	Soluble					
60%	Soluble					
in sodium chloride solution:						
5%	Soluble					
10%	Insoluble					
15%	Insoluble					
in ethanol solution:						
5%	Soluble					
20%	Slightly soluble					
95%	<0.1					
100%	<0.1					
in propylene glycol:	**@ 20°C**	0.4	**@ 50°C**	0.4	**@ 1000°C**	0.5
FUNCTION IN FOODS:	Water-soluble bluish-red food colour, or insoluble bluish-red food colour as the aluminium lake.					
ALTERNATIVES:	Other red food colours, although not of the same hue, include Carmine; Carmoisine; Ponceau 4R; Allura Red; Erythrosine; Beet Red; Anthocyanins (in acid media); Red 2G (where permitted)					
TECHNOLOGY OF USE IN FOODS:	A robust blue-red colour with good light stability and good heat stability to 105°C. Fades in the presence of sulphur dioxide and alkaline media. Alkaline media increases the blue hue.					
SYNERGISTS:	None known					
ANTAGONISTS:	Sulphur dioxide/Alkaline media					

FOOD SAFETY ISSUES:

Possible increase in mammary tumours on long-term rat feeding studies. Delisted by USA and restricted use by European Union.

LEGISLATION:

USA:
Not permitted

CANADA:
Permitted when certified, but restrictions apply

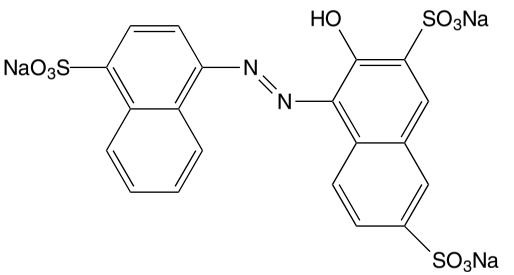
UK and EUROPE:
Permitted according to European Parliament and Council Regulation 1333/2008 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex IV:
Only for aperitif wines, spirit drinks including products with less than 15% alcohol by volume (max. 30 mg/L) Fish roe (max. 30 mg/L)

AUSTRALIA:
Permitted, but restrictions on use apply

REFERENCE:

Smith, J. (ed.) (1991) *Food Additive Users Handbook*. Blackie Academic and Professional, Glasgow.

STRUCTURE OF AMARANTH:



NAME	Ammonia caramel
CATEGORY:	Food colour
FOOD USE:	Baked goods/Cereal and cereal products/Dairy products/Meat and poultry products/Soft drinks/Sugars and preserves/Confectionery/Vinegars, pickles and sauces/Decorations and coatings/Edible ices/Desserts/ Seasonings/Savoury dry mixes
SYNONYMS:	E150c
FORMULA:	Not known
MOLECULAR MASS IN Daltons:	Not known
ALTERNATIVE FORMS:	N/A
PROPERTIES AND APPEARANCE:	Dark brown to black liquids or powders
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	N/A
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	Colour intensity 0.08–0.36 based on absorbance of a 0.1% solution of caramel colour in water in a 1-cm cell at 610 nm.
WATER CONTENT MAXIMUM IN %:	Typically 40 for liquids

HEAVY METAL CONTENT MAXIMUM IN ppm:	25					
ARSENIC CONTENT MAXIMUM IN ppm:	1					
ASH MAXIMUM IN %:	N/A					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	Completely soluble	**@ 50°C**	Completely soluble	**@ 100°C**	Completely soluble
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in sucrose solution:						
10%	Completely soluble					
40%	Completely soluble					
60%	Completely soluble					
in sodium chloride solution:						
5%	Completely soluble					
10%	Completely soluble					
15%	Completely soluble					
in ethanol solution:						
5%	Not stable (haze or precipitate)					
20%	Not stable (haze or precipitate)					
95%	Not stable (haze or precipitate)					
100%	Not stable (haze or precipitate)					
in propylene glycol:	**@ 20°C**	Dispersible	**@ 50°C**	Dispersible	**@ 100°C**	Dispersible
FUNCTION IN FOODS:	A water-soluble brown food colour					
ALTERNATIVES:	E150a, b and d; Brown HT; Brown FK					
TECHNOLOGY OF USE IN FOODS:	Fully water-soluble in both liquid and powder forms. To dissolve powders, use warm water. For dry mixes (e.g. instant desserts), the powder form can be used and dissolves when reconstituted by the consumer. *Note*: ammonia caramels are positively charged.					
SYNERGISTS:	N/A					

ANTAGONISTS:	N/A			
LEGISLATION:	**USA:** Permitted according to 21 CFR Part 73.85	**UK and EUROPE:** Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V Part 1 (of Directive 94/36/EC) for details of use	**CANADA:** Permitted	**AUSTRALIA:** Permitted
REFERENCE:	Smith, J. (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.			

NAME:	Annatto
CATEGORY:	Food colour
FOOD USE:	Yellow fats/Decorations/Coatings/Seasonings/Edible ices/Liqueurs/Cheese/Baked goods/Dairy products/Smoked fish/Desserts/Confectionery/Vinegar, pickles and sauces/Cereals and cereal products
SYNONYMS:	Bixin/Norbixin/E160b/C.I. 75120 Natural Orange 4
FORMULA:	Bixin $C_{25}H_{30}O_4$; Norbixin $C_{25}H_{28}O_4$
MOLECULAR MASS IN Daltons:	Bixin 394.51; Norbixin 380.48
ALTERNATIVE FORMS:	*Cis* and *trans* bixin/*Cis* and *trans* norbixin/Alkali salts of norbixin
PROPERTIES AND APPEARANCE:	Reddish-brown powder, suspension or solution
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	Not known
FLASH POINT IN °C:	Not known
IONISATION CONSTANT AT 25°C:	Not known
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	Not known
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	EC: Solvent extracted annatto: Bixin powders not less than 75% total carotenoids calculated as bixin Norbixin powders not less than 25% total carotenoids calculated as norbixin Alkali-extracted annatto: not less than 0.1% of total carotenoids calculated as norbixin Oil-extracted annatto: not less than 0.1% of total carotenoids calculated as bixin

WATER CONTENT MAXIMUM IN %:	N/A
HEAVY METAL CONTENT MAXIMUM IN ppm:	40
ARSENIC CONTENT MAXIMUM IN ppm:	3
ASH MAXIMUM IN %:	Not known

SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:

Norbixin is water soluble; bixin is oil soluble. Norbixin precipitates in acidic aqueous solutions but acid-stable preparations are available.

in water:	**@ 20°C**	Norbixin up to 1% pigment concentration in alkaline solutions
	@ 50°C	Norbixin up to 3% pigment concentration in alkaline solutions
	@ 100°C	Norbixin up to 7% pigment concentration in alkaline solutions
in vegetable oil:	**@ 20°C**	Bixin up to 0.05% pigment concentration
	@ 50°C	Bixin up to 0.1% pigment concentration
	@ 100°C	Bixin up to 0.25% pigment concentration
in sucrose solution:	Aqueous norbixin solutions are soluble in sucrose solutions	
in sodium chloride solution:	Salt-stable preparation of norbixin are soluble in 5% and 10% salt solutions	
in ethanol solution:	Aqueous norbixin solutions are soluble in aqueous ethanol	
in propylene glycol:	Aqueous norbixin solutions are soluble in propylene glycol if the water content is higher than 20%	

FUNCTION IN FOODS:	An orange-yellow food colour suitable for a wide range of food applications.
ALTERNATIVES:	Other orange/yellow food colours, although not of exactly the same hue, include Carminic acid; Sunset Yellow; Paprika; Beta-carotene/mixed carotene
TECHNOLOGY OF USE IN FOODS:	Annatto can be used in the following forms: (1) Suspension/dilute solution, for oil-based applications. (2) Aqueous alkali solution for aqueous application; acid-proof forms are available for acidic media. Heat and light stability are generally good. However, with annatto being a carotenoid, sensitivity to oxidation can be a problem.
SYNERGISTS:	Food-grade emulsifiers can be used to produce acid-stable forms. Antioxidants in oil-based forms can help stability. An alkali such as KOH or NaOH renders norbixin water-soluble.

ANTAGONISTS: Sulphur dioxide/Divalent cations (e.g. Ca^{2+})/Acids

FOOD SAFETY ISSUES: None known

LEGISLATION:

USA:
Permitted as non-certified food colour according to 21 CFR 7330, 73.1030, 73.2030

UK and EUROPE:
Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annexes III and IV for restrictions on use

CANADA:
Permitted

AUSTRALIA:
Permitted

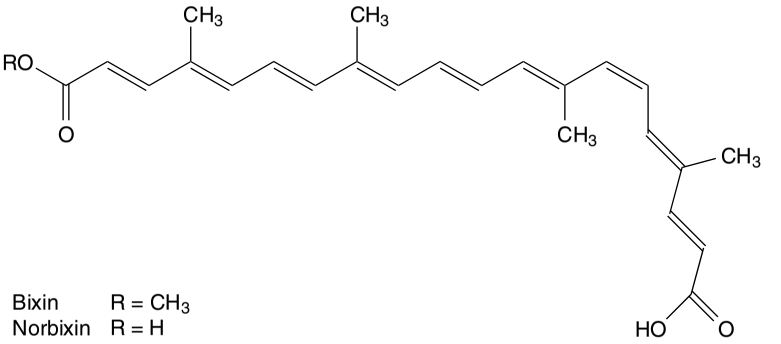
OTHER COUNTRIES:
Generally permitted in most countries

NOTE: In June 2006 JECFA allocated higher ADI figures for both norbixin and bixin. This will result in new JECFA specifications being issued and changes to the permitted levels of use.
INS 160b (i) has been allocated to Annatto Extract (bixin-based)
INS 160b (ii) has been allocated to Annatto Extract (norbixin-based)

REFERENCES:

Collins, P. (1992) The role of annatto in food colouring. *Food Ingredients and Processing International* February, 23–27.
Smith, J. (ed.) (1991) *Food Additive User's Handbook.* Blackie Academic and Professional, Glasgow.

STRUCTURE OF ANNATTO:



Bixin R = CH_3
Norbixin R = H

Note: also occurs as all-*trans* isomers.

NAME:	Anthocyanin
CATEGORY:	Food colour
FOOD USE:	Dairy products/Fruit, vegetable and nut products/Soft drinks/Alcoholic drinks/Sugars and preserves/Confectionery/Decorations and coatings/Edible ices/Desserts
SYNONYMS:	E163/Grapeskin extract/Enocianina/Cyanidin (3,3′,4′,5,7-Pentahydroxy-flavylium chloride)/Peonidin (3,4′,5,7-Tetrahydroxy-3′-methoxyflavylium chloride)/Malvidin (3,4′,5,7-Tetrahydroxy-3′,5′-dimethoxyflavylium chloride)/Delphinidin (3,5,7-Trihydroxy-2-(3,4,5-trihydroxyphenyl)-1-benzopyrilium chloride)/Petunidin (3,3′,4′,5,7-Pentahydroxy-5′-methoxyflavylium chloride)/Pelargonidin (3,5,7-Trihydroxy-2-(4-hydroxyphenyl)-1-benzopyrilium chloride)
FORMULA:	Cyanidin $C_{15}H_{11}O_6Cl$ Peonidin $C_{16}H_{13}O_6Cl$ Malvidin $C_{17}H_{15}O_7Cl$ Delphinidin $C_{15}H_{11}O_7Cl$ Petunidin $C_{16}H_{13}O_7Cl$ Pelargonidin $C_{15}H_{11}O_5Cl$
MOLECULAR MASS IN Daltons:	Cyanidin 322.6 Peonidin 336.7 Malvidin 366.7 Delphinidin 340.6 Petunidin 352.7 Pelargonidin 306.7
ALTERNATIVE FORMS:	Usually occur as glycosides (mono or di)
PROPERTIES AND APPEARANCE:	Not normally available in pure form. Generally available as an extract of the source fruit or vegetable. Extracts tend to be dark black/red liquids or powders with characteristic odour.
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	N/A
FLASH POINT IN °C:	N/A

IONISATION CONSTANT AT 25°C:	N/A					
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A					
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A					
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A					
PURITY %:	A standard grapeskin extract contains around 1% total anthocyanin pigments when in liquid form and 4% when in powder form.					
WATER CONTENT MAXIMUM IN %:	For a standard liquid grapeskin extract, typically 70					
HEAVY METAL CONTENT MAXIMUM IN ppm:	40					
ARSENIC CONTENT MAXIMUM IN ppm:	3					
ASH MAXIMUM IN %:	N/A					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	Completely soluble	**@ 50°C**	Completely soluble	**@ 100°C**	Completely soluble, but pigments will degrade
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in sucrose solution:						
10%	Completely soluble					
40%	Completely soluble					
60%	Completely soluble					
in sodium chloride solution:	Most purified anthocyanins are soluble in 5% and 10% sodium chloride solution; solubility depends on the botanical source of the anthocyanins.					

in ethanol solution:	
5%	Completely soluble
20%	Completely soluble
95%	Slightly soluble
100%	Slightly soluble
in propylene glycol:	Aqueous anthocyanin extracts are soluble in propylene glycol.
FUNCTION IN FOODS:	A water-soluble red/purple food colour for use in acidic food products.
ALTERNATIVES:	Other red/purple food colours, although not of exactly the same hue, include Beetroot Red; Carmine; Erythrosine; Carmoisine; Allura Red; Ponceau 4R; Amaranth; Red 2G
TECHNOLOGY OF USE IN FOODS:	Anthocyanins are fully water-soluble, but require an acidic environment to exhibit their characteristic red colour. At high temperatures (> 80°C), the anthocyanin pigments can degrade.
SYNERGISTS:	Ascorbic acid (although can degrade anthocyanin at high levels)/food acids (citric, etc.)
ANTAGONISTS:	Sulphur dioxide (bleaches monomeric anthocyanins, but has less effect on polymerised forms) Metal ions (Sn, Fe, etc.) Ascorbic acid at high levels
FOOD SAFETY ISSUES:	None known

LEGISLATION:

USA:
Generally permitted. The 21 CFR permits anthocyanins in four ways:
(1) 73.169 grape colour extract
(2) 73.170 grape skin extract (enocianina)
(3) 73.250 fruit juice
(4) 73.280 vegetable juice
The actual category then depends on the anthocyanin in question

UK and EUROPE:
Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Refer to Annex V Part 1 (of Directive 94/36/EC) for details of use

CANADA:
Generally permitted

AUSTRALIA:
Generally permitted

OTHER COUNTRIES:
Permitted in most countries of the world

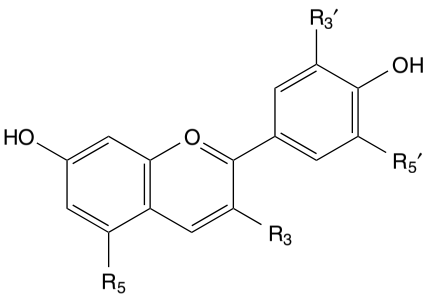
REFERENCES:

Goto, T. (1987) Structure, stability and colour variation of natural anthocyanins. In: Herz, W., Grisebach, H., Kirby, G.E. and Tamm, C. (eds) *Progress in the Chemistry of Organic Natural Products*. Springer-Verlag, New York, pp. 113–158.

Jackman, R.L., Yada, R.Y., Tung, M.A. and Speers, R.A. (1987) Anthocyanins as food colorants: a review. *Journal of Food Biochemistry* **11**, 201–247.

Smith, J. (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.

STRUCTURE OF ANTHOCYANINS:



Anthocyanidins		R_3 = OH	R_5 = OH
		R_3'	R_5'
Pelargonidin	(Pg)	H	H
Cyanidin	(Cy)	OH	H
Peonidin	(Pn)	OCH_3	H
Delphinidin	(Dp)	OH	OH
Petunidin	(Pt)	OCH_3	OH
Malvidin	(Mv)	OCH_3	OCH3

Anthocyanins: Pg, Cy, Pn, Dp, Pt, Mv

with R_3 = O–sugar
R_5 = OH or O–glucose

NAME:	Beetroot Red
CATEGORY:	Food colour
FOOD USE:	Baked goods/Cereals and cereal products/Dairy products/Meat and poultry products/Fruit, vegetable and nut products/Sugars and preserves/Confectionery/Vinegar, pickles and sauces/Decorations and coatings/Edible ices/Desserts/Seasonings
SYNONYMS:	Beet Red/Betanin
FORMULA:	$C_{24}H_{26}N_2O_{13}$
MOLECULAR MASS IN Daltons:	550.48
ALTERNATIVE FORMS:	None known
PROPERTIES AND APPEARANCE:	Red or dark-red liquid, paste, powder or solid
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	Not applicable
MELTING RANGE IN °C:	Not known
FLASH POINT IN °C:	Not known
IONISATION CONSTANT AT 25°C:	Not known
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	Not applicable
HEAT OF COMBUSTION AT 25°C IN J/kg:	Not applicable
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	Not known
PURITY %:	$\leq$0.4 betanin
WATER CONTENT MAXIMUM IN %:	N/A

HEAVY METAL CONTENT MAXIMUM IN ppm:	40					
ARSENIC CONTENT MAXIMUM IN ppm:	3					
ASH MAXIMUM IN %:	Not known					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	Readily soluble (0.5%)	**@ 50°C**	Readily soluble (0.5%)	**@ 100°C**	Readily soluble (0.5%)
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in sucrose solution:						
10%	Readily soluble (0.5%)					
40%	Readily soluble (0.5%)					
60%	Readily soluble (0.5%)					
in sodium chloride solution:						
5%	Readily soluble (0.5%)					
10%	Readily soluble (0.5%)					
15%	Readily soluble (0.1%)					
in ethanol solution:						
5%	Readily soluble (0.5%)					
20%	Readily soluble (0.5%)					
95%	Slightly soluble					
100%	Slightly soluble					
in propylene glycol:	**@ 20°C**	Readily soluble (0.5%)	**@ 50°C**	Readily soluble (0.5%)	**@ 100°C**	Readily soluble (0.5%)
FUNCTION IN FOODS:	A red/blue food colour suited to applications with little or no heat processing.					
ALTERNATIVES:	Other red food colours, although not of exactly the same hue, include Anthocyanins; Carmine; Carminic acid; Ponceau 4R; Carmoisine; Allura Red; Amaranth; Erythrosine					
TECHNOLOGY OF USE IN FOODS:	Beetroot Red in either liquid or powder form is suitable for a wide range of food applications. However, exposure to heat will degrade the pigment.					
SYNERGISTS:	Ascorbic acid					

ANTAGONISTS: Sulphur dioxide/Metal ions

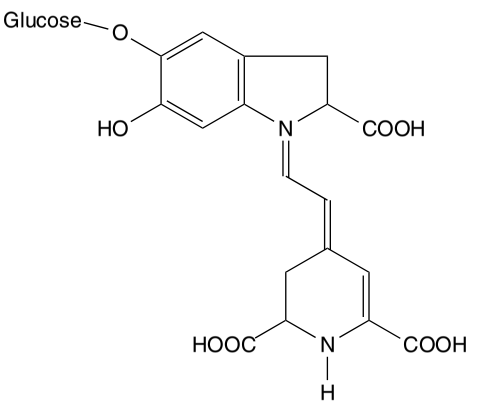
FOOD SAFETY ISSUES: None known

LEGISLATION:

USA:	UK and EUROPE:	CANADA:	AUSTRALIA:
Permitted as non-certified food colour according to 21 CFR 73.260	Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V Part 1 (of Directive 94/36/EC) for details of use	Permitted	Permitted

REFERENCE: Smith, J. (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.

STRUCTURE OF BETANIN:



NAME:	Beta-apo-8′-carotenal (C30)
CATEGORY:	Food colour
FOOD USE:	Soft drinks/Confectionery/Dairy products/Margarine and oils/Sauces/Processed cheese/Soups/Salad dressings/Ice-cream, edible ices/Canned products/Desserts
SYNONYMS:	E160e/C.I. 40820 (Food Orange 6)/β-apo-8′-carotenal/*Trans*-β-apo-8′-carotene-aldehyde
FORMULA:	$C_{30}H_{40}O$
MOLECULAR MASS IN Daltons:	416.65
ALTERNATIVE FORMS:	N/A
PROPERTIES AND APPEARANCE:	Dark violet crystals with metallic lustre or crystalline powder. Commercially available as suspensions of micronised crystals in vegetable oil or suspensions encapsulated to form fine granules.
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	136–140
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	Not less than 96% of total colouring matters
WATER CONTENT MAXIMUM IN %:	0.5
HEAVY METAL CONTENT MAXIMUM IN ppm:	40

ARSENIC CONTENT MAXIMUM IN ppm:	3					
ASH MAXIMUM IN %:	N/A					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 25°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in vegetable oil:	**@ 20°C**	0.07–1.5	**@ 50°C**	0.07–1.5	**@ 100°C**	0.07–1.5
in sucrose solution:						
10%	Insoluble					
40%	Insoluble					
60%	Insoluble					
in sodium chloride solution:						
5%	Insoluble					
10%	Insoluble					
15%	Insoluble					
in ethanol solution:						
5%	Insoluble					
20%	Insoluble					
95%	0.05					
100%	0.1					
in propylene glycol:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble

FUNCTION IN FOODS: Orange to orange/red food colour, depending on concentration. Water-miscible application forms are available.

ALTERNATIVES: Other orange food colours, although not of the same hue: Paprika; Sunset Yellow; Annatto

TECHNOLOGY OF USE IN FOODS: Available as a microcrystalline suspension in vegetable oil. To prepare a stock solution to colour margarine or oils, heat oil to 45–50°C and stir in about 30 g/L of suspension. If mixed with citrus oils, the oil may need to be heated to 70°C.

If used as 10% water-dispersible fine granules, add granules slowly to 10–15 times its weight of water at about 40°C with continuous stirring until all the particles are completely dispersed.

Reasonably stable to heat and light; stable to pH and acidic conditions. Stable to ascorbic acid.

Can oxidise, losing colour; hence stabilisation with antioxidants such as tocopherols is recommended.

When used to colour soft drinks it is recommended that the colour and flavour oils are homogenised before addition with the fruit juice and/or pulp to delay separation.

SYNERGISTS: Antioxidants such as tocopherols/ascorbic acid

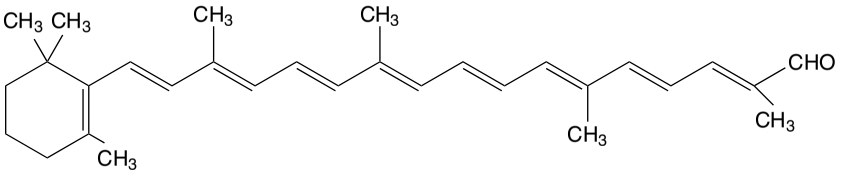
ANTAGONISTS: Oxidising agents/Peroxides

FOOD SAFETY ISSUES: Considered safe for food use. A vitamin A precursor.

LEGISLATION:

USA:	**UK and EUROPE:**	**CANADA:**	**AUSTRALIA:**
Permitted	Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008	Permitted, but restricted in use	Permitted

STRUCTURE OF β-APO-8′-CAROTENAL:



NAME:	Black iron oxide
CATEGORY:	Food colour
FOOD USE:	Confectionery coatings/Pet foods/Canned foods
SYNONYMS:	E172/C.I. 77499 (Pigment Black II)/Iron oxide black/Ferroso ferric oxide/Iron (II, III) oxide
FORMULA:	$FeO \cdot Fe_2O_3$
MOLECULAR MASS IN Daltons:	231.55
ALTERNATIVE FORMS:	N/A
PURITY %	Not less than 68% total iron, expressed as iron
WATER CONTENT MAXIMUM IN %:	N/A
HEAVY METAL CONTENT MAXIMUM IN ppm:	See relevant legislation for full details
ARSENIC CONTENT MAXIMUM IN ppm:	5
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** Insoluble **@ 50°C** Insoluble **@ 100°C** Insoluble
in vegetable oil:	**@ 20°C** Insoluble **@ 50°C** Insoluble **@ 100°C** Insoluble
in sucrose solution:	
10%	Insoluble
40%	Insoluble
60%	Insoluble
in sodium chloride solution:	
5%	Insoluble
10%	Insoluble
15%	Insoluble

in ethanol solution:							
5%	Insoluble						
20%	Insoluble						
95%	Insoluble						
100%	Insoluble						
in propylene glycol:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble	
ALTERNATIVES:	Vegetable carbon black powder						
TECHNOLOGY OF USE IN FOODS:	An insoluble heat- and light-stable black powder used mainly in canned or highly processed food and sugar-coated confectionery (dragees).						
SYNERGISTS:	None known						
ANTAGONISTS:	None known						
FOOD SAFETY ISSUES:	None known						
LEGISLATION:	**USA:** Not permitted	**UK and EUROPE:** Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V Part 1 (of Directive 94/36/EC) for details of use		**CANADA:** Permitted	**AUSTRALIA:** Permitted		
REFERENCE:	Smith, J (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.						

NAME:	Brilliant Black BN
CATEGORY:	Food colour
FOOD USE:	Sugar confectionery/Jams and preserves/Soft drinks
SYNONYMS:	Black PN/E151/C.I. 28440 (Food black 1)/Tetra sodium 4-acetamido-5-hydroxy-6-[7-sulfonato-4-(4 sulfonato phenylazo)-1-naphthylazo] naphthalene-1,7-disulfonate
FORMULA:	$C_{28}H_{17}N_5Na_4O_{14}S_4$
MOLECULAR MASS IN Daltons:	867.69
ALTERNATIVE FORMS:	Calcium salt/Potassium salt
PROPERTIES AND APPEARANCE:	Violet black powder or granules
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	N/A
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	Not less than 80% total colouring matter calculated on the sodium salt
WATER CONTENT MAXIMUM IN %:	20, but typically 3
HEAVY METAL CONTENT MAXIMUM IN ppm:	40

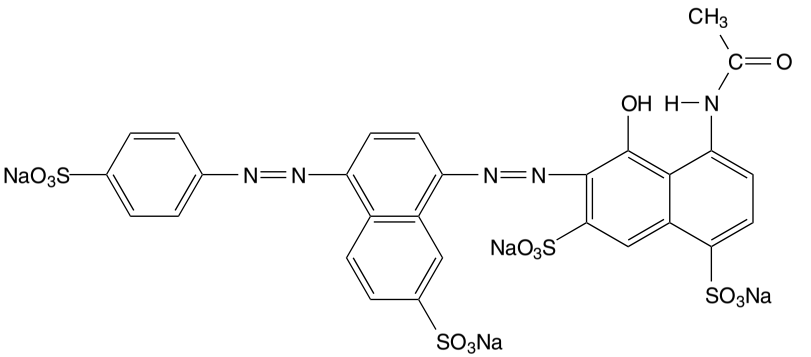
ARSENIC CONTENT MAXIMUM IN ppm:	3					
ASH MAXIMUM IN %:	N/A					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	5	**@ 50°C**	8	**@ 100°C**	15
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in sucrose solution:						
10%	5					
40%	4					
60%	2					
in sodium chloride solution:						
5%	Soluble					
10%	Insoluble					
15%	Insoluble					
in ethanol solution:						
5%	5					
20%	4					
95%	<0.1					
100%	<0.1					
in propylene glycol:	**@ 20°C**	1	**@ 50°C**	1.2	**@ 100°C**	1.5
FUNCTION IN FOODS:	Water-soluble violet food colour					
ALTERNATIVES:	Blends of other food colours to achieve a violet hue					
TECHNOLOGY OF USE IN FOODS:	A water-soluble violet food colour with excellent light stability, but poor heat stability. It has reasonable resistance to fruit acids and alkaline conditions. Fades in the presence of sulphur dioxide.					
SYNERGISTS:	None known					
ANTAGONISTS:	Sulphur dioxide/Ascorbic acid					
FOOD SAFETY ISSUES:	No known issues. Temporary ADI given. Additional toxicological data requested.					

LEGISLATION:	USA:	UK and EUROPE:	CANADA:	AUSTRALIA:
	Not permitted	Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V Part 2 (of Directive 94/36/EC) for a list of food categories and maximum levels of colour use	Not permitted	Permitted, but restrictions apply

REFERENCE:

Smith, J. (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.

STRUCTURE OF BRILLIANT BLACK BN:



NAME:	Brilliant Blue FCF
CATEGORY:	Food colour
FOOD USE:	Baked goods/Alcoholic drinks/Sauces and pickles/Confectionery/Coatings and decorations/Soups/Canned products/Dairy products/Snacks/Soft drinks/Cereal and cereal products/Meat and poultry products/Desserts/Edible ices/Fish products
SYNONYMS:	E133/FD&C Blue No. 1/C.I. 42090 (Food Blue 2)/disodium α-(4-(*N*-ethyl-3-sulfonatobenzyl amino)-phenyl)-α-(4-*N*-ethyl-3-sulfonatobenzyl imino)-cyclohexa-2,5-dienylidene) toluene-2-sulfonate
FORMULA:	$C_{37}H_{34}N_2Na_2O_9S_3$
MOLECULAR MASS IN Daltons:	792.84
ALTERNATIVE FORMS:	Calcium salt/Potassium salt/Aluminium lake (insoluble)
PROPERTIES AND APPEARANCE:	Reddish-blue powder or granules
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	Not known
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	Content not less than 85% total colouring matter, calculated as the sodium salt
WATER CONTENT MAXIMUM IN %:	15, but typically 3

HEAVY METAL CONTENT MAXIMUM IN ppm:	40					
ARSENIC CONTENT MAXIMUM IN ppm:	3					
ASH MAXIMUM IN %:	N/A					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	20	**@ 50°C**	20	**@ 100°C**	20
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in sucrose solution:						
10%	Soluble					
40%	Soluble					
60%	Soluble					
in sodium chloride solution:						
5%	Soluble					
10%	Insoluble					
15%	Insoluble					
in ethanol solution:						
5%	**25°C**	20	**60°C**	20		
20%	**25°C**	20	**60°C**	20		
95%	**25°C**	0.15	**60°C**	0.25		
100%	**25°C**	0.15	**60°C**	0.25		
in propylene glycol:	**@ 20°C**	20	**@ 50°C**	20	**@ 100°C**	20
FUNCTION IN FOODS:	Water-soluble, bright-blue food colour; or insoluble bright-blue food colour as the aluminium lake.					
ALTERNATIVES:	Other blue food colours, although not the same hue: Patent Blue V; Green S; Indigotine					
TECHNOLOGY OF USE IN FOODS:	A reasonably light-stable greenish-blue food colour with excellent heat stability. Stable in the presence of sodium benzoate, sulphur dioxide, fruit acids. Slight fading in the presence of 1% ascorbic acid. Fades in alkaline media.					
SYNERGISTS:	None known					
ANTAGONISTS:	Alkaline media/Ascorbic acid					

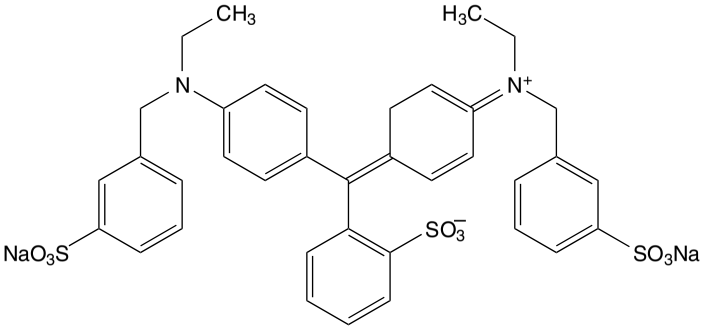
FOOD SAFETY ISSUES: None known

LEGISLATION:

USA:	**UK and EUROPE:**	**CANADA:**	**AUSTRALIA:**
FD&C Blue No. 1 certified food colour	Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Direcive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V Part 2 (of Directive 94/36/EC) for a list of food categories and maximum levels of colour use	Permitted if certified	Permitted, but restrictions apply

REFERENCE: Smith, J. (ed.) (1991) *Food Additive User's Handbook.* Blackie Academic & Professional, Glasgow.

STRUCTURE OF BRILLIANT BLUE FCF:



NAME:	Brown FK
CATEGORY:	Food colour
FOOD USE:	Smoked fish
SYNONYMS:	E154/C.I. Food Brown 1/A mixture of: (1) Sodium 4-(2,4-diaminophenylazo) benzene sulfonate (2) Sodium 4-(4,6-diamino-*H*-tolylazo) benzene sulfonate (3) Disodium 4,4′-(4,6-diamino-1,3-phenylene bisazo)di(benzene sulfonate) (4) Disodium 4,4′-(2,4-diamino-1,3-phenylene bisazo)di(benzene sulfonate) (5) Disodium 4,4′-(2,4-diamino-5-methyl-1,3-phenylene bisazo)di(benzene sulfonate) (6) Trisodium 4,4′,4″-(2,4-diaminobenzene-1,3,5-trisazo)tri-(benzene sulfonate)
FORMULA:	(1) $C_{12}H_{11}N_4NaO_3S$ (2) $C_{13}H_{13}N_4NaO_3S$ (3) $C_{18}H_{14}N_6Na_2O_6S_2$ (4) $C_{18}H_{14}N_6Na_2O_6S_2$ (5) $C_{19}H_{16}N_6Na_2O_6S_2$ (6) $C_{24}H_{17}N_8Na_3O_9S_3$
MOLECULAR MASS IN Daltons:	(1) 314.30; (2) 328.33; (3) 520.46; (4) 520.46; (5) 534.47; (6) 726.59
ALTERNATIVE FORMS:	Calcium salt/Potassium salt/Aluminium lake (insoluble)
PROPERTIES AND APPEARANCE:	Red-brown powder or granules
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	Not known
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A

HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A					
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A					
PURITY %:	Not less than 70% total colouring matter calculated as the sodium salt					
WATER CONTENT MAXIMUM IN %:	30, but typically 3					
HEAVY METAL CONTENT MAXIMUM IN ppm:	40					
ARSENIC CONTENT MAXIMUM IN ppm:	3					
ASH MAXIMUM IN %:	N/A					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	20	**@ 50°C**	20	**@ 100°C**	20
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in sucrose solution:						
10%	20					
40%	20					
60%	20					
in sodium chloride solution:						
5%	20					
10%	20					
15%	20					
in ethanol solution:						
5%	20					
20%	20					
95%	Slightly soluble					
100%	Slightly soluble					
in propylene glycol:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble

FUNCTION IN FOODS: A water-soluble brown food colour

ALTERNATIVES: Other brown food colours, although not the same hue, include Brown HT; Caramels; Blends of food colours to achieve a brown shade. For smoked fish, annatto can be used.

TECHNOLOGY OF USE IN FOODS: A light-stable, reddish-brown food colour with high water solubility. Resistant to brine solutions and mainly used for colouring of smoked fish, but bonds onto protein and has been used to colour meat products. Reasonably heat stable to 105°C. Fair resistance to fruit acids, alkaline media, benzoic acid. Fades in the presence of sulphur dioxide.

SYNERGISTS: None known

ANTAGONISTS: Sulphur dioxide

FOOD SAFETY ISSUES: Insufficient toxicological studies have been carried out to determine an ADI. Use restricted in Europe to kipper coloration (smoked cured herrings). Maximum level 20 mg/kg.

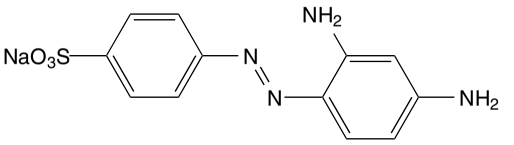
LEGISLATION:

USA:	**UK and EUROPE:**	**CANADA:**	**AUSTRALIA:**
Not permitted	Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008	Not permitted	Not permitted

REFERENCE: Smith, J. (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.

STRUCTURE OF BROWN FK:

Essentially a mixture of:



plus five related compounds

NAME:	Brown HT
CATEGORY:	Food colour
FOOD USE:	Baked goods/Dairy products/Confectionery/Edible ices/Desserts/Soups/Canned products/Snacks/Decorations and coatings/Sauces, seasonings
SYNONYMS:	E155/C.I. 20285 (Food Brown 3)/Disodium 4,4′-(2,4-dihydroxy-5-hydroxymethyl-1,3-phenylene bisazo) di(naphthalene-l-sulfonate)/Chocolate brown HT
FORMULA:	$C_{27}H_{18}N_4Na_2O_9S_2$
MOLECULAR MASS IN Daltons:	652.57
ALTERNATIVE FORMS:	Potassium salt/Calcium salt/Aluminium lake (insoluble)
PROPERTIES AND APPEARANCE:	Reddish-brown powder or granules
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	N/A
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	Not less than 70% total colouring matter calculated as the sodium salt
WATER CONTENT MAXIMUM IN %:	30, but typically 3
HEAVY METAL CONTENT MAXIMUM IN ppm:	40

ARSENIC CONTENT MAXIMUM IN ppm:	3					
ASH MAXIMUM IN %:	N/A					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	20	**@ 50°C**	20	**@ 100°C**	20
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in sucrose solution:						
10%	20					
40%	20					
60%	Soluble					
in sodium chloride solution:						
5%	Soluble					
10%	Insoluble					
15%	Insoluble					
in ethanol solution:						
5%	Insoluble					
20%	Insoluble					
95%	Insoluble					
100%	Insoluble					
in propylene glycol:	**@ 20°C**	15	**@ 50°C**	15	**@ 100°C**	20
FUNCTION IN FOODS:	Water-soluble brown food colour or insoluble brown food colour as the aluminium lake. A chocolate shade.					
ALTERNATIVES:	Other brown food colours, although not the same hue, include Caramels; Blends of food colours to achieve a brown shade; Brown FK where permitted					
TECHNOLOGY OF USE IN FOODS:	A heat- and light-stable food colour with high water solubility. Excellent for baked products, stable on baking to 200°C. Good stability in the presence of fruit acids. Good stability in alkaline media. Some fading in the presence of sulphur dioxide.					
SYNERGISTS:	None known					
ANTAGONISTS:	Sulphur dioxide					

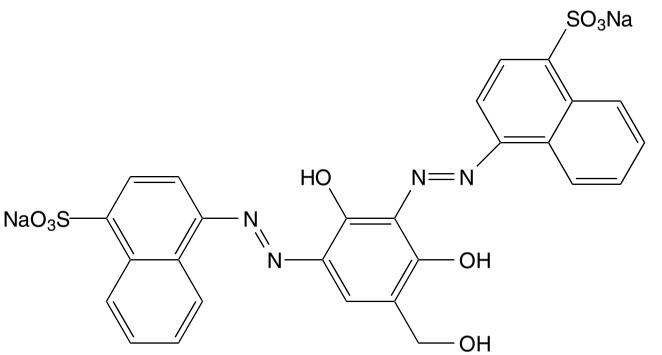
FOOD SAFETY ISSUES: None known

LEGISLATION:

USA:	UK and EUROPE:	CANADA:	AUSTRALIA:
Not permitted	Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V Part 2 (of Directive 94/36/EC) for a list of food categories and maximum levels of colour use	Not permitted	Permitted, but restrictions apply

REFERENCE: Smith, J. (ed.) (1991) *Food Additive User's Handbook.* Blackie Academic & Professional, Glasgow.

STRUCTURE OF BROWN HT:



NAME:	Calcium carbonate
CATEGORY:	Food colour
FOOD USE:	Sugar confectionery/Dairy creamers
SYNONYMS:	E170/C.I. 77220 Pigment White 18/Chalk
FORMULA:	$CaCO_3$
MOLECULAR MASS IN Daltons:	100.1
ALTERNATIVE FORMS:	N/A
PROPERTIES AND APPEARANCE:	White crystalline or amorphous powder
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	N/A
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	Not less than 98 on anhydrous basis
WATER CONTENT MAXIMUM IN %:	Not specified
HEAVY METAL CONTENT MAXIMUM IN ppm:	Lead: not more than 10
ARSENIC CONTENT MAXIMUM IN ppm:	3

ASH MAXIMUM IN %:	N/A					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	Insoluble in pure water	**@ 50°C**	Insoluble in pure water	**@ 100°C**	Insoluble in pure water
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
FUNCTION IN FOODS:	Insoluble white food colour					
ALTERNATIVES:	Titanium dioxide					
TECHNOLOGY OF USE IN FOODS:	Insoluble white food colour used to impart a white opaque effect to food products such as sugar confectionery, non-dairy creamers and salad dressings. Colour must be dispersed into a suitable medium since it is insoluble in solvents except acids. Dissolves readily in acidic media. Dissolves slowly in water containing carbon dioxide.					
SYNERGISTS:	None known					
ANTAGONISTS:	Food acids					
FOOD SAFETY ISSUES:	None known					
LEGISLATION:	**USA:** Not permitted as a food colour	**UK and EUROPE:** Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V Part 1 (of Directive 94/36/EC) for details of use	**CANADA:** Not permitted as a food colour	**AUSTRALIA:** Not permitted as a food colour		
REFERENCE:	Smith, J. (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.					

NAME:	Canthaxanthin
CATEGORY:	Food colour
FOOD USE:	Sausages/Sauces/Fish products/Confectionery/Soups/Tomato-based products/Processed cheese/ Ice-cream/Soft drinks/Salad dressings/Desserts/Meat products/Dairy products
SYNONYMS:	E161g/C.I. 40850 (Food Orange 8)/β-carotene-4,4′-dione/4,4′-Dioxo-β-carotene/4,4′-Diketo-β carotene
FORMULA:	$C_{40}H_{52}O_2$
MOLECULAR MASS IN Daltons:	564.86
ALTERNATIVE FORMS:	N/A
PROPERTIES AND APPEARANCE:	Deep violet crystals or crystalline powder
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	About 210 (decomposes)
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	Not less than 96% of total colouring matters
WATER CONTENT MAXIMUM IN %:	4, but typically less than 1
HEAVY METAL CONTENT MAXIMUM IN ppm:	40
ARSENIC CONTENT MAXIMUM IN ppm:	3

ASH MAXIMUM IN %:	N/A					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in vegetable oil:	**@ 20°C**	0.005	**@ 50°C**	0.01	**@ 100°C**	0.05
in sucrose solution:						
10%	Insoluble					
40%	Insoluble					
60%	Insoluble					
in sodium chloride solution:						
5%	Insoluble					
10%	Insoluble					
15%	Insoluble					
in ethanol solution:						
5%	Slightly soluble					
20%	Very slightly soluble					
95%	Below 0.01					
100%	Below 0.01					
in propylene glycol:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
FUNCTION IN FOODS:	Pink to red food colour, depending on concentration.					
ALTERNATIVES:	Other pink to red food colours, although not the same hue: Carmine; Ponceau 4R; Erythrosine					
TECHNOLOGY OF USE IN FOODS:	Commercially available as colloidal canthaxanthin in a gelatin carbohydrate matrix containing antioxidants. Disperse beadlets in 10–15 times its weight of water at 30–40°C with continuous stirring until all the particles are completely dispersed. Good stability to heat, light, and acidic and alkaline media. Stable to pH change and ascorbic acid. Can oxidise, losing colour; hence stabilisation with antioxidants such as tocopherols is recommended.					
SYNERGISTS:	Antioxidants such as tocopherols/Ascorbic acid					
ANTAGONISTS:	Oxidising agents/Peroxides					

FOOD SAFETY ISSUES:

The poor solubility in the blood on ingestion has caused this colour to be retained by the body longer than some medical authorities like when taken in large quantities. Thus its use has been restricted by some authorities.

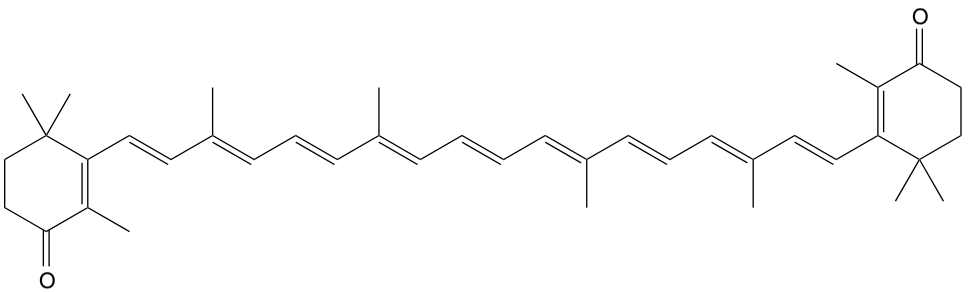
LEGISLATION:

USA:	**UK and EUROPE:**	**CANADA:**	**AUSTRALIA:**
Permitted according to 21 CFR 73.75	Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex IV: restricted for use in saucisses de Strasbourg at 15 mg/kg maximum	Permitted	Not permitted

REFERENCE:

Smith, J. (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.

STRUCTURE OF CARMINIC ACID:



NAME:	Carmine
CATEGORY:	Food colour
FOOD USE:	Baked goods/Cereals and cereal products/Dairy products/Fish, seafood products/Meat and poultry products/Fruit, vegetable and nut products/Soft drinks/Sugars and preserves/Confectionery/Vinegar, pickles and sauces/Decorations and coatings/Edible ices/Desserts/Seasonings
SYNONYMS:	E120/C.I. 75470/Hydrated aluminium chelate (lake) of carminic acid
FORMULA:	See carminic acid
MOLECULAR MASS IN Daltons:	See carminic acid
ALTERNATIVE FORMS:	Calcium aluminium lake of carminic acid
PROPERTIES AND APPEARANCE:	Red to dark red, friable, solid or powder
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	Not applicable
MELTING RANGE IN °C:	Not applicable
FLASH POINT IN °C:	Not known
IONISATION CONSTANT AT 25°C:	Not known
DENSITY AT 20°C (AND OTHER TEMPERATURES) g/L:	Not applicable
HEAT OF COMBUSTION AT 25°C IN J/kg:	Not known
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	Not applicable
PURITY %:	≥50% carminic acid
WATER CONTENT MAXIMUM IN %:	Not specified, but typically 10

HEAVY METAL CONTENT MAXIMUM IN ppm: 40

ARSENIC CONTENT MAXIMUM IN ppm: 3

SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:

in water:	**@ 20°C**	Insoluble in water Soluble in alkali, pH12 (2%)	**@ 50°C**	Soluble in alkali, pH12 (10%)	**@ 100°C**	Soluble in alkali, pH12 (15%)
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in sucrose solution:						
10%	Insoluble					
40%	Insoluble					
60%	Insoluble					
in sodium chloride solution:						
5%	Insoluble					
10%	Insoluble					
15%	Insoluble					
in ethanol solution:						
5%	Insoluble					
20%	Insoluble					
95%	Insoluble					
100%	Insoluble					
in propylene glycol:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble

Note: aqueous solutions of carmine are soluble in sucrose solution and propylene glycol.

FUNCTION IN FOODS: A red/pink food colour

ALTERNATIVES: Other red food colours, although not of exactly the same hue, include Beetroot Red; Anthocyanin; Carmoisine; Allura Red; Ponceau 4R; Erythrosine

TECHNOLOGY OF USE IN FOODS: Carmine can be used in its insoluble lake form as a pigment to impart surface colour or colour to opaque foodstuffs. Alternatively, an alkaline solution can be used to provide a water-soluble form suitable for use in a wide range of foodstuffs. Stability to heat, light and oxidation is excellent.

SYNERGISTS: Alkali salts can produce water-soluble solutions of carmine.

ANTAGONISTS: The action of heat in an acidic environment can de-lake the carmine and release carminic acid.

FOOD SAFETY ISSUES: None known

LEGISLATION:

USA:
Permitted as a non-certified food colour according to 21 CFR 73.100, 73.1100, 73.2087

UK and EUROPE:
Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V Part 2 (of Directive 94/36/EC) for a list of food categories and maximum levels of colour use

CANADA:
Permitted

AUSTRALIA:
Permitted

OTHER COUNTRIES:
Generally permitted in most countries

REFERENCES:

Lloyd, A.G. (1980) Extraction and chemistry of cochineal. *Food Chemistry* **5**, 91–107.
Smith, J. (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.

NAME:	Carminic acid
CATEGORY:	Food colour
FOOD USE:	Dairy products/Meat and poultry products/Soft drinks/Sugars and preserves/Confectionery/Decorations and coatings/Edible ices/Desserts/Seasonings
SYNONYMS:	Cochineal/E120/C.I. 75470/7-β-D-glucopyranosyl-3,5,6,8-tetrahydroxy-l-methyl-9,10-dioxoanthracene-2-carboxylic acid
FORMULA:	$C_{22}H_{20}O_{13}$
MOLECULAR MASS IN Daltons:	492.39
ALTERNATIVE FORMS:	The aluminium lake is known as carmine
PROPERTIES AND APPEARANCE:	A red/orange powder, or a dark red liquid
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	Not applicable
MELTING RANGE IN °C:	Not known
FLASH POINT IN °C:	Not known
IONISATION CONSTANT AT 25°C:	Not known
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	Not applicable
HEAT OF COMBUSTION AT 25°C IN J/kg:	Not known
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mm Hg:	Not applicable
PURITY %:	≤2.0% carminic acid in aqueous extracts
WATER CONTENT MAXIMUM IN %:	Not specified

HEAVY METAL CONTENT MAXIMUM IN ppm:	40					
ARSENIC CONTENT MAXIMUM IN ppm:	3					
ASH MAXIMUM IN %:	Not known					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	Readily soluble (3%)	**@ 50°C**	Readily soluble (5%)	**@ 100°C**	Readily soluble (10%)
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in sucrose solution:						
10%	Readily soluble (5%)					
40%	Readily soluble (5%)					
60%	Readily soluble (5%)					
in sodium chloride solution:						
5%	Partially soluble					
10%	Partially soluble					
15%	Partially soluble					
in ethanol solution:						
5%	Readily soluble (5%)					
20%	Readily soluble (5%)					
95%	Soluble (5%)					
100%	Soluble (5%)					
in propylene glycol:	Aqueous extracts of cochineal are soluble in propylene glycol					
FUNCTION IN FOODS:	A bright yellow/orange to red/purple food colour dependent on pH. Acidic environments give yellow/orange colours, becoming progressively redder as the pH approaches neutral.					
ALTERNATIVES:	Sunset Yellow; Carmine; Beetroot Red; Beta-carotene; Paprika; β-Apo-8-carotenal					
TECHNOLOGY OF USE IN FOODS:	Carminic acid is generally used in an aqueous alcoholic solution and gives a colour that is very pH-dependent: pH3 → yellow; pH7 → red/purple. Stability to heat, light and oxygen is excellent.					
SYNERGISTS:	None known					

ANTAGONISTS: Sulphur dioxide/Metal ions (e.g. Al^{3+})

FOOD SAFETY ISSUES: None known

LEGISLATION:

USA:
Permitted as non-certified food colour according to 21 CFR 73.100, 73.1100

UK and EUROPE:
Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V Part 2 (of Directive 94/36/EC) for a list of food categories and maximum levels of colour use

CANADA:
Permitted

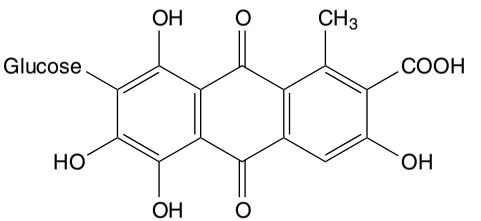
AUSTRALIA:
Permitted

OTHER COUNTRIES:
Generally permitted in most countries

REFERENCES:

Lloyd, A.G. (1980) Extraction and chemistry of cochineal. *Food Chemistry* **5**, 91–107.
Smith, J. (ed.) (1991) *Food Additive Users Handbook*. Blackie Academic & Professional, Glasgow.

STRUCTURE OF CARMINIC ACID:



NAME:	Carmoisine
CATEGORY:	Food colour
FOOD USE:	Baked goods/Meat and poultry products/Soft drinks/Fruit, vegetable and nut products/Beverages/Edible ices/ Sugars and preserves/Confectionery/Desserts/Vinegar, pickles and sauces/Decorations and coatings/ Seasonings/Cereals and cereal products/Dairy products/Soups/Snacks
SYNONYMS:	Azorubine/E122/C.I. 14720 (Food Red 3)/Disodium 4-hydroxy-3-(4-sulfonato-1-naphthylazo) naphthalene-1-sulfonate
FORMULA:	$C_{20}H_{12}N_2Na_2O_7S_2$
MOLECULAR MASS IN Daltons:	502.44
ALTERNATIVE FORMS:	Calcium salt/Potassium salt/Aluminium lake
PROPERTIES AND APPEARANCE:	Red to maroon powder or granules
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	N/A
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	Not less than 85% dye content calculated as the sodium salt
WATER CONTENT MAXIMUM IN %:	15, but typically 3

HEAVY METAL CONTENT MAXIMUM IN ppm:	40					
ARSENIC CONTENT MAXIMUM IN ppm:	3					
ASH MAXIMUM IN %:	N/A					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	8	**@ 50°C**	8	**@ 100°C**	8
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in sucrose solution:						
10%	8					
40%	8					
60%	8					
in sodium chloride solution:						
5%	Soluble					
10%	Insoluble					
15%	Insoluble					
in ethanol solution:						
5%	Soluble					
20%	Slightly soluble					
95%	<0.1					
100%	<0.1					
in propylene glycol:	**@ 20°C**	1	**@ 50°C**	1	**@ 100°C**	2
FUNCTION IN FOODS:	Water-soluble red food colour or insoluble red food colour as the aluminium lake.					
ALTERNATIVES:	Other red food colours, although not of exactly the same hue, include Carmine; Ponceau 4R; Allura Red; Erythrosine; Beet Red; Anthocyanins (in acidic media); Red 2G (where permitted)					
TECHNOLOGY OF USE IN FOODS:	A robust red colour with good light stability. Fairly stable in use to 105°C. Fades in the presence of sulphur dioxide, and alkaline media. Will fade with heat.					
SYNERGISTS:	None known					

ANTAGONISTS: Sulphur dioxide/Alkaline media

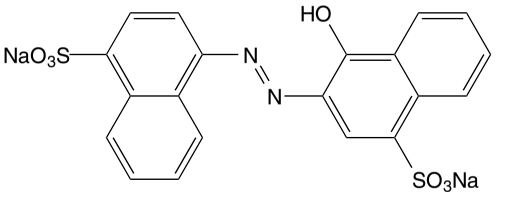
FOOD SAFETY ISSUES: None known

LEGISLATION:

USA:	UK and EUROPE:	CANADA:	AUSTRALIA:
Not permitted	Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V Part 2 (of Directive 94/36/EC) for a list of food categories and maximum levels of colour use	Not permitted	Permitted, but restrictions apply

REFERENCE: Smith, J. (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.

STRUCTURE FOR CARMOISINE:



NAME:	Beta-carotene
CATEGORY:	Food colour
FOOD USE:	Baked goods/Cereal and cereal products/Dairy products/Fish and seafood products/Meat and poultry products/Egg products/Fruit, vegetable and nut products/Soft drinks/Sugars and preserves/Confectionery/Vinegar, pickles and sauces/Decorations and coatings/Edible ices/Desserts/Seasonings
SYNONYMS:	E160a (ii)/C.I. 40800 Food Orange 5
FORMULA:	$C_{40}H_{56}$
MOLECULAR MASS IN Daltons:	536.88
ALTERNATIVE FORMS:	*Cis* and *trans* forms
PROPERTIES AND APPEARANCE:	Red to brownish-red crystals or crystalline powder
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	Not applicable
MELTING RANGE IN °C:	176–182
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	Not applicable
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	Not applicable
PURITY %:	$\leq$96
WATER CONTENT MAXIMUM IN %:	2

HEAVY METAL CONTENT MAXIMUM IN ppm:	Not more than 2 ppm lead					
ARSENIC CONTENT MAXIMUM IN ppm:	Not specified					
ASH MAXIMUM IN %:	Not specified					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in vegetable oil:	**@ 20°C**	0.05	**@ 50°C**	0.10	**@ 100°C**	0.25
in sucrose solution:						
10%	Insoluble					
40%	Insoluble					
60%	Insoluble					
in sodium chloride solution:						
5%	Insoluble					
10%	Insoluble					
15%	Insoluble					
in ethanol solution:						
5%	Insoluble					
20%	Insoluble					
95%	<0.01					
100%	<0.01					
in propylene glycol:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
FUNCTION IN FOODS:	A bright yellow to orange food colour					
ALTERNATIVES:	Other yellow/orange food colours, although not of exactly the same hue, include Mixed carotenes; Annatto; Carminic acid; Sunset Yellow; Paprika					
TECHNOLOGY OF USE IN FOODS:	For oil-based applications (e.g. yellow fats) a suspension in oil can be applied directly or made into a stock solution in vegetable oil at 45–50°C. For aqueous food products water-dispersible forms are attained, generally with a food-grade emulsifier. Typical water-dispersible forms contain 1–10% beta-carotene, and in powdered form need to be slowly added to water at 40°C (approximately 1 part to 15 parts of water). E160a (ii) covers two products: Beta-carotene (obtained by synthesis); Beta-carotene from *Blakeslea trispora*.					

SYNERGISTS: Antioxidants/Emulsifiers

ANTAGONISTS: Sulphur dioxide/Oxygen/Metal ions

FOOD SAFETY ISSUES: None known

LEGISLATION:

USA:
Permitted as a non-certified food colour according to 21 CFR 73.95

UK and EUROPE:
Permitted according to European Parliament and Council Directive 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V, Part I (of Directive 94/36/EC) for details of use

CANADA:
Permitted

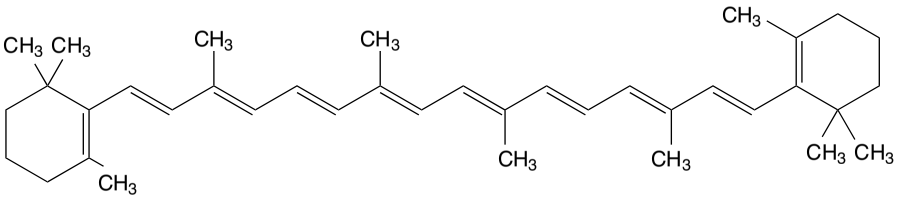
AUSTRALIA:
Permitted

OTHER COUNTRIES:
Generally permitted in most countries

REFERENCES:

Killeit, U. (1991) Beta-carotene: more than a colorant. *Food Marketing and Technology* November, 23–27.
Smith, J. (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.

STRUCTURE OF BETA-CAROTENE:



$C_{40}H_{56}$

NAME:	Caustic sulphite caramel
CATEGORY:	Food colour
FOOD USE:	Baked goods/Cereal and cereal products/Dairy products/Meat and poultry products/Soft drinks/Sugars and preserves/Confectionery/Vinegars, pickles and sauces/Decorations and coatings/Edible ices/Desserts/ Seasonings/Savoury dry mixes
SYNONYMS:	E150b
FORMULA:	Not known
MOLECULAR MASS IN Daltons:	Not known
ALTERNATIVE FORMS:	N/A
PROPERTIES AND APPEARANCE:	Dark brown to black liquids or powders
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	N/A
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	Colour intensity 0.05–0.13 based on absorbance of a 0.1% solution of caramel colour in water in a 1-cm cell at 610 nm.
WATER CONTENT MAXIMUM IN %:	Typically 40 for liquids

HEAVY METAL CONTENT MAXIMUM IN ppm:	25					
ARSENIC CONTENT MAXIMUM IN ppm:	1					
ASH MAXIMUM IN %:	N/A					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	Completely soluble	**@ 50°C**	Completely soluble	**@ 100°C**	Completely soluble
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in sucrose solution:						
10%	Completely soluble					
40%	Completely soluble					
60%	Completely soluble					
in sodium chloride solution:						
5%	Completely soluble					
10%	Completely soluble					
15%	Completely soluble					
in ethanol solution:						
5%	Not stable (haze or precipitate)					
20%	Not stable (haze or precipitate)					
95%	Not stable (haze or precipitate)					
100%	Not stable (haze or precipitate)					
in propylene glycol:	**@ 20°C**	Dispersible	**@ 50°C**	Dispersible	**@ 100°C**	Dispersible
FUNCTION IN FOODS:	A water-soluble brown food colour					
ALTERNATIVES:	E150a, c and d; Brown HT; Brown FK					
TECHNOLOGY OF USE IN FOODS:	Fully water-soluble in both liquid and powder forms. To dissolve powders, use warm water. For dry mixes (i.e. instant desserts), the powdered form is used and dissolves when reconstituted by the consumer. *Note*: caustic sulphite caramels are negatively charged.					
SYNERGISTS:	N/A					

ANTAGONISTS:	N/A			
LEGISLATION:	**USA:** Permitted according to 21 CFR Part 73.85	**UK and EUROPE:** Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V Part 1 (of Directive 94/36/EC) for details of use	**CANADA:** Permitted	**AUSTRALIA:** Permitted
REFERENCE:	Smith, J. (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.			

NAME:	Chlorophyll
CATEGORY:	Food colour
FOOD USE:	Dairy products/Soft drinks/Alcoholic drinks/Sugars and preserves/Confectionery/Vinegars, pickles and sauces/Decorations and coatings/Edible ices/Desserts
SYNONYMS:	E140(i)/C.I. 75810/Natural Green 3/Magnesium chlorophyll/Magnesium phaeophytin
FORMULA:	Chlorophyll *a* $C_{55}H_{72}MgN_4O_5$; Chlorophyll *b* $C_{55}H_{70}MgN_4O_6$
MOLECULAR MASS IN Daltons:	Chlorophyll *a* 893.51; Chlorophyll *b* 907.49
ALTERNATIVE FORMS:	N/A
PROPERTIES AND APPEARANCE:	Waxy solid ranging in colour from olive green to dark green depending on the content of coordinated magnesium.
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	Chlorophyll *a* 117–120; Chlorophyll *b* 120–130
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	$\leq$10
WATER CONTENT MAXIMUM IN %:	Typically less than 2
HEAVY METAL CONTENT MAXIMUM IN ppm:	40

ARSENIC CONTENT MAXIMUM IN ppm:	3					
ASH MAXIMUM IN %:	Not specified					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in vegetable oil:	**@ 20°C**	Completely soluble	**@ 50°C**	Completely soluble	**@ 100°C**	Completely soluble
in sucrose solution:						
10%	Insoluble					
40%	Insoluble					
60%	Insoluble					
in sodium chloride solution:						
5%	Insoluble					
10%	Insoluble					
15%	Insoluble					
in ethanol solution:						
5%	Insoluble					
20%	Slightly soluble					
95%	5					
100%	5					
in propylene glycol:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
FUNCTION IN FOODS:	An oil-soluble olive-green food colour. Can be rendered water-dispersible by use of a suitable emulsifier.					
ALTERNATIVES:	Other green colours, although not of the same hue (and not necessarily oil-soluble), include Green S E142; Copper chlorophyll(in)					
TECHNOLOGY OF USE IN FOODS:	Fully oil-soluble, so can be used in concentrated or dilution in oil for direct addition to oil-based foodstuffs. Exposure to heat (> 65°C), particularly if prolonged, will denature the pigment, with the colour becoming progressively more yellow. For water-based foodstuffs, a water-dispersible form based on a suitable emulsifier can be used. Again, sensitivity to heat and oxidation will limit potential.					
SYNERGISTS:	Antioxidants/Copper (but this forms the copper complex, E141)					

ANTAGONISTS: Sulphur dioxide/Metal ions

FOOD SAFETY ISSUES: None known

LEGISLATION:

USA:
Not permitted unless as a vegetable juice
21 CFR 73.260

UK and EUROPE:
Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V, Part 1 for details of use

CANADA:
Permitted

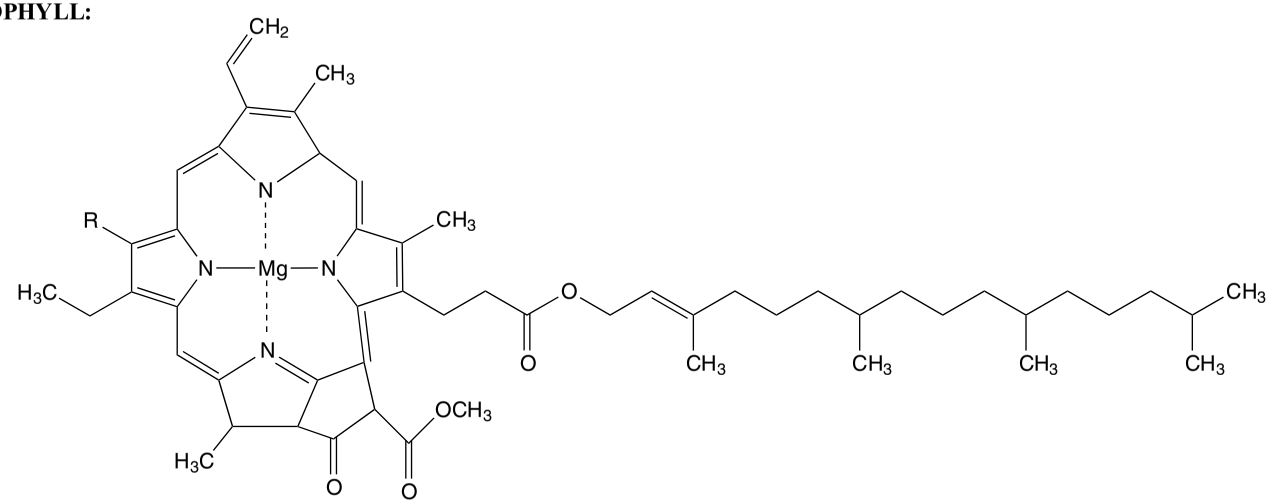
AUSTRALIA:
Permitted

OTHER COUNTRIES:
Generally permitted in most countries of the world

REFERENCE:

Smith, J. (ed.) (1991) *Food Additive User's Handbook.* Blackie Academic & Professional, Glasgow.

STRUCTURE OF CHLOROPHYLL:



Chlorophyll a R = CH_3

Chlorophyll b R = CHO

NAME:	Chlorophyllins
CATEGORY:	Food colour
FOOD USE:	Dairy products/Cereals/Soft drinks/Sugars and preserves/Confectionery/Vinegars, pickles and sauces/ Decorations and coatings/Edible ices/Desserts
SYNONYMS:	E140 (ii)/C.I. 75815/C.I. Natural Green 5
FORMULA:	Chlorophyllin *a* $C_{34}H_{34}N_4O_5$; Chlorophyllin *b* $C_{34}H_{32}N_4O_6$
MOLECULAR MASS IN Daltons:	Chlorophyllin *a* 578.68; Chlorophyllin *b* 592.66
ALTERNATIVE FORMS:	Sodium chlorophyllin/Potassium chlorophyllin
PROPERTIES AND APPEARANCE:	Dark green to blue/black powder
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	Not known
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 25°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	$\leq$95 total chlorophyllins on a dry weight basis
WATER CONTENT MAXIMUM IN %:	Typically 3
HEAVY METAL CONTENT MAXIMUM IN ppm:	40

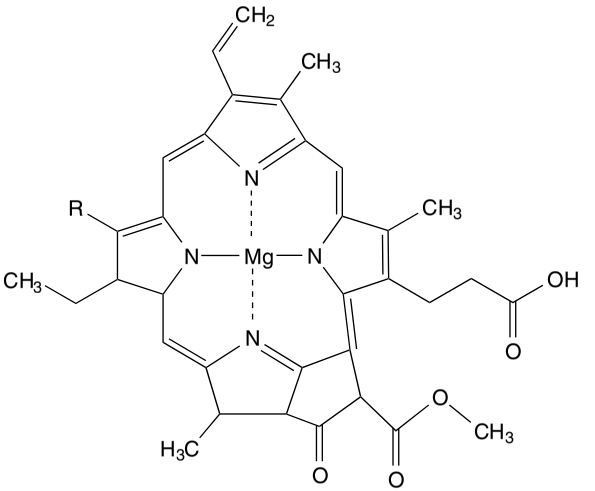
ARSENIC CONTENT MAXIMUM IN ppm:	3					
ASH MAXIMUM IN %:	Not specified					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	Completely soluble	**@ 50°C**	Completely soluble	**@ 100°C**	Completely soluble
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in sucrose solution:						
10%	Completely soluble					
40%	Completely soluble					
60%	Completely soluble					
in sodium chloride solution:						
5%	Completely soluble					
10%	Soluble					
15%	Soluble					
in ethanol solution:						
5%	Completely soluble					
20%	Completely soluble					
95%	Slightly soluble					
100%	Slightly soluble					
in propylene glycol:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
FUNCTION IN FOODS:	A water-soluble green to olive-green food colour					
ALTERNATIVES:	Other green colours, although not of the same hue, include Green S E142; Copper chlorophyll(in); Chlorophyll					
TECHNOLOGY OF USE IN FOODS:	Readily water soluble, since in powdered form a pre-dilution is helpful. Stability to heat and oxidation is relatively poor, so may only be suitable in certain applications.					
SYNERGISTS:	Antioxidants/Copper (however, the copper complex is formed)					
ANTAGONISTS:	Sulphur dioxide/Metal ions					
FOOD SAFETY ISSUES:	None known					

LEGISLATION:	USA:	UK and EUROPE:	CANADA:	AUSTRALIA:
	Not permitted	Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V, Part 1 for details of use	Permitted	Permitted

REFERENCE:

Smith, J. (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.

STRUCTURE OF CHLOROPHYLLIN:



Chlorophyllin a R = CH_3

Chlorophyllin b R = CHO

NAME:	Copper chlorophylls
CATEGORY:	Food colour
FOOD USE:	Dairy products/Soft drinks/Alcoholic drinks/Sugars and preserves/Confectionery/Vinegars, pickles and sauces/Decorations and coatings/Edible ices/Desserts
SYNONYMS:	E141 (i)/C.I. 75810/C.I. Natural Green 3/Copper phaeophytin
FORMULA:	Copper chlorophyll *a* $C_{55}H_{72}CuN_4O_5$; Copper chlorophyll *b* $C_{55}H_{70}CuN_4O_6$
MOLECULAR MASS IN Daltons:	Copper chlorophyll *a* 932.75; Copper chlorophyll *b* 946.73
ALTERNATIVE FORMS:	N/A
PROPERTIES AND APPEARANCE:	Waxy solid ranging in colour from blue/green to dark green
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	Not known
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	$\leq$10 total copper chlorophylls
WATER CONTENT MAXIMUM IN %:	Typically <2
HEAVY METAL CONTENT MAXIMUM IN ppm:	Lead not more than 10. Total copper not more than 8.0% of the total copper phaeophytins. Copper ions not more than 200

ARSENIC CONTENT MAXIMUM IN ppm:	3					
ASH MAXIMUM IN %:	Not specified					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in vegetable oil:	**@ 20°C**	Completely soluble	**@ 50°C**	Completely soluble	**@ 100°C**	Completely soluble
in sucrose solution:						
10%	Insoluble					
40%	Insoluble					
60%	Insoluble					
in sodium chloride solution:						
5%	Insoluble					
10%	Insoluble					
15%	Insoluble					
in ethanol solution:						
5%	Insoluble					
20%	Slightly soluble					
95%	5					
100%	5					
in propylene glycol:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
FUNCTION IN FOODS:	An oil-soluble blue/green food colour. Can be rendered water dispersible by use of a suitable emulsifier.					
ALTERNATIVES:	Other green colours, although not of the same hue (and not necessarily oil-soluble), include Green S E142; Copper chlorophyllin; Chlorophyll					
TECHNOLOGY OF USE IN FOODS:	Fully oil-soluble, so pre-dilute or direct addition to oil-based foodstuffs. Heat stability is far superior to that of the uncoppered form, as is stability to oxidation. Water-dispersible forms based on a suitable emulsifier are used for aqueous-based foodstuffs.					
SYNERGISTS:	None known					
ANTAGONISTS:	Sulphur dioxide					
FOOD SAFETY ISSUES:	None known					

LEGISLATION:	USA:	UK and EUROPE:	CANADA:	AUSTRALIA:
	Not permitted	Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V, Part 1 for details of use	Not permitted	Permitted

REFERENCE:

Smith, J. (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.

NAME:	Copper chlorophyllins
CATEGORY:	Food colour
FOOD USE:	Dairy products/Cereals/Soft drinks/Sugars and preserves/Confectionery/Vinegars, pickles and sauces/Decorations and coatings/Edible ices/Desserts
SYNONYMS:	E141 (ii)/C.I. 75815/C.I. Natural Green 5
FORMULA:	Copper chlorophyllin *a* $C_{34}H_{32}CuN_4O_5$; Copper chlorophyllin *b* $C_{34}H_{30}CuN_4O_6$
MOLECULAR MASS IN Daltons:	Copper chlorophyllin *a* 640.20; Copper chlorophyllin *b* 654.18
ALTERNATIVE FORMS:	Sodium copper chlorophyllin/Potassium copper chlorophyllin
PROPERTIES AND APPEARANCE:	Dark green to blue/black powder
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	Not known
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	≤95 copper chlorophyllin on a dry weight basis
WATER CONTENT MAXIMUM IN %:	Typically 3
HEAVY METAL CONTENT MAXIMUM IN ppm:	Lead not more than 10. Total copper not more than 8.0% of the total copper chlorophyllins. Ionic copper not more than 200

ARSENIC CONTENT MAXIMUM IN ppm:	3					
ASH MAXIMUM IN %:	Not specified					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	Completely soluble	**@ 50°C**	Completely soluble	**@ 100°C**	Completely soluble
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in sucrose solution:						
10%	Completely soluble					
40%	Completely soluble					
60%	Completely soluble					
in sodium chloride solution:						
5%	Completely soluble					
10%	Soluble					
15%	Soluble					
in ethanol solution:						
5%	Completely soluble					
20%	Completely soluble					
95%	Slightly soluble					
100%	Slightly soluble					
in propylene glycol:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
FUNCTION IN FOODS:	A water-soluble blue/green food colour					
ALTERNATIVES:	Other green colours, although not of the same hue, include Green S E142; Chlorophyllin; Copper chlorophyll; Chlorophyll					
TECHNOLOGY OF USE IN FOODS:	Readily water soluble, since in powdered form a pre-dilution is helpful. Stability to heat and oxidation is far superior to that of the uncoppered chlorophyllin.					
SYNERGISTS:	None known					
ANTAGONISTS:	Sulphur dioxide/Metal ions					
FOOD SAFETY ISSUES:	None known					

LEGISLATION:	USA:	UK and EUROPE:	CANADA:	AUSTRALIA:
	Not permitted	Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V, Part 1 for details of use	Not permitted	Permitted

REFERENCE:

Smith, J. (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.

NAME:	Curcumin
CATEGORY:	Food colour
FOOD USE:	Baked goods/Cereals and cereal products/Dairy products/Smoked fish/Fish and seafood products/Meat and poultry products/Egg products/Fruit, vegetable and nut products/Canned soft drinks/Snacks/Soups/Sugars and preserves/Confectionery/Vinegar, pickles and sauces/Mustard/Decorations and coatings/Edible ices/Desserts/Seasonings
SYNONYMS:	Turmeric yellow/Curcuma/C.I. 75300 Natural Yellow 3/Diferoyl methane/(1,7-bis(4-hydroxy-3-methoxyphenyl)hepta-1,6-diene-3,5-dione/E100
FORMULA:	$C_{21}H_{20}O_6$
MOLECULAR MASS IN Daltons:	368.39
ALTERNATIVE FORMS:	Demethoxy curcumin/Bis-demethoxy curcumin/Aluminium lake
PROPERTIES AND APPEARANCE:	Orange/yellow crystalline powder
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	Not applicable
MELTING RANGE IN °C:	179–182
FLASH POINT IN °C:	Not known
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	Not applicable
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	$\leq$90% total colouring matter
WATER CONTENT MAXIMUM IN %:	Typically 2

HEAVY METAL CONTENT MAXIMUM IN ppm:	40					
ARSENIC CONTENT MAXIMUM IN ppm:	3					
ASH MAXIMUM IN %:	Not specified					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	Insoluble	Readily soluble in alkali, but becomes orange (red colour)			
	@ 50°C	Insoluble	Readily soluble in alkali, but becomes orange (red colour)			
	@ 100°C	Insoluble	Readily soluble in alkali, but becomes orange (red colour)			
in vegetable oil:	**@ 20°C**	<0.1	**@ 50°C**	0.1	**@ 100°C**	0.25
in sucrose solution:						
10%	Insoluble					
40%	Insoluble					
60%	Insoluble					
in sodium chloride solution:						
5%	Insoluble					
10%	Insoluble					
15%	Insoluble					
in ethanol solution:						
5%	Insoluble					
20%	Insoluble					
95%	<0.1					
100%	0.1					
in propylene glycol:	**@ 20°C**	Insoluble	**@ 50°C**	<0.1	**@ 100°C**	0.7
FUNCTION IN FOODS:	A bright-yellow food colour, mainly suited to food applications where light stability is not critical.					
ALTERNATIVES:	Other yellow food colours, although not of exactly the same hue, include Quinoline Yellow; Riboflavin; Tartrazine; Safflower; Beta-carotene; Gardenia Yellow					
TECHNOLOGY OF USE IN FOODS:	Curcumin is generally used in an emulsified solution, in which case it is water-dispersible. Contact with alkalis should be avoided. The greatest limitation on curcumin is its tendency to fade on exposure to light					

(photo-oxidation). One contradiction to this is in high boilings, where curcumin exhibits good light stability; this is due to the low water activity in these types of applications. Special application forms are available for use with products where good light stability is required.

SYNERGISTS: A food-grade emulsifier is generally needed to render curcumin water-dispersible.

ANTAGONISTS: Strong alkalis such as NaOH/Sulphur dioxide/Metal ions (e.g. Sn^{2+})/Boric acid and/or borates

FOOD SAFETY ISSUES: None known

LEGISLATION:

USA:
GRAS, permitted as non-certified food colour according to 21CFR 73.600

UK and EUROPE:
Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V, Part 2 (of Directive 94/36/EC) for a list of food categories and maximum levels of colour use

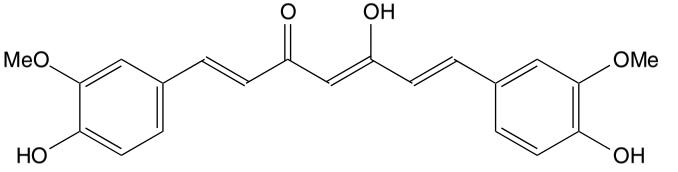
CANADA:
Permitted

AUSTRALIA:
Permitted

OTHER COUNTRIES:
Generally permitted in most countries

REFERENCE:
Smith, J. (ed.) (1991) *Food Additives Users Handbook*. Blackie Academic & Professional, Glasgow.

STRUCTURE OF CURCUMIN:



NAME:	Erythrosine
CATEGORY:	Food colour
FOOD USE:	Cocktail cherries/Meat and poultry products/Candied cherries/Decorations and coatings/Bigarreau cherries in syrup and in cocktails/Canned products/Confectionery
SYNONYMS:	E127/C.I. 45430 (Food Red 14)/FD&C Red No 3/Disodium 2-(2,4,5,7-tetraiodo-3-oxido-6-oxoxanthen-9-yl)benzoate monohydrate/Disodium 9(*O*-carboxy-phenyl)-6-hydroxy-2,4,5,7-tetraiodo-3*H*-xanthen-3-one
FORMULA:	$C_{20}H_6I_4Na_2O_5 \cdot H_2O$
MOLECULAR MASS IN Daltons:	897.88
ALTERNATIVE FORMS:	Calcium salt/Potassium salt/Aluminium lake (insoluble)
PROPERTIES AND APPEARANCE:	Bluish-red powder or granules
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	Not known
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	Content not less than 87% total colouring matter, calculated as the anhydrous sodium salt
WATER CONTENT MAXIMUM IN %:	13, but typically 3
HEAVY METAL CONTENT MAXIMUM IN ppm:	40

ARSENIC CONTENT MAXIMUM IN ppm:	3					
ASH MAXIMUM IN %:	N/A					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	9 (pH 7)	**@ 50°C**	17 (pH 7)	**@ 100°C**	20 (pH 7)
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in sucrose solution:						
10%	Soluble					
40%	Soluble					
60%	Soluble					
in sodium chloride solution:						
5%	Slightly soluble					
10%	Insoluble					
15%	Insoluble					
in ethanol solution:						
5%	**@ 25°C**	10				
20%	**@ 25°C**	8.0	**@ 60°C**	10		
95%	Insoluble					
100%	Insoluble					
in propylene glycol:	**@ 20°C**	20	**@ 50°C**	20	**@ 100°C**	20

FUNCTION IN FOODS: Water-soluble red food colour, or insoluble red food colour as the aluminium lake.

ALTERNATIVES: Other red food colours, although not of exactly the same hue, include Carmine; Anthocyanins (in acidic media); Carmoisine; Allura Red; Ponceau 4R; Beet Red; Red 2G (where permitted)

TECHNOLOGY OF USE IN FOODS: In solutions below pH 3–4, erythrosine forms erythrosinic acid, which is only slightly soluble. Used to colour cherries since the insoluble colour can be formed in the cherry and therefore the colour will not leach out to colour the syrup or other fruit.

Poor light stability. Precipitates in acid media. Faded by alkaline media.

SYNERGISTS: None known

ANTAGONISTS: Alkaline media/Ascorbic acid (insoluble in 1%)/Acid media (precipitates below pH 3–4)

FOOD SAFETY ISSUES: The colour contains iodine, and it has been suggested that iodine supplementation in the diet may be associated with an increased incidence of thyrotoxicosis. The use of this colour has been restricted.

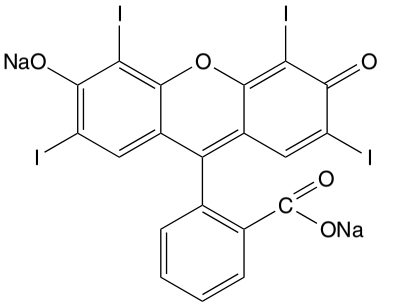
LEGISLATION:

USA:	**UK and EUROPE:**	**CANADA:**	**AUSTRALIA:**
FD&C Red No. 3 certified food colour	Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V, Part 1 for details of use	Permitted when certified, but restrictions apply	Not permitted

REFERENCE:

Smith, J. (ed.) (1991) *Food Additive User's Handbook.* Blackie Academic & Professional, Glasgow.

STRUCTURE OF ERYTHROSINE:



NAME:	Ethyl ester of beta-apo-8′-carotenoic acid (C30)
CATEGORY:	Food colour
FOOD USE:	Soft drinks/Confectionery/Processed cheese/Sauces/Margarine and oils/Soups/Salad dressings/Ice-cream, edible ices/Canned products/Desserts
SYNONYMS:	E160f/C.I. 40825 Food Orange 7/β-apo-8′-carotenoic ester/Ethyl β-apo-8′-carotenoate/β-apo-8′-carotenoic acid ethyl ester/Ethyl 8′-apo-β-caroten-8′-oate
FORMULA:	$C_{32}H_{44}O_2$
MOLECULAR MASS IN Daltons:	460.70
ALTERNATIVE FORMS:	Methyl ester where permitted
PROPERTIES AND APPEARANCE:	Red to violet-red crystals or crystalline powder. Commercially available as a suspension of micronised crystals in vegetable oil.
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	134–138
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	Not less than 96% of total colouring matter
WATER CONTENT MAXIMUM IN %:	N/A

HEAVY METAL CONTENT MAXIMUM IN ppm:	40					
ARSENIC CONTENT MAXIMUM IN ppm:	3					
ASH MAXIMUM IN %:	N/A					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in vegetable oil:	**@ 20°C**	0.7–1	**@ 50°C**	0.7–1	**@ 100°C**	1–1.5
in sucrose solution:						
10%	Insoluble					
40%	Insoluble					
60%	Insoluble					
in sodium chloride solution:						
5%	Insoluble					
10%	Insoluble					
15%	Insoluble					
in ethanol solution:						
5%	Insoluble					
20%	Insoluble					
95%	Slightly soluble					
100%	Slightly soluble					
in propylene glycol:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
FUNCTION IN FOODS:	Yellow to orange food colour depending on concentration.					
ALTERNATIVES:	Other yellow to orange food colours, although not of the same hue, include Beta-carotene; Curcumin; Annatto; Tartrazine/Sunset Yellow; Quinoline Yellow					
TECHNOLOGY OF USE IN FOODS:	Available as a microcrystalline suspension in vegetable oil. It is rarely used in foodstuffs. Its principal use is in animal feed and as a marker in butter. To prepare a stock solution to colour margarine or oils, heat oil to 45–50°C and stir in about 50 g/l of 20% suspension.					

If mixed with citrus oils, heat to 70 °C to disperse.

Reasonably stable to heat and light; stable to pH change and acidic conditions; stable to ascorbic acid. Can oxidise, losing colour, and stabilisation with antioxidants such as tocopherols is recommended.

SYNERGISTS: Antioxidants (such as tocopherols)/Ascorbic acid

ANTAGONISTS: Oxidising agents/Peroxides

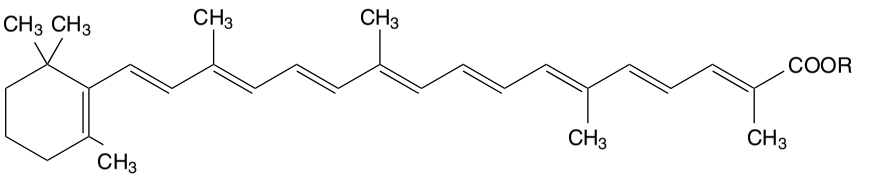
FOOD SAFETY ISSUES: Considered safe for food use

LEGISLATION:

USA:	**UK and EUROPE:**	**CANADA:**	**AUSTRALIA:**
Not permitted	Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V, Part 2 (of Directive 94/36/EC) for a list of food categories and maximum levels of colour use	Permitted, but restricted in use	Permitted

REFERENCE: Smith, J. (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.

STRUCTURE OF ETHYL ESTER OF β-APO-8′-CAROTENOIC ACID:



NAME:	Fast Green FCF
CATEGORY:	Food colour
FOOD USE:	Baked goods/Fruit and vegetable and nut products/Snacks/Confectionery/Cereal and cereal products/Sauces/Soft drinks/Decorations and coatings/Soups/Desserts/Dairy products/Seasonings/Canned products/Edible ices/Meat and poultry products
SYNONYMS:	FD&C Green No. 3/C.I. 42053 Food Green 3/*N*-ethyl-*N*-(4-(ethyl)((3-sulphophenyl)methyl)amino)phenyl)(4-hydroxy-2-sulphophenyl)methylene)-2,5-cyclohexadien-1-ylidene)-3-sulphobenzene methanaminium hydroxide, inner salt disodium salt
FORMULA:	$C_{37}H_{34}N_2O_{10}S_3Na_2$
MOLECULAR MASS IN Daltons:	808.86
ALTERNATIVE FORMS:	Potassium salt/Aluminium lake (insoluble)
PROPERTIES AND APPEARANCE:	Dark black/green granules or powder
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	N/A
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	85 miniumum
WATER CONTENT MAXIMUM IN %:	15, but typically 3

HEAVY METAL CONTENT MAXIMUM IN ppm:	Lead: maximum 10					
ARSENIC CONTENT MAXIMUM IN ppm:	3					
ASH MAXIMUM IN %:	N/A					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	20	**@ 50°C**	20	**@ 100°C**	20
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in sucrose solution:						
10%	20					
40%	20					
60%	20					
in sodium chloride solution:						
5%	20					
10%	10					
15%	5					
in ethanol solution:						
5%	20					
20%	10					
95%	0.02					
100%	0.01					
in propylene glycol:	**@ 20°C**	20	**@ 50°C**	20	**@ 100°C**	Insoluble
FUNCTION IN FOODS:	Water-soluble blue/green food colour, or insoluble blue/green food colour as the aluminium lake.					
ALTERNATIVES:	Other blue/green food colours, although not of the same hue, include Green S; Copper chlorophyllin					
TECHNOLOGY OF USE IN FOODS:	A fairly light- and heat-stable food colour. Stable to food acids and sulphur dioxide; turns bluer in alkaline media and fades. Sensitive to oxidation.					
SYNERGISTS:	None known					
ANTAGONISTS:	Alkaline media/Ascorbic acid					

FOOD SAFETY ISSUES:	None known			
LEGISLATION:	**USA:**	**UK and EUROPE:**	**CANADA:**	**AUSTRALIA:**
	Permitted 21 CFR 74.203	Not permitted	Permitted, but restrictions apply	Permitted
REFERENCE:	Smith, J. (ed.) (1991) *Food Additive User's Handbook.* Blackie Academic & Professional, Glasgow.			

NAME:	Gardenia Yellow
CATEGORY:	Food colour
FOOD USE:	Baked goods/Dairy products/Egg products/Soft drinks/Sugars and preserves/Confectionery/Vinegar, pickles and sauces/Decorations and coatings/Desserts/Seasonings/Flour confectionery/Edible ices/Fish and seafood products/Cereal and cereal products
SYNONYMS:	INS 164/Gardenia Yellow/Gardenia extract (if extracted from *Gardenia* jasminoids). Saffron extract (if extracted from *Crocus sativa*). Both extracts contain crocin as the principal colorant.
FORMULA:	$C_{44}H_{64}O_{24}$ (crocin)
MOLECULAR MASS IN Daltons:	976.90 (crocin)
ALTERNATIVE FORMS:	Mono- and di-glycosides of crocetin
PROPERTIES AND APPEARANCE:	A dark-brown/orange liquid
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	Not known
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	Typically contains 10% pigment
WATER CONTENT MAXIMUM IN %:	N/A

HEAVY METAL CONTENT MAXIMUM IN ppm:	Not more than 40					
ARSENIC CONTENT MAXIMUM IN ppm:	4					
ASH MAXIMUM IN %:	Not specified					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	Completely soluble	**@ 50°C**	Completely soluble	**@ 100°C**	Completely soluble
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in sucrose solution:						
10%	Completely soluble					
40%	Completely soluble					
60%	Completely soluble					
in sodium chloride solution:						
5%	Soluble					
10%	Soluble					
15%	Soluble					
in ethanol solution:						
5%	Completely soluble					
20%	Completely soluble					
95%	Soluble					
100%	Soluble					
in propylene glycol:	**@ 20°C**	Soluble	**@ 50°C**	Soluble	**@ 100°C**	Soluble
FUNCTION IN FOODS:	A bright egg-yellow, water-soluble food colour					
ALTERNATIVES:	Other yellow colours, although not of exactly the same hue, include Beta-carotene; Tartrazine; Sunset Yellow; Turmeric/Curcumin; Safflower					
TECHNOLOGY OF USE IN FOODS:	Readily soluble in water. Can be applied directly into aqueous foodstuffs. Not suitable for oil-based products.					
SYNERGISTS:	Ascorbic acid/Antioxidants					
ANTAGONISTS:	Sulphur dioxide/Metal ions/Oxygen					

FOOD SAFETY ISSUES: None known

LEGISLATION:

USA:	UK and EUROPE:	CANADA:	AUSTRALIA/PACIFIC RIM:
Not permitted	Not permitted, although saffron extract is allowed as a spice/ flavour	Permitted as saffron	Australia: Permitted as saffron/ crocin Japan: Permitted for use as a natural colour as gardenia yellow

REFERENCES:

Smith, J. (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.

Timberlake, C.F. and Henry, B.S. (1986) Plant pigment as natural food colours. *Endeavour* (*New Series*) **10**, 31–35.

ANY OTHER RELEVANT INFORMATION:

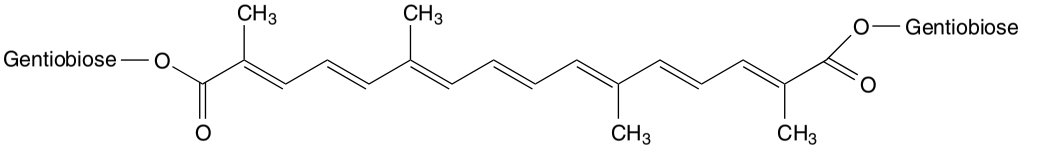
Crocin was permitted in the UK according to the Colouring Matter in Foodstuff Regulations 1973 (as amended). However, the adopted (1996) EC directive on food colours does not list crocin as a permitted colour.

Joint FAO/WHO Expert Committee on Food Additives (JECFA), FAO Food and Nutrition Paper 52 (1992) specifies Saffron (the unextracted dried stigma).

INS 164 refers to Gardenia Yellow.

Japan's Specifications and Standards for Food Additives includes a monograph for Gardenia Yellow.

STRUCTURE OF CROCIN:



NAME:	Gold
CATEGORY:	Food colour
FOOD USE:	Surface coating of confectionery/Decoration of chocolates/Liqueurs
SYNONYMS:	E175/C.I. 77480 (Pigment Metal 3)/Aurum
FORMULA:	Au
MOLECULAR MASS IN Daltons:	197.0
ALTERNATIVE FORMS:	N/A
PROPERTIES AND APPEARANCE:	Gold-coloured powder or thin sheets (leaf)
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	2610
MELTING RANGE IN °C:	1063
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	Not less than 90
WATER CONTENT MAXIMUM IN %:	N/A
HEAVY METAL CONTENT MAXIMUM IN ppm:	Not specified
ARSENIC CONTENT MAXIMUM IN ppm:	Not specified

ASH MAXIMUM IN %:	N/A					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in sucrose solution:						
10%	Insoluble					
40%	Insoluble					
60%	Insoluble					
in sodium chloride solution:						
5%	Insoluble					
10%	Insoluble					
15%	Insoluble					
in ethanol solution:						
5%	Insoluble					
20%	Insoluble					
95%	Insoluble					
100%	Insoluble					
in propylene glycol:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble

FUNCTION IN FOODS: Used as a dispersed powder or gold leaf to surface-colour sugar or chocolate confectionery, or as an additive to certain liqueurs.

ALTERNATIVES: Aluminium powder pigmented with yellow/orange lake food colours and polished to a gloss after application

TECHNOLOGY OF USE IN FOODS: Applied as leaf or powder to the surface of hard sugar or chocolate confectionery, then polished to a high gloss as a decoration. Can be added as fine particles or leaf to certain liqueurs.

SYNERGISTS: None known

ANTAGONISTS: None known

FOOD SAFETY ISSUES: None known

LEGISLATION:	USA:	UK AND EUROPE:	CANADA:	AUSTRALIA:
	Not permitted	Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex IV for restrictions on use	Permitted	Not permitted

REFERENCE:

Smith, J. (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.

NAME:	Green S
CATEGORY:	Food colour
FOOD USE:	Baked goods/Fruit and vegetable and nut products/Edible ices/Confectionery/Cereal and cereal products/Seasonings/Soft drinks/Decorations and coatings/Soups/Desserts/Dairy products/Snacks/Canned products/Meat and poultry products/Sauces
SYNONYMS:	E142/C.I. 44090 (Food Green 4)/Brilliant Green BS/Sodium *N*-[4-[[4-(dimethylamino)phenyl](2-hydroxy-3,6-disulfo-1-naphthalenyl)-methylene]2,5-cyclohexadien-1-ylidene]-*N*-methylmethanaminium/Sodium 5-[4-dimethylamino-α-(4-dimethyliminocyclohexa-2,5-dienylidene)benzyl]-6-hydroxy-7-sulfonato-naphthalene-2-sulfonate
FORMULA:	$C_{27}H_{25}N_2NaO_7S_2$
MOLECULAR MASS IN Daltons:	576.63
ALTERNATIVE FORMS:	Calcium salt/Potassium salt/Aluminium lake (insoluble)
PROPERTIES AND APPEARANCE:	Dark blue or dark green powder or granules
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	Not known
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	Not less than 80% total colouring matter calculated as the sodium salt

WATER CONTENT MAXIMUM IN %:	20, but typically 3					
HEAVY METAL CONTENT MAXIMUM IN ppm:	40					
ARSENIC CONTENT MAXIMUM IN ppm:	3					
ASH MAXIMUM IN %:	N/A					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	5	**@ 50°C**	7	**@ 100°C**	10
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in sucrose solution:						
10%	5					
40%	5					
60%	5					
in sodium chloride solution:						
5%	Soluble					
10%	Insoluble					
15%	Insoluble					
in ethanol solution:						
5%	5					
20%	5					
95%	0.2					
100%	0.2					
in propylene glycol:	**@ 20°C**	2	**@ 50°C**	2	**@ 100°C**	3
FUNCTION IN FOODS:	Water-soluble blue/green food colour, or insoluble blue/green food colour as the aluminium lake.					
ALTERNATIVES:	Other blue/green food colours, although not of the same hue, include Brilliant Blue FCF; Patent Blue V; Indigotine					
TECHNOLOGY OF USE IN FOODS:	A heat-stable blue/green food colour useful as a component in green colour for canned peas and as a dulling agent in brown shades. The colour has moderate light stability, reasonable stability to acid conditions, and fair stability to alkaline conditions.					

SYNERGISTS: None known

ANTAGONISTS: Sulphur dioxide/Metal ions

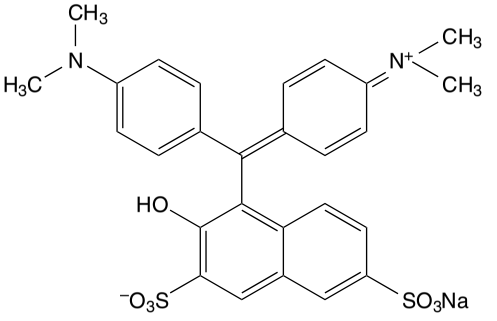
FOOD SAFETY ISSUES: None known

LEGISLATION:

USA:	**UK and EUROPE:**	**CANADA:**	**AUSTRALIA:**
Not permitted	Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V Part 2 (of Directive 94/36/EC) for a list of food categories and maximum levels of use	Not permitted	Permitted, but restrictions apply

REFERENCE: Smith, J. (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.

STRUCTURE OF GREEN S:



NAME:	Indigotine
CATEGORY:	Food colour
FOOD USE:	Confectionery/Preserves/Desserts
SYNONYMS:	Indigo Carmine/E132/FD&C Blue No. 2/C.I. 73015 (Food Blue 1)/Disodiom 3,3′-dioxo-2,2′-bis-indolylidene-5,5′-disulfonate
FORMULA:	$C_{16}H_8N_2Na_2O_8S_2$
MOLECULAR MASS IN Daltons:	466.36
ALTERNATIVE FORMS:	Calcium salt/Potassium salt/Aluminium lake (insoluble)
PROPERTIES AND APPEARANCE:	Dark blue powder or granules
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	Not known
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	Content not less that 85% total colouring matter, calculated as the sodium salt
WATER CONTENT MAXIMUM IN %:	15, but typically 3
HEAVY METAL CONTENT MAXIMUM IN ppm:	40

ARSENIC CONTENT MAXIMUM IN ppm:	3									
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:										
in water:	**@ 20°C**	1.6%	**@ 50°C**	2.2%	**@ 100°C**	2.5%				
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble				
in sucrose solution:	**@ 10%**	1.5%	**@ 40%**	1.5%	**@ 60%**	1.5%				
in sodium chloride solution:	**@ 5%**	Soluble	**@ 10%**	Insoluble	**@ 15%**	Insoluble				
in ethanol solution:	**@ 5%**	1.0%	**@ 20%**	**@ 25°C** 0.5%	**@ 95%**	0.007%	**@100%**	**@ 60°C**	0.007%	
in propylene glycol:	**@ 20°C**	0.1%	**@ 50°C**	0.1%	**@ 100°C**	0.1%				

FUNCTION IN FOODS: Water-soluble blue food colour, or insoluble blue food colour as the aluminium lake.

ALTERNATIVES: Other blue food colours, although not of the same hue, include Brilliant Blue FCF; Green S; Patent Blue V

TECHNOLOGY OF USE IN FOODS: A blue food colour with poor solubility and poor light stability. Not stable to oxidation or pH change.

SYNERGISTS: None known

ANTAGONISTS: Ascorbic acid/Sulphur dioxide/Citric acid/Sodium bicarbonate/Sodium carbonate/Ammonium hydroxide/ Dextrose 10%

FOOD SAFETY ISSUES: None known

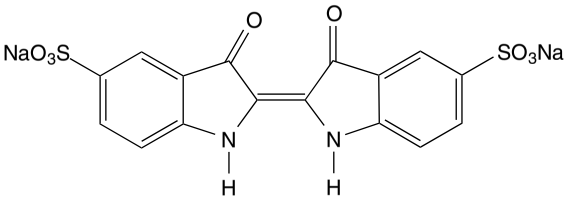
LEGISLATION:

USA:	**UK and EUROPE:**	**CANADA:**	**AUSTRALIA:**
FD&C Blue No. 2 certified food colour	Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/ 2008. Refer to Annex IV for restrictions on use	Permitted when certified, but restrictions apply	Permitted, but restrictions apply

REFERENCE:

Smith, J (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.

STRUCTURE OF INDIGOTINE:



NAME:	Litholrubine BK
CATEGORY:	Food colour
FOOD USE:	Edible cheese rind
SYNONYMS:	E180/C.I. 15850:l (Pigment Red 57)/Rubinpigment/Carmine 6B/Calcium 3-hydroxy-4-(4-methyl-2-sulfonatophenylazo)-2-naphthalene carboxylate
FORMULA:	$C_{18}H_{12}CaN_2O_6S$
MOLECULAR MASS IN Daltons:	424.45
PROPERTIES AND APPEARANCE:	Red powder
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	N/A
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	Not less than 90% total colouring matter
WATER CONTENT MAXIMUM IN %:	10
HEAVY METAL CONTENT MAXIMUM IN ppm:	40
ARSENIC CONTENT MAXIMUM IN ppm:	3

SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in vegetable oil:	**@ 20°C**	Soluble	**@ 50°C**	Soluble	**@ 100°C**	Soluble
in sucrose solution:						
10%	Insoluble					
40%	Insoluble					
60%	Insoluble					
in sodium chloride solution:						
5%	Insoluble					
10%	Insoluble					
15%	Insoluble					
in ethanol solution:						
5%	Insoluble					
20%	Insoluble					
95%	Insoluble					
100%	Insoluble					
in propylene glycol:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble

FUNCTION IN FOODS: Water-insoluble bright-red food colour used for cheese rind and surface marking.

ALTERNATIVES: Carmine or other red insoluble lake colours can be dispersed into wax to give a similar coloration to Litholrubine BK

TECHNOLOGY OF USE IN FOODS: A red, water-insoluble food colour. Soluble in oil and hydrocarbon solvents. Used to colour cheese wax rind.

SYNERGISTS: None known

ANTAGONISTS: None known

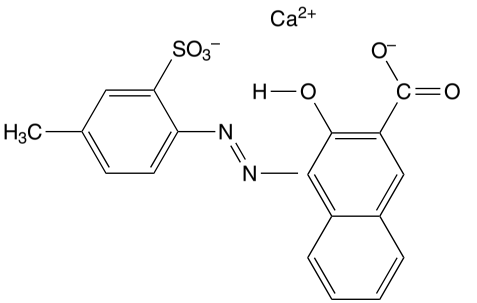
FOOD SAFETY ISSUES: No ADI set due to insufficient toxicological data being available.

LEGISLATION:	USA:	UK and EUROPE:	CANADA:	AUSTRALIA:
	Not permitted	Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex IV: restricted to colouring edible cheese rind	Not permitted	Not permitted

REFERENCE:

Smith, J. (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.

STRUCTURE OF LITHOLRUBINE BK:



NAME:	Lutein
CATEGORY:	Food colour
FOOD USE:	Baked goods/Dairy products/Egg products/Soft drinks/Sugars and preserves/Confectionery/Decorations and coatings/Edible ices/Desserts
SYNONYMS:	E161b/Mixed carotenoids/Xanthophylls/Tagetes
FORMULA:	$C_{40}H_{56}O_2$
MOLECULAR MASS IN Daltons:	568.88
ALTERNATIVE FORMS:	Fatty acid esters (mono and di)
PROPERTIES AND APPEARANCE:	An orange/brown oleoresin
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	≤4% calculated as lutein
WATER CONTENT MAXIMUM IN %:	Not specified, typically <2
HEAVY METAL CONTENT MAXIMUM IN ppm:	40
ARSENIC CONTENT MAXIMUM IN ppm:	3

ASH MAXIMUM IN %:	Not specified					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in vegetable oil:	**@ 20°C**	Very slightly soluble	**@ 50°C**	0.5	**@ 100°C**	2
in sucrose solution:						
10%	Insoluble					
40%	Insoluble					
60%	Insoluble					
in sodium chloride solution:						
5%	Insoluble					
10%	Insoluble					
15%	Insoluble					
in ethanol solution:						
5%	Insoluble					
20%	Very slightly soluble					
95%	0.5					
100%	0.5					
in propylene glycol:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble

FUNCTION IN FOODS: A bright egg-yellow food colour

ALTERNATIVES: Other yellow food colours, although not of exactly the same hue, include Mixed carotenes; Beta-carotene; Carminic acid; Sunset Yellow; Quinoline Yellow; Crocin

TECHNOLOGY OF USE IN FOODS: For oil-based applications, a solution of the oleoresin in vegetable oil can be directly applied.

For aqueous-based food products, water-dispersible forms are required. These are generally oil-in-water emulsions with the pigment dissolved in the oil phase and using a food-grade emulsifier such as polysorbate.

SYNERGISTS: Antioxidants/Emulsifiers (e.g. polysorbates)/Vegetable oil

ANTAGONISTS: Sulphur dioxide/Oxygen/Metal ions

FOOD SAFETY ISSUES: None known

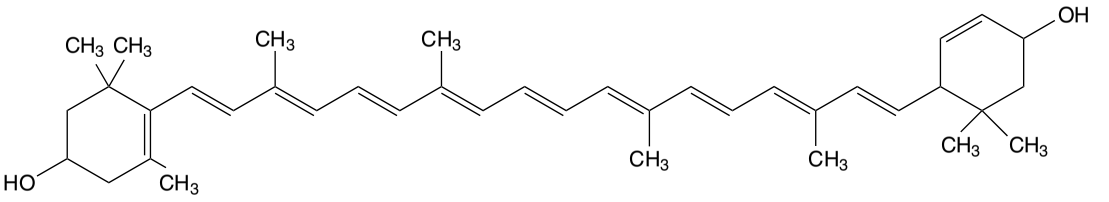
LEGISLATION:	USA:	UK and EUROPE:	CANADA:	AUSTRALIA:
	Not permitted as food colour	Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V Part 2 (of Directive 94/36/EC) for a list of food categories and maximum levels of use	Permitted as xanthophyll	Permitted

REFERENCES:

Philip, T. and Berry, J.W. (1976) A process for the purification of lutein-fatty acid esters from marigold petals. *Journal of Food Science* **41**, 163–164.

Smith, J. (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.

STRUCTURE OF LUTEIN:



NAME:	Lycopene
CATEGORY:	Food colour
FOOD USE:	Baked goods/Dairy products/Egg products/Soft drinks/Sugars and preserves/Confectionery/Vinegar, pickles and sauces/Decorations and coatings/Desserts/Seasonings
SYNONYMS:	E160d/Natural Yellow 27/C.I. 75125/ψ,ψ-carotene
FORMULA:	$C_{40}H_{56}$
MOLECULAR MASS IN Daltons:	536.85
PROPERTIES AND APPEARANCE:	An orange/red suspension in oil
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	169–171
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	Not less than 5% of total colouring matters (when derived from tomatoes)
WATER CONTENT MAXIMUM IN %:	Not specified, typically <2
HEAVY METAL CONTENT MAXIMUM IN ppm:	40
ARSENIC CONTENT MAXIMUM IN ppm:	3

ASH MAXIMUM IN %:	0.1% sulphated ash					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in vegetable oil:	**@ 20°C**	Very slightly soluble	**@ 50°C**	0.05	**@ 100°C**	0.10
in sucrose solution:						
10%	Insoluble					
40%	Insoluble					
60%	Insoluble					
in sodium chloride solution:						
5%	Insoluble					
10%	Insoluble					
15%	Insoluble					
in ethanol solution:						
5%	Insoluble					
20%	Insoluble					
95%	0.05					
100%	0.05					
in propylene glycol:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
FUNCTION IN FOODS:	An orange/red food colour					
ALTERNATIVES:	Paprika; Beta-carotene; Mixed carotenes; Annatto; Sunset Yellow					
TECHNOLOGY OF USE IN FOODS:	For oil-based applications, a suspension in oil can be directly applied. For aqueous food products, water-dispersible forms are required, using food-grade emulsifiers.					
SYNERGISTS:	Antioxidants/Vegetable oil/Emulsifiers					
ANTAGONISTS:	Sulphur dioxide/Oxygen/Metal ions					
FOOD SAFETY ISSUES:	None known					

LEGISLATION:	USA:	UK and EUROPE:	CANADA:	AUSTRALIA:
	Not permitted specifically, but if used in form of concentrated tomato extract, then it would be permitted as a non-certified colour according to 21 CFR 73 (vegetable juice)	Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V Part 2 (of Directive 94/36/EC) for a list of food categories and maximum levels of use	Not permitted	Permitted

NOTES:

It is proposed that two additional lycopene products be added to the list of EC permitted colours in 2011/12.

Synthetic lycopene contains not less than 96% total lycopenes.

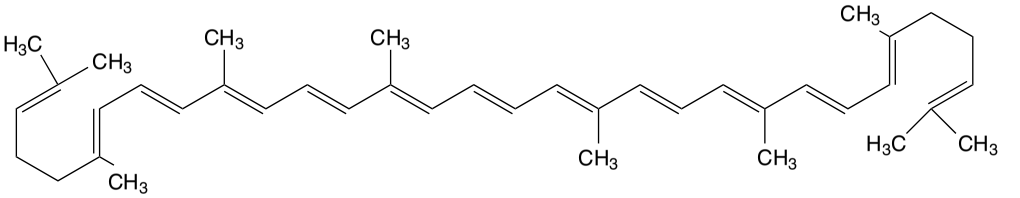
Lycopene from *Blakeslea trispora* contains not less than 95% total lycopenes.

REFERENCES:

Nir, Z., Hartal, D. and Raveh, Y. (1993) Lycopene from tomatoes. *International Food Ingredients* 6, 45–51.

Smith, J. (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.

STRUCTURE OF LYCOPENE:



NAME:	Mixed carotenes
CATEGORY:	Food colour
FOOD USE:	Baked goods/Cereal and cereal products/Dairy products/Fish and seafood products/Meat and poultry products/Egg products/Fruit, vegetable and nut products/Soft drinks/Sugars and preserves/Confectionery/Vinegar, pickles and sauces/Decorations and coatings/Edible ices/Desserts/Seasonings
SYNONYMS:	E160a(i)/C.I. Food Orange 5/C.I. No. 75130
FORMULA:	$C_{40}H_{56}$
MOLECULAR MASS IN Daltons:	536.88
ALTERNATIVE FORMS:	*Cis* and *trans* forms/Contains α, β and γ carotene
PROPERTIES AND APPEARANCE:	Red to orange/red crystals or suspension
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	176–182
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	Not less than 5% for plant carotenes; not less than 20% for algal carotenes
WATER CONTENT MAXIMUM IN %:	Not specified
HEAVY METAL CONTENT MAXIMUM IN ppm:	Lead not more than 5

ARSENIC CONTENT MAXIMUM IN ppm:	Not specified					
ASH MAXIMUM IN %:	Not specified					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in vegetable oil:	**@ 20°C**	0.05	**@ 50°C**	0.10	**@ 100°C**	0.25
in sucrose solution:						
10%	Insoluble					
40%	Insoluble					
60%	Insoluble					
in sodium chloride solution:						
5%	Insoluble					
10%	Insoluble					
15%	Insoluble					
in ethanol solution:						
5%	Insoluble					
20%	Insoluble					
95%	<0.01					
100%	<0.01					
in propylene glycol:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
FUNCTION IN FOODS:	A bright-yellow to orange food colour					
ALTERNATIVES:	Other yellow/orange food colours, although not of exactly the same hue, include Beta-carotene; Annatto; Carminic acid; Sunset Yellow; Paprika; Crocin; Tartrazine					
TECHNOLOGY OF USE IN FOODS:	For oil-based applications (e.g. yellow fats), a suspension in oil can be applied directly. For aqueous food products, water-dispersible forms are attained, generally using a food-grade emulsifier.					
SYNERGISTS:	Antioxidants/Emulsifiers					
ANTAGONISTS:	Sulphur dioxide/Oxygen/Metal ions					
FOOD SAFETY ISSUES:	None known					

LEGISLATION:	USA:	UK and EUROPE:	CANADA:	AUSTRALIA:
	Not permitted	Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V Part 1 (of Directive 94/36/EC) for details of use	Permitted	Permitted

REFERENCES:

Smith, J. (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.

Tan, B. (1989) Palm carotenoids, tocopherols and tocotrienols. *Journal of the American Oil Chemists Society* **66**, 770–776.

NAME:	Paprika extract
CATEGORY:	Food colour
FOOD USE:	Baked goods/Dairy products/Fish and seafood products/Meat and poultry products/Egg products/Soft drinks/ Sugars and preserves/Confectionery/Vinegar, pickles and sauces/Decorations and coatings/Edible ices/ Desserts/Seasonings
SYNONYMS:	Paprika oleoresin/Capsanthin/Capsorubin/E160c
FORMULA:	Capsanthin, $C_{40}H_{56}O_3$; Capsorubin, $C_{40}H_{56}O_4$
MOLECULAR MASS IN Daltons:	Capsanthin 584.85; Capsorubin 600.85
ALTERNATIVE FORMS:	Fatty acid esters
PROPERTIES AND APPEARANCE:	A dark orange/brown oleoresin
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	N/A
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY IN %:	Not less than 7.0% carotenoids, of which capsanthin/capsorubin not less than 30% of total carotenoids
WATER CONTENT MAXIMUM IN %:	Not specified, typically less than 1
HEAVY METAL CONTENT MAXIMUM IN ppm:	40

ARSENIC CONTENT MAXIMUM IN ppm:	3					
ASH MAXIMUM IN %:	Not specified					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in vegetable oil:	**@ 20°C**	0.5	**@ 50°C**	1.0	**@ 100°C**	10.0
in sucrose solution:						
10%	Insoluble					
40%	Insoluble					
60%	Insoluble					
in sodium chloride solution:						
5%	Insoluble					
10%	Insoluble					
15%	Insoluble					
in ethanol solution:						
5%	Insoluble					
20%	Insoluble					
95%	0.10					
100%	0.10					
in propylene glycol:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
FUNCTION IN FOODS:	An orange/red food colour					
ALTERNATIVES:	Beta-carotene; Mixed carotenes; Annatto; Lycopene; Sunset Yellow					
TECHNOLOGY OF USE IN FOODS:	Paprika oleoresin can be dispersed in vegetable oil for direct application into oil-based food products. For aqueous-based food products, water-dispersible forms are required and food-grade emulsifiers are used. Care needs to be taken to use deodorised forms for sweet or dairy applications.					
SYNERGISTS:	Vegetable oil/Antioxidants/Emulsifiers					
ANTAGONISTS:	Sulphur dioxide/Oxygen/Metal ions					
FOOD SAFETY ISSUES:	None known					

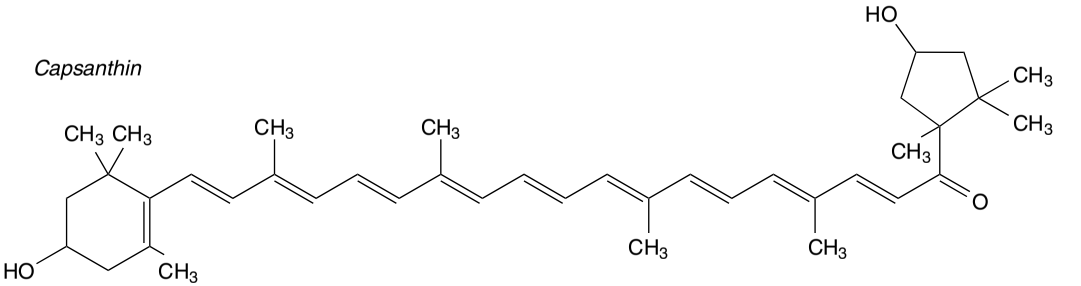
LEGISLATION:	USA:	UK and EUROPE:	CANADA:	AUSTRALIA:
	Permitted as non-certified food colour according to 21 CFR 73	Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V Part 1 (of Directive 94/36/EC) for details of use	Permitted	Permitted

REFERENCE:

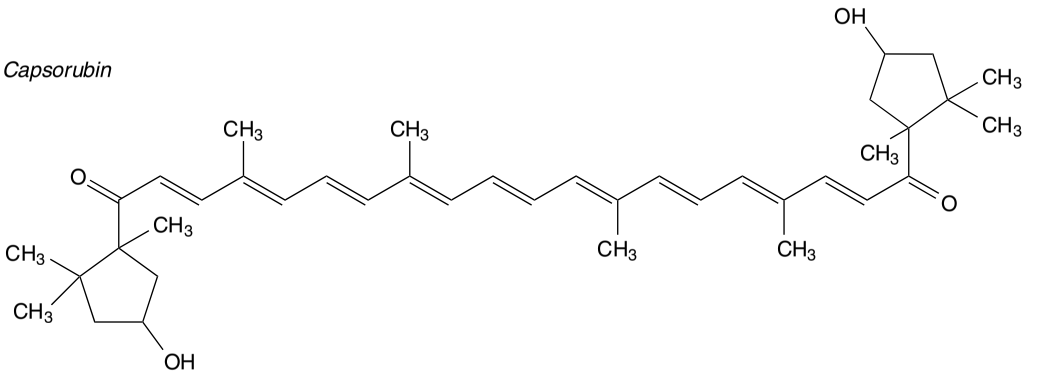
Smith, J. (ed.) (1991) *Food Additive Users Handbook*. Blackie Academic & Professional, Glasgow.

STRUCTURE OF PAPRIKA CAROTENOIDS:

Capsanthin



Capsorubin



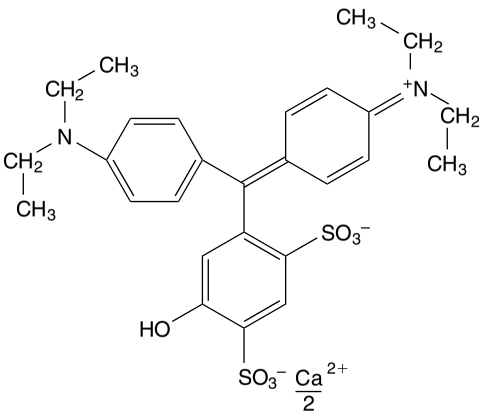
NAME:	Patent Blue V
CATEGORY:	Food colour
FOOD USE:	Baked goods/Fruit and vegetable and nut products/Edible ices/Confectionery/Cereal and cereal products/Seasonings/Canned products/Decorations and coatings/Soups/Soft drinks/Dairy products/Snacks/Desserts/Meat and poultry products
SYNONYMS:	E131/C.I. 42051 (Food Blue 5)/Calcium or sodium compound of (4-(α(4-diethylaminophenyl)-5-hydroxy-2,4-disulfophenyl-methylidene)2,5-cyclohexadien-1-ylidene)diethyl-ammonium hydroxide inner salt
FORMULA:	$C_{27}H_{31}N_2O_7S_2Ca_{1/2}$; $C_{27}H_{31}N_2O_7S_2Na$
MOLECULAR MASS IN Daltons:	Calcium salt 579.72; Sodium salt 582.67
ALTERNATIVE FORMS:	Potassium salt/Aluminium lake (insoluble)
PROPERTIES AND APPEARANCE:	Dark blue powder or granules
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	N/A
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	Content not less than 85% total colouring matter, calculated as the sodium salt
WATER CONTENT MAXIMUM IN %:	15, but typically 3

HEAVY METAL CONTENT MAXIMUM IN ppm:	40					
ARSENIC CONTENT MAXIMUM IN ppm:	3					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	4	**@ 50°C**	5	**@ 100°C**	6
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in sucrose solution:						
10%	4					
40%	2					
60%	1					
in sodium chloride solution:						
5%	Soluble					
10%	Insoluble					
15%	Insoluble					
in ethanol solution:						
5%	4					
20%	2					
95%	<0.1					
100%	<0.1					
in propylene glycol:	**@ 20°C**	2.0	**@ 50°C**	2.5	**@ 100°C**	3
FUNCTION IN FOODS:	Water-soluble blue food colour, or insoluble blue food colour as the aluminium lake.					
ALTERNATIVES:	Other blue food colours, although not of the same hue, include Brilliant Blue FCF; Green S; Indigotine					
TECHNOLOGY OF USE IN FOODS:	A light- and heat-stable blue food colour. Fades in the presence of sulphur dioxide, ascorbic acid, fruit acids and alkaline media.					
SYNERGISTS:	None known					
ANTAGONISTS:	Sulphur dioxide/Ascorbic acid/Fruit acids/Alkaline media					
FOOD SAFETY ISSUES:	None known					

LEGISLATION:	USA:	UK and EUROPE:	CANADA:	AUSTRALIA:
	Not permitted	Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V Part 2 (of Directive 94/36/EC) for a list of food categories and maximum levels of colour use	Not permitted	Not permitted

REFERENCE: Smith, J. (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.

STRUCTURE OF PATENT BLUE V:



NAME	Plain caramel
CATEGORY:	Food colour
FOOD USE:	Baked goods/Cereal and cereal products/Dairy products/Meat and poultry products/Soft drinks/Alcoholic drinks/Sugars and preserves/Confectionery/Vinegars, pickles and sauces/Decorations and coatings/Edible ices/Desserts/Seasonings
SYNONYMS:	E150a/Spirit caramel
FORMULA:	Not known
MOLECULAR MASS IN Daltons:	Not known
ALTERNATIVE FORMS:	N/A
PROPERTIES AND APPEARANCE:	A dark-brown black viscous liquid or brown powder
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	N/A
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	Colour intensity 0.01–0.12 based on absorbance of a 0.1% solution of caramel colour in water in a 1-cm cell at 610 nm.
WATER CONTENT MAXIMUM IN %:	Typically 40 for liquids

HEAVY METAL CONTENT MAXIMUM IN ppm:	25					
ARSENIC CONTENT MAXIMUM IN ppm:	1					
ASH MAXIMUM IN %:	N/A					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	Completely soluble	**@ 50°C**	Completely soluble	**@ 100°C**	Completely soluble
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in sucrose solution:						
10%	Completely soluble					
40%	Completely soluble					
60%	Completely soluble					
in sodium chloride solution:						
5%	Completely soluble					
10%	Completely soluble					
15%	Completely soluble					
in ethanol solution:						
5%	Completely soluble					
20%	Completely soluble					
95%	Completely soluble					
100%	Completely soluble					
in propylene glycol:	**@ 20°C**	Dispersible	**@ 50°C**	Dispersible	**@ 100°C**	Dispersible
FUNCTION IN FOODS:	A water- or alcohol-soluble brown food colour					
ALTERNATIVES:	E150b–d in non-alcoholic applications; Brown HT; Brown FK					
TECHNOLOGY OF USE IN FOODS:	Fully water- and/or alcohol-soluble liquid and powdered forms available depending on the nature of the application.					
SYNERGISTS:	N/A					
ANTAGONISTS:	N/A					

LEGISLATION:	USA:	UK and EUROPE:	CANADA:	AUSTRALIA:
	Permitted according to 21 CFR Part 73.85	Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V Part 2 (of Directive 94/36/EC) for a list of food categories and maximum levels of colour use	Permitted	Permitted
REFERENCE:	Smith, J. (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.			

NAME:	Ponceau 4R
CATEGORY:	Food colour
FOOD USE:	Baked goods/Cereals and cereal products/Soft drinks/Fruit, vegetable and nut products/Meat and poultry products/Edible ices/Canned products/Confectionery/Desserts/Sugars and preserves/Decorations and coatings/Seasonings/Beverages/Dairy products/Snacks/Fish and seafood products
SYNONYMS:	E124/C.I. 16255 (Food Red 7)/Cochineal red A/New coccine/Trisodium 2-hydroxy-1-(4-sulfonato-1-naphthylazo) naphthalene-6,7-disulfonate
FORMULA:	$C_{20}H_{11}N_2Na_3O_{10}S_3$
MOLECULAR MASS IN Daltons:	604.48
ALTERNATIVE FORMS:	Calcium salt/Potassium salt/Aluminium lake (insoluble)
PROPERTIES AND APPEARANCE:	Red powder or granules
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	N/A
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	Not less than 80% total colouring matter, calculated as the sodium salt
WATER CONTENT MAXIMUM IN %:	20, but typically 3

HEAVY METAL CONTENT MAXIMUM IN ppm:	40					
ARSENIC CONTENT MAXIMUM IN ppm:	3					
ASH MAXIMUM IN %:	N/A					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	14	**@ 50°C**	20	**@ 100°C**	30
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in sucrose solution:						
10%	10					
40%	5					
60%	2					
in sodium chloride solution:						
5%	Soluble					
10%	Insoluble					
15%	Insoluble					
in ethanol solution:						
5%	10					
20%	5					
95%	0.1					
100%	<0.1					
in propylene glycol:	**@ 20°C**	4	**@ 50°C**	5	**@ 100°C**	6
FUNCTION IN FOODS:	Water-soluble red food colour, or insoluble red food colour as the aluminium lake.					
ALTERNATIVES:	Other red food colours, although not of exactly the same hue, include Carmine; Carmoisine; Allura Red; Erythrosine; Beet Red; Anthocyanins (in acidic media); Red 2G (where permitted)					
TECHNOLOGY OF USE IN FOODS:	A robust red colour with good light stability. Good heat stability to 105°C. Fades in alkaline media. Some fading with sulphur dioxide and ascorbic acid.					
SYNERGISTS:	None known					

ANTAGONISTS: Sulphur dioxide/Alkaline media/Ascorbic acid

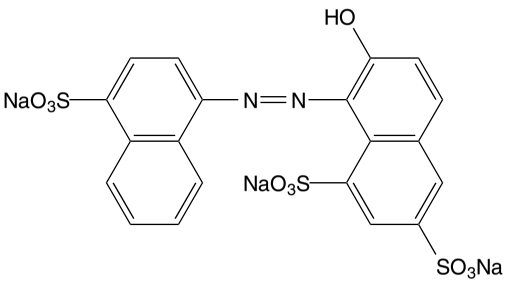
FOOD SAFETY ISSUES: None known

LEGISLATION:

USA:	UK and EUROPE:	CANADA:	AUSTRALIA:
Not permitted	Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V Part 2 (of Directive 94/36/EC) for a list of food categories and maximum levels of colour use	Not permitted	Permitted, but restrictions apply

REFERENCE: Smith, J. (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.

STRUCTURE OF PONCEAU 4R:



NAME:	Ponceau SX
CATEGORY:	Food colour
FOOD USE:	Colouring of cherries
SYNONYMS:	C.I. 14700 (Food Red 1)/Formerly FD&C Red 4/2-(5-Sulpho-2,4-xylylazo)-1-naphthol-4-sulfonate disodium salt
FORMULA:	$C_{18}H_{14}N_2O_7S_2Na_2$
MOLECULAR MASS IN Daltons:	480.23
ALTERNATIVE FORMS:	Potassium salt/Calcium salt
PROPERTIES AND APPEARANCE:	Dark red powder
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	N/A
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	87
WATER CONTENT MAXIMUM IN %:	10, but typically 3
HEAVY METAL CONTENT MAXIMUM IN ppm:	40

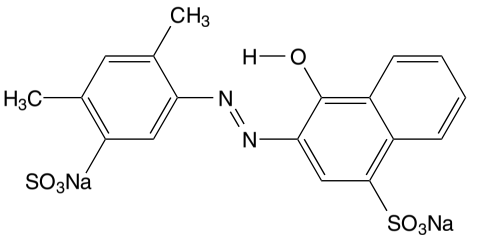
ARSENIC CONTENT MAXIMUM IN ppm:	3					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	Soluble	**@ 50°C**	Soluble	**@ 100°C**	Soluble
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in sucrose solution:						
10%	Soluble					
40%	Soluble					
60%	Soluble					
in sodium chloride solution:						
5%	Soluble					
10%	Partially soluble					
15%	Slightly soluble					
in ethanol solution:						
5%	Soluble					
20%	Soluble					
95%	Slightly soluble					
100%	Slightly soluble					
in propylene glycol:	**@ 20°C**	Soluble	**@ 50°C**	Soluble	**@ 100°C**	Soluble
FUNCTION IN FOODS:	Bright yellowish-red food colour					
ALTERNATIVES:	Erythrosine, but the shade is bluer					
TECHNOLOGY OF USE IN FOODS:	Water-soluble yellowish-red food colour, stable to heat to about 205°C. Excellent stability to fruit acids and benzoic acid. Poor stability to alkaline media. Good stability to sulphur dioxide. Major use for colouring of cherries, where permitted.					
SYNERGISTS:	None known					
ANTAGONISTS:	Alkaline media					
FOOD SAFETY ISSUES:	No ADI. Reproductive toxicology studies required					

LEGISLATION:	USA:	UK and EUROPE:	CANADA:	AUSTRALIA:
	Not now permitted	Not permitted	Permitted (when certified) to a maximum of 150 ppm	Not permitted

REFERENCE:

Walford, J. (ed.) (1980) *Developments in Food Colours 1*. Applied Science Publishers, Glasgow.

STRUCTURE OF PONCEAU SX:



NAME:	Quinoline Yellow
CATEGORY:	Food colour
FOOD USE:	Baked goods/Meat and poultry products/Egg products/Fruit, vegetable and nut products/Beverages/Soft drinks/ Sugars and preserves/Confectionery/Edible ices/Vinegar, pickles and sauces/Decorations and coatings/ Desserts/Cereals and cereal products/Dairy products/Snacks/Seasonings/Soups
SYNONYMS:	E104/C.I. 47005 (Food Yellow 13)/Disodium salts of the disulfonates of 2-(2-quinolyl) indan-1, and 3-dione (principal components)
FORMULA:	$C_{18}H_9NNa_2O_8S_2$ (principal component)
MOLECULAR MASS IN Daltons:	477.38 (principal component)
ALTERNATIVE FORMS:	Calcium salt/Potassium salt/Aluminium lake (insoluble)
PROPERTIES AND APPEARANCE:	A green/yellow powder or granules
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	N/A
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	Not less than 70% total colouring matter calculated as the sodium salt
WATER CONTENT MAXIMUM IN %:	30, but typically 3

HEAVY METAL CONTENT MAXIMUM IN ppm:	40					
ARSENIC CONTENT MAXIMUM IN ppm:	3					
ASH MAXIMUM IN %:	N/A					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	14	**@ 50°C**	14	**@ 100°C**	14
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in sucrose solution:						
10%	14					
40%	10					
60%	5					
in sodium chloride solution:						
5%	Soluble					
10%	Insoluble					
15%	Insoluble					
in ethanol solution:						
5%	0.1					
20%	<0.1					
95%	Insoluble					
100%	Insoluble					
in propylene glycol:	**@ 20°C**	<0.1	**@ 50°C**	0.1	**@ 100°C**	0.2
FUNCTION IN FOODS:	Water-soluble yellow food colour, or insoluble yellow food colour as the aluminium lake.					
ALTERNATIVES:	Other yellow food colours, although not of exactly the same hue, include Tartrazine; Riboflavin; Curcumin; Crocin; Safflower; Beta-carotene					
TECHNOLOGY OF USE IN FOODS:	Very robust in use, good heat stability. Less light-stable in alkaline medium. Some fade in the presence of benzoic acid.					
SYNERGISTS:	None known					
ANTAGONISTS:	Sodium hydroxide/Benzoic acid					

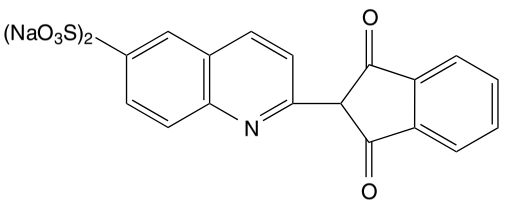
FOOD SAFETY ISSUES: None known

LEGISLATION:

USA:	UK and EUROPE:	CANADA:	AUSTRALIA:
Not permitted	Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V Part 2 (of Directive 94/36/EC) for a list of food categories and maximum levels of colour use	Not permitted	Permitted, but restrictions apply

REFERENCE: Smith, J. (Ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.

STRUCTURE OF QUINOLINE YELLOW:



NAME:	Red iron oxide
CATEGORY:	Food colour
FOOD USE:	Confectionery coatings/Pet foods/Canned foods
SYNONYMS:	E172/C.I. 77491 (Pigment Red 101 and 102)/Iron oxide red/Anhydrous ferric oxide/Anhydrous iron (III) oxide
FORMULA:	Fe_2O_3
MOLECULAR MASS IN Daltons:	159.70
ALTERNATIVE FORMS:	N/A
PROPERTIES AND APPEARANCE:	Red powder
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	N/A
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	Not less than 68% total iron, expressed as iron
WATER CONTENT MAXIMUM IN %:	N/A
HEAVY METAL CONTENT MAXIMUM IN ppm:	See relevant legislation for full details
ARSENIC CONTENT MAXIMUM IN ppm:	5

ASH MAXIMUM IN %:	N/A					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in sucrose solution:						
10%	Insoluble					
40%	Insoluble					
60%	Insoluble					
in sodium chloride solution:						
5%	Insoluble					
10%	Insoluble					
15%	Insoluble					
in ethanol solution:						
5%	Insoluble					
20%	Insoluble					
95%	Insoluble					
100%	Insoluble					
in propylene glycol:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
FUNCTION IN FOODS:	Insoluble red food colour					
ALTERNATIVES:	Other insoluble red colours or blends, but these are less heat-stable normally: Carmine; Ponceau 4R lake; Allura Red as lake					
TECHNOLOGY OF USE IN FOODS:	An insoluble orange red heat- and light-stable powder used mainly in canned or highly processed food and sugar-coated confectionery (dragees).					
SYNERGISTS:	None known					
ANTAGONISTS:	None known					
FOOD SAFETY ISSUES:	None known					

LEGISLATION:	USA:	UK and EUROPE:	CANADA:	AUSTRALIA:
	Not permitted	Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V Part 1 (of Directive 94/36/EC) for details of use	Permitted	Permitted

REFERENCE:

Smith, J (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.

NAME:	Riboflavin
CATEGORY:	Food colour
FOOD USE:	Confectionery/Cereal products/Sauces/Dairy products
SYNONYMS:	E101 (i)/Lactoflavin/Vitamin B2/7,8-Dimethyl-10-(D-ribo-2,3,4,5-tetrahydroxypentyl)-benzo(g)pteridine-2,4-(3*H*,10*H*)-dione/7,8-Dimethyl-10-(1′-D-ribityl)isoalloxazine
FORMULA:	$C_{17}H_{20}N_4O_6$
MOLECULAR MASS IN Daltons:	376.37
PROPERTIES AND APPEARANCE:	Yellow to orange/yellow crystalline powder
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	278–282
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	Not less than 98% on the anhydrous basis
WATER CONTENT MAXIMUM IN %:	1.5
HEAVY METAL CONTENT MAXIMUM IN ppm:	40
ARSENIC CONTENT MAXIMUM IN ppm:	3

ASH CONTENT IN %:	Not more than 0.1% sulphated ash					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	Slightly soluble; readily soluble in alkaline solutions pH >8.0	**@ 50°C**	Slightly soluble	**@ 100°C**	Soluble (0.03%)
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in sucrose solution:						
10%	Slightly soluble					
40%	Slightly soluble					
60%	Slightly soluble					
in sodium chloride solution:						
5%	Slightly soluble (more so than in water)					
10%	Slightly soluble (more so than in water)					
15%	Slightly soluble (more so than in water)					
in ethanol solution:						
5%	Slightly soluble					
20%	Slightly soluble					
95%	Sparingly soluble (0.005%)					
100%	Sparingly soluble (0.005%)					
in propylene glycol:	**@ 20°C**	Slightly soluble	**@ 50°C**	Slightly soluble	**@ 100°C**	Slightly soluble
FUNCTION IN FOODS:	Greenish-yellow food colour (vitamin B2)					
ALTERNATIVES:	Other yellow food colours, although not of the same hue, include Curcumin; Tartrazine; Quinoline Yellow; Beta-carotene; Riboflavin-5′-phosphate					
TECHNOLOGY OF USE IN FOODS:	Can be added direct to foodstuffs to act as a pigment, or dissolved if at low concentrations. A stock solution in dilute alkali can be prepared to facilitate coloration of the foodstuff.					
SYNERGISTS:	Antioxidants					
ANTAGONISTS:	Strong alkalis/Sulphur dioxide/Metal ions					

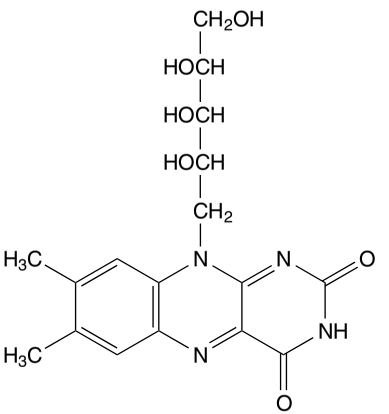
FOOD SAFETY ISSUES: None known

LEGISLATION:

USA:	UK and EUROPE:	CANADA:	AUSTRALIA:
Not permitted as food colouring	Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V Part 1 (of Directive 94/36/EC) for details of use	Permitted	Permitted

REFERENCE: Smith, J. (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.

STRUCTURE OF RIBOFLAVIN:



NAME:	Riboflavin-5′-phosphate
CATEGORY:	Food colour
FOOD USE:	Confectionery/Cereal products/Sauces/Dairy products
SYNONYMS:	E101 (ii)/Riboflavin-5′-phosphate sodium salt/(2*R*,3*R*,4*S*)-5-(3′)10′-dihydro-7′,8′-dimethyl-2′,4′-dioxo-10′-benzo[y]pteridinyl)-2,3,4-trihydroxypentyl phosphate/Monosodium salt of 5′-monophosphate ester of riboflavin
FORMULA:	$C_{17}H_{20}N_4NaO_9P{\cdot}2H_2O$
MOLECULAR MASS IN Daltons:	541.36
PROPERTIES AND APPEARANCE:	Yellow to orange crystalline hygroscopic powder
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	Not less than 95% total colouring matter calculated as the dihydrate
WATER CONTENT MAXIMUM IN %:	8
HEAVY METAL CONTENT MAXIMUM IN ppm:	$\leq$40
ARSENIC CONTENT MAXIMUM IN ppm:	3

ASH CONTENT IN %:	Not more than 25% sulphated ash					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	Soluble (10%)	**@ 50°C**	Soluble (10%)	**@ 100°C**	Soluble (12%)
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in sucrose solution:						
10%	Soluble					
40%	Soluble					
60%	Soluble					
in sodium chloride solution:						
5%	Slightly soluble (more soluble than in water)					
10%	Slightly soluble (more soluble than in water)					
15%	Slightly soluble (more soluble than in water)					
in ethanol solution:						
5%	Slightly soluble					
20%	Slightly soluble					
95%	Sparingly soluble (0.005%)					
100%	Sparingly soluble (0.005%)					
in propylene glycol:	**@ 20°C**	Soluble	**@ 50°C**	Soluble	**@ 100°C**	Soluble
FUNCTION IN FOODS:	Greenish-yellow food colour (vitamin B2)					
ALTERNATIVES:	Other yellow food colours, although not of the same hue, include Riboflavin; Curcumin; Tartrazine; Quinoline Yellow; Beta-carotene					
TECHNOLOGY OF USE IN FOODS:	Can be added directly to foodstuffs. A stock solution in water can be prepared to facilitate the coloration of the foodstuff.					
SYNERGISTS:	Antioxidants					
ANTAGONISTS:	Strong alkalis/Sulphur dioxide/Metal ions					
FOOD SAFETY ISSUES:	None known					

LEGISLATION:	USA:	UK and EUROPE:	CANADA:	AUSTRALIA:
	Not permitted as food colouring	Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V Part 1 (of Directive 94/36/EC) for details of use	Permitted	Permitted

REFERENCE:

Smith, J. (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.

NAME:	Safflower
CATEGORY:	Food colour (spice/flavour)
FOOD USE:	Baked goods/Dairy products/Egg products/Soft drinks/Sugars and preserves/Confectionery/Vinegars, pickles and sauces/Desserts/Seasonings/Alcoholic drinks/Edible ices
SYNONYMS:	Safflower Yellow/Cartham/Carthamus Yellow/Carthamus/C.I. Natural Yellow 5
FORMULA:	$C_{27}H_{32}O_{16}$
MOLECULAR MASS IN Daltons:	612.5
ALTERNATIVE FORMS:	N/A
PROPERTIES AND APPEARANCE:	Hygroscopic yellow to dark brown crystals, paste or powder with a faint characteristic odour
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	Unknown
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	Typically extracts contain 5% pigment
WATER CONTENT MAXIMUM IN %:	N/A
HEAVY METAL CONTENT MAXIMUM IN ppm:	Lead: not more than 5

ARSENIC CONTENT MAXIMUM IN ppm:	Not specified					
ASH MAXIMUM IN %:	Not specified					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	Completely soluble	**@ 50°C**	Completely soluble	**@ 100°C**	Completely soluble
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in sucrose solution:						
10%	Completely soluble					
40%	Completely soluble					
60%	Completely soluble					
in sodium chloride solution:						
5%	Soluble					
10%	Soluble					
15%	Soluble					
in ethanol solution:						
5%	Completely soluble					
20%	Soluble					
95%	Practically insoluble					
100%	Practically insoluble					
in propylene glycol:	**@ 20°C**	Miscible	**@ 50°C**	Miscible	**@ 100°C**	Miscible
FUNCTION IN FOODS:	A bright-yellow water-soluble food colour that also imparts a characteristic flavour.					
ALTERNATIVES:	Other yellow colours, although not of exactly the same hue, include Beta-carotene; Tartrazine; Sunset Yellow; Turmeric/Curcumin					
TECHNOLOGY OF USE IN FOODS:	Readily soluble in water and can be added directly to aqueous foodstuffs. For ease of addition, a pre-dilution in water can be used.					
SYNERGISTS:	None known					
ANTAGONISTS:	Sulphur dioxide					
FOOD SAFETY ISSUES:	None known					

LEGISLATION:	USA: Not permitted as a food colour, but may be used as a characteristic flavour	UK and EUROPE: Not permitted as a food colour, but may be used as a characteristic flavour	CANADA: Not permitted but may be used as a characteristic flavour	AUSTRALIA: Not permitted, but may be used as a characteristic flavour JAPAN: Permitted as a natural colour
REFERENCE:	Joint FAO/WHO Expert Committee on Food Additives (JECFA), FAO Food and Nutrition Paper 52/6 (1998). FAO, Rome.			

NAME:	Santalin
CATEGORY:	Food colour (spice)
FOOD USE:	Meat and poultry products/Alcoholic drinks/Desserts/Confectionery/Fish and fish products/Sugars and preserves/Vinegars, pickles and sauces/Decorations and coatings/Seasonings/Snack foods
SYNONYMS:	Sandalwood/Red sandalwood/Saunderswood/Sanders Red/INS 166
FORMULA:	Santalin A $C_{33}H_{26}O_{10}$; Santalin B $C_{34}H_{28}O_{10}$
MOLECULAR MASS IN Daltons:	Santalin A 582.52; Santalin B 596.54
ALTERNATIVE FORMS:	A much lesser pigment, santalin C, is also reported in the literature
PROPERTIES AND APPEARANCE:	A dark red/brown oleoresin or crystalline powder
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	Santalin A 302–303; Santalin B 292–294
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	Typically around 5% pigment content
WATER CONTENT MAXIMUM IN %:	N/A
HEAVY METAL CONTENT MAXIMUM IN ppm:	<20

ARSENIC CONTENT MAXIMUM IN ppm:	<1					
ASH MAXIMUM IN %:	Not specified					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Very slightly soluble	**@ 100°C**	Slightly soluble
in sucrose solution:						
10%	Insoluble					
40%	Insoluble					
60%	Insoluble					
in sodium chloride solution:						
5%	Insoluble					
10%	Insoluble					
15%	Insoluble					
in ethanol solution:						
5%	Insoluble					
20%	Slightly soluble					
95%	Soluble					
100%	Soluble					
in propylene glycol:	**@ 20°C**	Insoluble	**@ 50°C**	Miscible	**@ 100°C**	Miscible
FUNCTION IN FOODS:	A spice or oleoresin that imparts a red/brown colour and characteristic flavour.					
ALTERNATIVES:	Other red/brown food colours, or combinations, although not of exactly the same hue, include Caramel; Beetroot; Carmine; Paprika					
TECHNOLOGY OF USE IN FOODS:	Directly soluble in alcohol, so an alcoholic solution can be used to colour/flavour alcoholic drinks. An emulsified formulation, usually based on polysorbate, can be used to add to aqueous foodstuffs. Such a formulation does not normally provide a clear solution in water, but rather a hazy red/brown colour.					
SYNERGISTS:	Emulsifiers, particularly polysorbates					
ANTAGONISTS:	Sulphur dioxide					

FOOD SAFETY ISSUES: None known

LEGISLATION:

USA:	**UK and EUROPE:**	**CANADA:**	**AUSTRALIA:**
Not permitted as food colour specifically, but may be used as a spice/ flavouring	Not permitted as a food colour but may be used as a spice/flavour	Permitted as saunderswood	Not permitted as a food colour, but may be used as a spice/flavour

REFERENCES:

Arnone, A., Camarda, L., Merlini, L. and Nasini, G. (1975) Structures of the red sandalwood pigments, santalins A and B. *Journal of the Chemical Society Perkin's Transactions* **I**, 186–194.

Verghese, J. (1986) Santalin: a peerless natural colourant. *Cosmetics and Toiletries* **101**, 69–74.

ANY OTHER RELEVANT INFORMATION: Santalin was permitted in the UK according to the Colouring Matter in Foodstuff Regulations 1973 (as amended). However, the 1996 EC directive on food colours does not list santalin as a permitted colour.

NAME:	Silver
CATEGORY:	Food colour
FOOD USE:	Surface coating of confectionery/Decoration of chocolates/Liqueurs
SYNONYMS:	E174/Argentum/C.I. 77820
FORMULA:	Ag
MOLECULAR MASS IN Daltons:	107.87
PROPERTIES AND APPEARANCE:	Silver powder or thin sheets (leaf)
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	1955
MELTING RANGE IN °C:	960.5
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	Not less than 99.5
WATER CONTENT MAXIMUM IN %:	N/A
HEAVY METAL CONTENT MAXIMUM IN ppm:	Not specified
ARSENIC CONTENT MAXIMUM IN ppm:	Not specified
ASH MAXIMUM IN %:	N/A

SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:

in water:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in sucrose solution:						
10%	Insoluble					
40%	Insoluble					
60%	Insoluble					
in sodium chloride solution:						
5%	Insoluble					
10%	Insoluble					
15%	Insoluble					
in ethanol solution:						
5%	Insoluble					
20%	Insoluble					
95%	Insoluble					
100%	Insoluble					
in propylene glycol:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble

FUNCTION IN FOODS: Used as a dispersed powder or silver leaf to surface-colour sugar or chocolate confectionery, or as an additive to certain liqueurs.

ALTERNATIVES: Aluminium powder or leaf

TECHNOLOGY OF USE IN FOODS: Applied as leaf or powder to the surface of hard sugar or chocolate confectionery, then polished to a high gloss as a decoration. Can be added as fine particles or leaf to certain liqueurs.

SYNERGISTS: None known

ANTAGONISTS: Moist air can cause oxidation and loss of gloss

FOOD SAFETY ISSUES: None known

LEGISLATION:	USA:	UK and EUROPE:	CANADA:	AUSTRALIA:
	Not permitted	Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex IV for restrictions of use	Permitted	Not permitted

REFERENCE:

Smith, J. (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.

NAME:	Sulphite ammonia caramel
CATEGORY:	Food colour
FOOD USE:	Baked goods/Cereals and cereal products/Dairy products/Meat and poultry products/Soft drinks/Sugars and preserves/Confectionery/Vinegars, pickles and sauces/Decorations and coatings/Edible ices/Desserts/Seasonings/Savoury dry mixes
SYNONYMS:	E150d
FORMULA:	Not known
MOLECULAR MASS IN Daltons:	Not known
ALTERNATIVE FORMS:	N/A
PROPERTIES AND APPEARANCE:	Dark brown to black liquids or powders
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760mmHg):	N/A
MELTING RANGE IN °C:	N/A
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	Colour intensity 0.10–0.60 based on absorbance of a 0.1% solution of caramel colour in water in a 1-cm cell at 610 nm.
WATER CONTENT MAXIMUM IN %:	Typically 40 for liquids

HEAVY METAL CONTENT MAXIMUM IN ppm:	25					
ARSENIC CONTENT MAXIMUM IN ppm:	1					
ASH MAXIMUM IN %:	N/A					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	Completely soluble	**@ 50°C**	Completely soluble	**@ 100°C**	Completely soluble
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in sucrose solution:						
10%	Completely soluble					
40%	Completely soluble					
60%	Completely soluble					
in sodium chloride solution:						
5%	Completely soluble					
10%	Completely soluble					
15%	Completely soluble					
in ethanol solution:						
5%	Not stable (haze or precipitate)					
20%	Not stable (haze or precipitate)					
95%	Not stable (haze or precipitate)					
100%	Not stable (haze or precipitate)					
in propylene glycol:	**@ 20°C**	Dispersible	**@ 50°C**	Dispersible	**@ 100°C**	Dispersible
FUNCTION IN FOODS:	A water-soluble brown food colour					
ALTERNATIVES:	E150a, b and c; Brown HT; Brown FK					
TECHNOLOGY OF USE IN FOODS:	Fully water-soluble in both liquid and powder forms. To dissolve powders, use warm water. For dry mixes (e.g. instant desserts), the powderer form can be used and dissolves when reconstituted by the consumer. *Note*: caustic sulphite caramels are negatively charged and ideally suited for use in Cola drinks.					
SYNERGISTS:	N/A					

ANTAGONISTS: N/A

LEGISLATION:

USA: Permitted according to 21 CFR Part 73.85

UK and EUROPE: Permitted according to European Parliament and Council Directive 1333/2008 of 16 December 2008 and Directive 94/36/EC of June 30th 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V Part 1 for details of use

CANADA: Permitted

AUSTRALIA: Permitted

OTHER COUNTRIES: Generally permitted in most countries

REFERENCE:

Smith, J. (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.

NAME:	Sunset Yellow
CATEGORY:	Food colour
FOOD USE:	Baked goods/Cereals and cereal products/Dairy products/Fish and seafood products/Meat and poultry products/Egg products/Fruit, vegetable and nut products/Beverages/Soft drinks/Sugars and preserves/Confectionery/Alcoholic drinks/Vinegar, pickles and sauces/Decorations and coatings/Edible ices/Seasonings/Desserts/Snacks/Soups
SYNONYMS:	FD&C Yellow No. 6/E110/C.I. 15985 Food Yellow 3/Orange Yellow S/Disodium 2-hydroxy-1-(4-sulfonatophenylazo) naphthalene-6-sulfonate
FORMULA:	$C_{16}H_{10}N_2Na_2O_7S_2$
MOLECULAR MASS IN Daltons:	452.37
ALTERNATIVE FORMS:	Potassium salt/Calcium salt/Aluminium lake
PROPERTIES AND APPEARANCE:	Bright orange/red powder or granules
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	Not applicable
MELTING RANGE IN °C:	N/A
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	Not applicable
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	≤85% total colouring matter calculated as the sodium salt
WATER CONTENT MAXIMUM IN %:	15 but typically 3%

HEAVY METAL CONTENT MAXIMUM IN ppm:	Lead: not more than 2					
ARSENIC CONTENT MAXIMUM IN ppm:	3					
ASH MAXIMUM IN %:	N/A					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	18	**@ 50°C**	19	**@ 100°C**	19
in vegetable oil:	**@ 20°C**	Insoluble				
in sucrose solution:						
10%	18					
40%	18					
60%	18					
in sodium chloride solution:						
5%	18					
10%	18					
15%	18					
in ethanol solution:						
5%	18					
20%	18					
100%	**@ 60°C**	<0.1				
in propylene glycol:	**@ 20°C**	2	**@ 50°C**	2	**@ 100°C**	2
FUNCTION IN FOODS:	Water-soluble orange/yellow food colour, of insoluble pigment as the aluminium lake.					
ALTERNATIVES:	Other orange/yellow colours, although not of exactly the same hue, include Annatto; Carminic acid; Beta-carotene; Paprika					
TECHNOLOGY OF USE IN FOODS:	Very robust in use. Excellent stability up to 205°C. Slight fade in 10% NaOH, considerable fade in 1% ascorbic acid and appreciable fade in sulphur dioxide. Calcium ions can lead to precipitation.					
SYNERGISTS:	None known					
ANTAGONISTS:	Ascorbic acid/Sulphur dioxide/Sodium hydroxide (and other strong alkalis)					

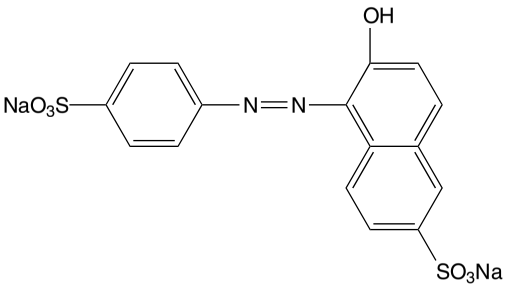
FOOD SAFETY ISSUES: None known

LEGISLATION:

USA:	**UK and EUROPE:**	**CANADA:**	**AUSTRALIA:**
GRAS; permitted as certified food colour according to 21 CFR 74.706	Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V Part 2 (of Directive 94/36/EC) for a list of food categories and maximum levels of colour use	Permitted	Permitted

REFERENCE: Smith, J. (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.

STRUCTURE OF SUNSET YELLOW:



NAME:	Tartrazine
CATEGORY:	Food colour
FOOD USE:	Baked goods/Cereals and cereal products/Dairy products/Fish and seafood products/Meat and poultry products/Egg products/Fruit, vegetable and nut products/Beverages/Soft drinks/Sugars and preserves/Confectionery/Alcoholic drinks/Vinegar, pickles and sauces/Decorations and coatings/Edible ices/Desserts including flavoured milk/Seasonings/Smoked fish/Snacks/Soups
SYNONYMS:	FD&C Yellow No. 5/E102/C.I. 19140 (Food Yellow 4)/Trisodium 5-hydroxy-1-(4-sulfonatophenyl)-4-(4-sulfonatophenylazo)-*H*-pyrazole-3-carboxylate/5-Oxo-1-(*p*-sulfophenyl)-4-[(*p*-sulfophenyl)azo]-2-pyrazoline-3-carboxylic acid, trisodium salt
FORMULA:	$C_{16}H_9N_4Na_3O_9S_2$
MOLECULAR MASS IN Daltons:	534.37
ALTERNATIVE FORMS:	Potassium salt/Calcium salt/Aluminium lake (insoluble)
PROPERTIES AND APPEARANCE:	A bright-yellow/orange powder or granules
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	Not applicable
MELTING RANGE IN °C:	N/A
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	Not applicable
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	Not applicable
PURITY %:	Not less than 85% total colouring matter calculated as the sodium salt

WATER CONTENT MAXIMUM IN %:	15, but typically 3					
HEAVY METAL CONTENT MAXIMUM IN ppm:	40					
ARSENIC CONTENT MAXIMUM IN ppm:	3					
ASH MAXIMUM IN %:	N/A					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	15	**@ 50°C**	15	**@ 100°C**	15
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in sucrose solution:						
10%	15					
40%	15					
60%	15					
in sodium chloride solution:						
5%	15					
10%	15					
15%	15					
in ethanol solution:						
20%	**@ 25°C**	10.7%	**@ 60°C**	14.5		
100%	**@ 25°C**	Insoluble	**@ 60°C**	<0.1		
in propylene glycol:	**@ 20°C**	6.5	**@ 50°C**	6.5	**@ 100°C**	6.5
FUNCTION IN FOODS:	Water-soluble yellow food colour, or insoluble yellow food colour as the aluminium lake.					
ALTERNATIVES:	Other yellow food colours, although not of exactly the same hue, include Quinoline Yellow; Riboflavin; Curcumin; Safflower; Beta-carotene					
TECHNOLOGY OF USE IN FOODS:	Very robust in use; very good stability up to 205°C. Fades in presence of 10% NaOH. Appreciable fade with 1% ascorbic acid and over 25 ppm sulphur dioxide.					
SYNERGISTS:	None known					
ANTAGONISTS:	Ascorbic acid/Sulphur dioxide/Sodium hydroxide (and other strong alkalis)					

FOOD SAFETY ISSUES:

Media and public attention has been drawn to possible involvement in hyperactivity, particularly with respect to children. Scientific evidence in this respect is limited.

LEGISLATION:

USA:	UK and EUROPE:	CANADA:	AUSTRALIA:
GRAS; permitted as certified food colour according to 21 CFR 74.706	Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V Part 2 (of Directive 94/36/EC) for a list of food categories and maximum levels of colour use	Permitted	Permitted

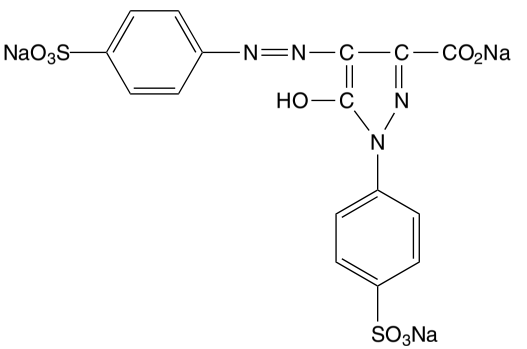
REFERENCE:

Smith, J. (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.

FOOD USE CATEGORY:

An important comment under this heading that applies to all colours is that although they can be used in the food categories listed, local legislation should be checked to ensure that the use of a particular colour is permitted in any specified country.

STRUCTURE OF TARTRAZINE:



NAME:	Titanium dioxide
CATEGORY:	Food colour
FOOD USE:	Confectionery coatings/Salad dressings/Non-dairy creamers
SYNONYMS:	E171/C.I. 77891 (Pigment White 6)
FORMULA:	TiO_2
MOLECULAR MASS IN Daltons:	79.88
PROPERTIES AND APPEARANCE:	Fine white powder
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	N/A
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	Not less than 99% on an alumina and silica-free basis
WATER CONTENT MAXIMUM IN %:	0.5
HEAVY METAL CONTENT MAXIMUM IN ppm:	Lead: not more than 10
ARSENIC CONTENT MAXIMUM IN ppm:	3
ASH MAXIMUM IN %:	N/A

SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in sucrose solution:						
10%	Insoluble					
40%	Insoluble					
60%	Insoluble					
in sodium chloride solution:						
5%	Insoluble					
10%	Insoluble					
15%	Insoluble					
in ethanol solution:						
5%	Insoluble					
20%	Insoluble					
95%	Insoluble					
100%	Insoluble					
in propylene glycol:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
FUNCTION IN FOODS:	Insoluble white food colour					
ALTERNATIVES:	Calcium carbonate					
TECHNOLOGY OF USE IN FOODS:	Insoluble white food colour used to impart a white opaque finish to sugar-panned confectionery, or as a background to added colours. Used to enhance the whiteness of non-dairy creamers, salad dressings or similar products. Colour must be dispersed into a suitable medium since it is insoluble in solvents except acids.					
SYNERGISTS:	None known					
ANTAGONISTS:	None known					
FOOD SAFETY ISSUES:	None known					

LEGISLATION:	USA:	UK and EUROPE:	CANADA:	AUSTRALIA and PACIFIC RIM:
	GRAS; permitted as certified food colour according to 21 CFR 74.706	Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V Part 2 (of Directive 94/36/EC) for a list of food categories and maximum levels of colour use	Permitted	Permitted

REFERENCE:

Smith, J. (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.

NAME:	Vegetable carbon
CATEGORY:	Food colour
FOOD USE:	Baked goods/Cereal and cereal products/Dairy products/Meat and poultry products/Sugars and preserves/ Confectionery/Decorations and coatings/Edible ices
SYNONYMS:	Carbon black/E153
FORMULA:	C
MOLECULAR MASS IN Daltons:	12.01
ALTERNATIVE FORMS:	None known
PROPERTIES AND APPEARANCE:	Black powder, odourless and tasteless
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	Not applicable
MELTING RANGE IN °C:	Not applicable
FLASH POINT IN °C:	Not known
IONISATION CONSTANT AT 25°C:	Not known
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	Not applicable
HEAT OF COMBUSTION AT 25°C IN J/kg:	Not known
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	Not applicable
PURITY %:	≤95% carbon on an anhydrous and ash-free basis
WATER CONTENT MAXIMUM IN %:	Typically 3
HEAVY METAL CONTENT MAXIMUM IN ppm:	40

ARSENIC CONTENT MAXIMUM IN ppm:	3					
ASH MAXIMUM IN %:	4.0					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in sucrose solution:						
10%	Insoluble					
40%	Insoluble					
60%	Insoluble					
in sodium chloride solution:						
5%	Insoluble					
10%	Insoluble					
15%	Insoluble					
in ethanol solution:						
5%	Insoluble					
20%	Insoluble					
95%	Insoluble					
100%	Insoluble					
in propylene glycol:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
FUNCTION IN FOODS:	A black food colour mainly used in sugar confectionery and commonly used as a shading agent.					
ALTERNATIVES:	Other black food colours, although not of exactly the same hue, include Brilliant Black PN					
TECHNOLOGY OF USE IN FOODS:	Vegetable carbon is an insoluble pigment and as such is generally used in the form of a suspension.					
SYNERGISTS:	None known					
ANTAGONISTS:	None known					
FOOD SAFETY ISSUES:	None known					

LEGISLATION:	USA:	UK and EUROPE:	CANADA:	AUSTRALIA:
	Not permitted	Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V Part 1 (of Directive 94/36/EC) for details of use	Permitted	Permitted

REFERENCE:

Smith, J. (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.

NAME:	Yellow iron oxide
CATEGORY:	Food colour
FOOD USE:	Confectionery coatings/Pet foods/Canned foods
SYNONYMS:	E172/C.I. 77492 (Pigment Yellow 42 and 43)/Iron oxide yellow/Hydrated ferric oxide/Hydrated iron (III) oxide
FORMULA:	$FeO(OH)H_2O$
MOLECULAR MASS IN Daltons:	88.85
ALTERNATIVE FORMS:	N/A
PROPERTIES AND APPEARANCE:	Yellow powder
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	N/A
MELTING RANGE IN °C:	N/A
FLASH POINT IN °C:	N/A
IONISATION CONSTANT AT 25°C:	N/A
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	N/A
HEAT OF COMBUSTION AT 25°C IN J/kg:	N/A
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	N/A
PURITY %:	Not less than 60% total iron, expressed as iron
WATER CONTENT MAXIMUM IN %:	N/A
HEAVY METAL CONTENT MAXIMUM IN ppm:	See relevant legislation for full details

ARSENIC CONTENT MAXIMUM IN ppm:	5					
ASH MAXIMUM IN %:	N/A					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in vegetable oil:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
in sucrose solution:						
10%	Insoluble					
40%	Insoluble					
60%	Insoluble					
in sodium chloride solution:						
5%	Insoluble					
10%	Insoluble					
15%	Insoluble					
in ethanol solution:						
5%	Insoluble					
20%	Insoluble					
95%	Insoluble					
100%	Insoluble					
in propylene glycol:	**@ 20°C**	Insoluble	**@ 50°C**	Insoluble	**@ 100°C**	Insoluble
FUNCTION IN FOODS:	Insoluble yellow food colour					
ALTERNATIVES:	Other insoluble yellow colours or blends, but these are normally less heat-stable: Tartrazine lake/Quinoline Yellow lake					
TECHNOLOGY OF USE IN FOODS:	An insoluble, yellow, heat- and light-stable powder used mainly in canned or highly processed food and sugar-coated confectionery (dragees).					
SYNERGISTS:	None known					
ANTAGONISTS:	None known					
FOOD SAFETY ISSUES:	None known					

LEGISLATION:	USA:	UK and EUROPE:	CANADA:	AUSTRALIA:
	Not permitted	Permitted according to European Parliament and Council Regulation 1333/2008 of 16 December 2008 and Directive 94/36/EC of 30 June 1994 on colours for use in foodstuffs. Directive 94/36/EC is scheduled to be replaced in 2011 and incorporated (in modified form) into Regulation 1333/2008. Refer to Annex V Part 1 (of Directive 94/36/EC) for details of use	Permitted	Permitted

REFERENCE:

Smith, J. (ed.) (1991) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow.

Part 4

Emulsifiers

Carla A. Poirier

This Part is based upon the First Edition contribution of Eric A. Flack

Food Additives Data Book, Second Edition. Edited by Jim Smith and Lily Hong-Shum.
 Published 2011 by Blackwell Publishing Ltd.

NAME:	Acetic acid esters of mono- and diglycerides of fatty acids
CATEGORY:	Emulsifier
FOOD USE:	Chewing gum base/Cake batters/Topping powders/Aerated desserts/Coatings
SYNONYMS:	Acetylated monoglycerides/Acetem/E472a/Acetylated mono- and diglycerides/Acetoglycerides
FORMULA:	CH_2-O-$COCH_3$-CHOH-CH_2·O·CO·$(CH_2)_{16}$·CH_3 (for stearate)
MOLECULAR MASS IN Daltons:	400
ALTERNATIVE FORMS:	Varies according to degree of acetylation (50–96%) and fatty acid composition
PROPERTIES AND APPEARANCE:	Colourless to ivory, oily to waxy liquid
MELTING RANGE IN °C:	5–50
PURITY %:	Total acetic acid min. 9, max. 32
WATER CONTENT MAXIMUM IN %:	2
HEAVY METAL CONTENT MAXIMUM IN ppm:	10 (as Pb)
ARSENIC CONTENT MAXIMUM IN ppm:	3
ASH MAXIMUM IN %:	0.5
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** Insoluble
FUNCTION IN FOODS:	Fat crystal modification: alpha-tending. Excellent aerating, and foam stiffening and stabilising. Release agent for high sugar goods. Coating agent (mono-molecular film forming) for nuts, fruit pieces, meat joints. Amylose complexing index (min 90% monoester): 26–35 (poor) HLB 2 (low polarity)
ALTERNATIVES:	Lactic acid esters/Propylene glycol monostearate and palmitate

TECHNOLOGY OF USE IN FOODS:

Stabilises monoglycerides in α crystal form in emulsions used to facilitate aeration of cake and sponge batters. Maintains fats in α crystal form to stabilise aeration of whipped desserts, imitation creams and toppings. Forms protective coating against loss of moisture and fat oxidation for nuts, raisins, etc.

FOOD SAFETY ISSUES:

No acute toxic effects at practicable dosage levels. ADI not specified.

LEGISLATION:

USA:
US FDA 21 CFR 172.828 food additive

CANADA:
Permitted in unstandardised foods at GMP levels

UK and EUROPE:
E472a: ADI not specified
EC Directive 95/2 (OJ No. L61, 18.3.95) Miscellanous Additives (enacted in UK as Statutory Instrument 1995 No. 3187)
Schedule 1 (Generally permitted for use in food) and Schedules 4, 7 and 8 Purity Criteria laid down in EC Directive 78/663 (OJ No. L223, 14.7.78)

REFERENCES:

Andreasen, J. (1973) The efficiency of emulsifiers in whipped topping. Presented at CIFST Annual Conference, Vancouver, Canada, April.
Martin, J.B. and Lutton, E.S. (1972) Preparation and phase behavior of acetyl monoglycerides. *Journal of the American Oil Chemists Society* **49**, 683.

ANY OTHER RELEVANT INFORMATION:

Acid value max. 3; Iodine value max. 5 or 40–50; Saponification value 280–385

NAME:	Ammonium phosphatides
CATEGORY:	Emulsifier
FOOD USE:	Chocolate/Coatings
SYNONYMS:	E442/Emulsifier YN/Ammonium salts of phosphatidic acid/Mixed ammonium salts of phosphorylated glycerides
FORMULA:	$CH_2{\cdot}O{\cdot}R_1\text{-}CH_2{\cdot}O{\cdot}R_2\text{-}CH_2\text{-}O\text{-}P{=}O{\cdot}OH\text{-}O\text{-}NH_4$ where R_1 and R_2 represent a fatty acid moiety or hydrogen
PROPERTIES AND APPEARANCE:	Viscous semi-solid @ 25°C
PURITY %:	Phosphorus 3.0–3.4%; nitrogen 1.2–1.5%
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ARSENIC CONTENT MAXIMUM IN ppm:	3
ASH MAXIMUM IN %:	2.5
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** Insoluble
in vegetable oil:	**@ 20°C** Soluble
in ethanol solution (5%)	Partially soluble
FUNCTION IN FOODS:	Reduces casson plastic viscosity and yield value at levels of 0.2–0.5%. Synthetic lecithin produced to overcome the flavour problems with natural lecithin when used in chocolate.
ALTERNATIVES:	Soya lecithin
TECHNOLOGY OF USE IN FOODS:	Controls viscosity of chocolate and coatings.
FOOD SAFETY ISSUES:	Long-term studies show no untoward effects up to 6% of the diet.

LEGISLATION:

USA:
Not listed

AUSTRALIA:
Permitted

CANADA:
Permitted in a wide variety of applications

UK and EUROPE:
E 442: ADI 0–30 mg/kg body weight
EC Directive 95/2 (OJ No. L61, 18.3.95) Miscellaneous Additives (enacted in UK as Statutory Instrument 1995 No. 3187)
Schedule 3 (Other Permitted Miscellaneous Additives) and Schedule 4 includes specific Purity Criteria (Schedule 5)
Maximum level in chocolate products: 10 g/kg

REFERENCES:

Anonymous (1991) Food emulsifiers. *Confectionery Production,* February, 136–140.
Chevalley, J. (1994) Chocolate flow properties. In: Beckett, S.T. (ed.) *Industrial Chocolate Manufacture and Use*, 2nd edn. Blackie, Glasgow.

ANY OTHER RELEVANT INFORMATION:

pH of aqueous extract 6.0–8.0

NAME:	Calcium stearoyl lactylate
CATEGORY:	Emulsifier
FOOD USE:	Bread/Baked goods/Coffee whiteners/Confectionery
SYNONYMS:	CSL/E482/Calcium stearoly-2-lactylate
FORMULA:	CH_3-CHOCO[CHOCO$(CH_2)_{16}$-CH_3]CH_3-COOCaOH
MOLECULAR MASS IN Daltons:	468
PROPERTIES AND APPEARANCE:	White/cream powder, flakes or beads
MELTING RANGE IN °C:	45–55
PURITY %:	Total lactic acid (free + combined) min. 15, max. 40; calcium min. 1, max. 5.2
HEAVY METAL CONTENT MAXIMUM IN ppm:	10 (as Pb)
ARSENIC CONTENT MAXIMUM IN ppm:	3
FUNCTION IN FOODS:	Excellent dough strengthener and crumb softener in bread. Used at levels of 0.3–0.5% (see also references to DATEM and distilled monoglycerides). Amylose complexing index 65 (good) HLB 5–6 (medium polarity)
ALTERNATIVES:	Combination of DATEM and distilled monoglycerides.
TECHNOLOGY OF USE IN FOODS:	Dough strengthener and crumb softener in bread: use at levels of 0.3–0.5%.

LEGISLATION:	**USA:** US FDA 21 CFR §172.844 Regulated dough conditioner, whipping agent, conditioning agent **AUSTRALIA/PACIFIC RIM:** Japan: approved with restrictions: bread 5.5 mg/kg max.; cake 8 mg/kg max.; confectionery 5 g/kg max.; pasta 4.5 g/kg max.	**UK and EUROPE:** E482: ADI 0–20 mg/kg body weight EC Directive 95/2 (OJ No. L61, 18.3.95) Miscellaneous Additives (Enacted in UK as Statutory Instrument 1995 No. 3187) Schedule 3 (Other Permitted Miscellaneous Additives) Purity Criteria laid down in EC Directive 78/663 (OJ No.L223, 14.7.78)
REFERENCE:	Kamel, B.S. (1991) Emulsifiers. In: Smith, J. (ed.) *Food Additive User's Handbook*. Blackie, Glasgow, pp. 169–201.	
ANY OTHER RELEVANT INFORMATION:	Acid value 50–130	

NAME:	Citric acid esters of mono- and diglycerides of fatty acids
CATEGORY:	Emulsifier
FOOD USE:	Frying margarine/Meat products/Spreads/Whipping cream/Beverage emulsions/Mayonnaise/Salad dressings/Sauces/Bread
SYNONYMS:	Citroglycerides/E472c/Citrem/Monoglyceride citrate
FORMULA:	$CH_2{\cdot}O{\cdot}C{=}O{\cdot}CH_2{\cdot}COH{\cdot}COOH{\cdot}CH_2{\cdot}COOH\text{-}CHOH\text{-}CH_2{\cdot}O{\cdot}CO(CH_2)_{16}{\cdot}CH_3$ (for stearate)
MOLECULAR MASS IN Daltons:	532
ALTERNATIVE FORMS:	Varies according to degree of citration and fatty acid composition
PROPERTIES AND APPEARANCE:	White to off-white powder or flakes
MELTING RANGE IN °C:	58–64
FLASH POINT IN °C:	>100
PURITY %:	Total citric acid min. 13, max. 50
WATER CONTENT MAXIMUM IN %:	2
HEAVY METAL CONTENT MAXIMUM IN ppm:	10 (as Pb)
ARSENIC CONTENT MAXIMUM IN ppm:	3
ASH MAXIMUM IN %:	0.5
FUNCTION IN FOODS:	Provides emulsion stability through fine distribution of water droplets. Synergist/solubiliser for antioxidants. Amylose complexing index 36 (poor) HLB 10–12 (medium/high polarity)
TECHNOLOGY OF USE IN FOODS:	Crystallises in α crystal form. Excellent anti-spattering agent.

LEGISLATION:	**USA:** US FDA 21 CFR 172.832	**UK and EUROPE:** E472c: ADI not specified EC Directive 0.5/2 (OJ No. L61, 18.3.95) Schedule 1 (enacted in UK as Statutory Instrument 1995 No. 3187) Miscellaneous additives generally permitted for use in food Also Schedules 4 and 8 (Part 3) Purity Criteria laid down in EC Directive 78/663 (OJ No. L223, 14.7.78)
REFERENCE:	Flack, E. (1985) Foam stabilisation of dairy whipping cream. *Dairy Industries International* **50**(6), 35, 37.	
ANY OTHER RELEVANT INFORMATION:	Acid value 10–40; Saponification value 220–255	

NAME:	Diacetyl tartaric acid esters of mono- and diglycerides of fatty acids
CATEGORY:	Emulsifier
FOOD USE:	Baked goods/Bread/Cereal products/Coffee whiteners/Biscuits/Extruded snacks/Sauces/Soups/Colour concentrates/Chewing gum/Meat and poultry products
SYNONYMS:	DATEM/Mono- and diacetyl tartaric acid/E472e/Esters of mono- and diglycerides of fatty acids/Acetylated tartaric acid esters of mono- and diglycerides
FORMULA:	$CH_2{\cdot}O{\cdot}C{=}O{\cdot}CH{\cdot}O{\cdot}COCH_3{\cdot}CH{\cdot}O{\cdot}COCH_3{\cdot}COOH\text{-}CHOH\text{-}CH_2{\cdot}O{\cdot}CO{\cdot}(CH_2)_{16}{\cdot}CH_3$ (for stearate)
MOLECULAR MASS IN Daltons:	574
ALTERNATIVE FORMS:	Varies according to level of diacetyl tartaric acid and fatty acid composition
PROPERTIES AND APPEARANCE:	Pale liquid to paste to powder/flakes
MELTING RANGE IN °C:	Liquid to 45°
PURITY %:	Total tartaric acid content: min. 10, max. 40
WATER CONTENT MAXIMUM IN %:	2
HEAVY METAL CONTENT MAXIMUM IN ppm:	10 (as Pb)
ARSENIC CONTENT MAXIMUM IN ppm:	3
ASH MAXIMUM IN %:	0.5
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** Dispersible
in vegetable oil:	**@ 20°C** Partially soluble
FUNCTION IN FOODS:	Used in bread and yeast-raised products at levels of 0.2–0.6% of flour weight. DATEM possess excellent dough-strengthening properties due to their ability to interact with gluten. They thus enhance gas (CO_2) retention and improve tolerance to mechanical handling. HLB 8–10 improves fat particle distribution in coffee whiteners, thereby improving whitening effect. Effective at levels of 0.125–0.5% in reduction of fat in biscuits.

Amylose complexing index 49 (fair)
HLB 7–8 (medium polarity)

ALTERNATIVES: E472f/SSL/Succinic acid esters

TECHNOLOGY OF USE IN FOODS: Invariably used in form of improvers. Fine-powdered forms are blended with up to 20% anti-caking agents such as calcium carbonate or tricalcium orthophosphate and with soya flour, etc. Liquid and paste forms are blended with fats (m.p. 35–38°C) and sugars.

Improvers are added to the dough to provide 0.2–0.6% DATEM on flour weight.

SYNERGISTS: Ascorbic acid/Potassium or calcium bromate/Enzymes (α-amylase, hemicellulase)

LEGISLATION:

USA:
US FDA 21 CFR §182.1101.
GRAS: emulsifier, flavouring agent and adjuvant. Narrower compositional range than EC, i.e. 17–20% esterified tartaric acid, 14–17% esterified acetic acid, min. 12% glycerol (*Food Chemicals Codex*, 2nd edn, 1972)

UK and EUROPE:
E472e: ADI 0–50 mg/kg body weight
EC Directive 95/2 (OJ No.L61, 18.3.95) Miscellaneous Additives (enacted in UK as Statutory Instrument 1995 No.3187)
Schedule 1 (Generally permitted for use in food) and Schedules 4 and 7 Purity Criteria laid down in EC Directive 78/663 (OJ, No.L223, 14.7.78)

CANADA:
Permitted and used at up to 0.6% on flour weight and at GMP levels in unstandardiszed foods

REFERENCES:

Schuster, G. and Adams, W. (1981) Gibt es gemischte Wein-, Essig- und FettsaureEster des Glycerins (E472f): Seifen, Öle, Fette, Wachse, (heft 3), 61.
Tamstorf, S. (2009) Emulsifiers for bakery and starch products. Danisco Technical Paper TP 1001.

ANY OTHER RELEVANT INFORMATION: Total tartaric acid min. 10%, max. 40%; Total glycerol min. 11%, max. 28%; Total acetic acid min. 8%, max. 32%; Acid value 62–76

NAME:	Dioctyl sodium sulphosuccinate
CATEGORY:	Emulsifier
FOOD USE:	Fruit drinks/Sugar/Molasses/Chocolate drinks
SYNONYMS:	Sodium dioctyl sulfosuccinate/Dicusate sodium/DSS
FORMULA:	$C_8H_{17}OOCCH_2CH(SO_3Na)COOC_8H_{17}$
MOLECULAR MASS IN Daltons:	445
PROPERTIES AND APPEARANCE:	White waxy solid
MELTING RANGE IN °C:	173–179
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** Slowly soluble
in ethanol solution (5%)	Soluble
FOOD SAFETY ISSUES:	LD_{50} (oral, rat) 1900 mg/kg. Moderately toxic by ingestion. Gives off toxic fumes of SO_2 and Na_2O.
LEGISLATION:	**USA:** US FDA 21 CFR §73.1 Diluent for colour additives, mixtures for food additives, processing and in sugar industry. Limitations: 9 ppm finished food; 25 ppm molasses
	UK and EUROPE: Not listed

NAME:	Ethoxylated mono- and diglycerides of fatty acids
CATEGORY:	Emulsifier
FOOD USE:	Baked goods/Bread/Tin-grease emulsions/Pan release/Non-dairy creamers
SYNONYMS:	Polyoxyethylene monoglycerides/PEG 20 mono- and diglycerides
FORMULA:	$CH_3(CH_2)_{16}{\cdot}CO{\cdot}O{\cdot}CH_2{\cdot}COH{\cdot}HCH_2(OCH_2CH_2){\cdot}OH$
ALTERNATIVE FORMS:	Varies with fatty acid composition and degree of ethoxylation
PROPERTIES AND APPEARANCE:	Cream to pale yellow paste
MELTING RANGE IN °C:	Semi-liquid at room temperature
FLASH POINT IN °C:	> 300
FUNCTION IN FOODS:	Dough conditioner: bread 0.5%. Emulsifier for cake batter 0.45%. Coffee whitener 0.4%. Pan release 0.5%
ALTERNATIVES:	Mono- and diglycerides/DATEM
TECHNOLOGY OF USE IN FOODS:	Dough strengthening very good; crumb softening (amylose complexing) poor HLB 10–12 (medium polarity)
LEGISLATION:	**USA:** US FDA 21 CFR §172.834. Regulated emulsifier, dough conditioner. Limitation 0.2–0.5% **UK and EUROPE:** Not listed
ANY OTHER RELEVANT INFORMATION:	Saponification value 65–75; Hydroxyl value 65–80

NAME:	Lactic acid esters of mono- and diglycerides of fatty acids
CATEGORY:	Emulsifier
FOOD USE:	Shortening/Cake and sponge batters/Aerated desserts and toppings/Imitation cream/Cake margarine/Whipping cream/Chocolate compounds
SYNONYMS:	Lactylated monoglycerides/LACTEM/E472b/Lactylated mono- and diglycerides/Lactoglycerides/Lactic acid esters of mono- and diglycerides/GLP
FORMULA:	$CH_2{\cdot}O{\cdot}CO\text{-}CHOH\text{-}CH_3\text{-}CHOH\text{-}CH_2{\cdot}O{\cdot}CO{\cdot}(CH_2)_{16}{\cdot}CH_3$ (for stearate)
MOLECULAR MASS IN Daltons:	430
ALTERNATIVE FORMS:	Varies according to lactic acid content (13–45%) and fatty acid composition
PROPERTIES AND APPEARANCE:	White to cream powder, flakes or paste
MELTING RANGE IN °C	45–50
WATER CONTENT MAXIMUM IN %:	2
HEAVY METAL CONTENT MAXIMUM IN ppm:	10 (as Pb)
ARSENIC CONTENT MAXIMUM IN ppm:	3
ASH MAXIMUM IN %	0.5
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** Insoluble
FUNCTION IN FOODS:	Alpha-tending emulsifier used in combination with saturated monoglycerides to stabilise their α-crystalline form. Amylose complexing index 22 (poor) HLB 5–8 (medium polarity)
TECHNOLOGY OF USE IN FOODS:	Can modify the crystallisation behaviour of fats and improves their whipping effect in batters and creams.

LEGISLATION:	**USA:** US FDA 21 CFR §172.852 Emulsifier, plasticiser, surface-active agent **CANADA:** Permitted at max. 8% of shortening weight	**UK and EUROPE:** E472b: ADI not specified EC Directive 95/2 (OJ No.L61, 18.3.95) Schedule 1 (enacted in UK as Statutory Instrument 1995 No.3187) Miscellaneous Additives Generally Permitted for Use in Food Also Schedule 8 (parts 3 and 4) Purity Criteria laid down in EC Directive 78/663 (OJ No.L223, 14.7.78)
REFERENCE:	Qi Si, J. (2009) The technology of imitation whipping cream. Danisco Technical Paper TP 2502.	
ANY OTHER RELEVANT INFORMATION:	Acid value max. 5; Saponification value 245–320	

NAME:	Lecithins
CATEGORY:	Emulsifier/Antioxidant
FOOD USE:	Baked goods/Chocolate/Confectionery/Cake fillings/Margarine/Spreads/Dairy products/Processed cheese/Instant foods/Beverage powders/Salad dressings and sauces
SYNONYMS:	Phosphatidylcholine/1,2-Diacyl-*sn*-glycero-3-phosphorylcholine/E322
FORMULA:	Complex mixture of phosphatidylcholine, phosphatidylethanolamine, phosphatidylinositol, phosphatidic acid, glycolipids, etc.
ALTERNATIVE FORMS:	Depending on source (soya, corn, sunflower, rapeseed, egg) and degree of refining and/or modification (fractionation, hydroxylation, etc.)
PROPERTIES AND APPEARANCE:	Cream to brown viscous liquid or paste to fawn granules
PURITY %:	Acetone insoluble min. 62
WATER CONTENT MAXIMUM IN %:	1.5
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ARSENIC CONTENT MAXIMUM IN ppm:	3
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** Dispersible
FUNCTION IN FOODS:	Anti-spattering agent in margarine. Emulsifying agent in baked goods, margarine, spreads, processed cheese, salad dressings and sauces. Release agent in baked goods. Wetting agent in instant foods, beverage powders. Antioxidant in margarine, edible oils and fats. Viscosity reduction in chocolate and coatings. Reduced sticking, improves texture in confectionery. Amylose complexing poor HLB lecithin 3–4 (low polarity); modified lecithin 10–12 (medium polarity)
ALTERNATIVES:	Mono- and diglycerides. Polysorbates and sucrose esters for high HLB

TECHNOLOGY OF USE IN FOODS: Variety of uses due to wide range of pH values through modification.

FOOD SAFETY ISSUES: No known safety problems

LEGISLATION:

USA:
US FDA 21 CFR
§184.1400. GRAS

CANADA:
Permitted in a wide variety
of applications

AUSTRALIA:
Permitted

UK and EUROPE:
E322: ADI not specified
EC Directive 95/2 (OJ No.L61, 18.3.95) Miscellanous Additives (enacted in UK as Statutory Instrument 1995 No. 3187)
Schedule 1 (Generally permitted for use in food) Schedules 4, 7, and 8 Purity Criteria laid down in EC Directive 78/663 (OJ No. L223, 14.7.78)

REFERENCES:

Bonekamp-Nasner, A. (1992) Emulsifiers: Lecithin and lecithin derivatives in chocolate. *Confectionery Production* **58**, 66–68.

Gunstone, F.D., Harwood, J.L. and Padley, F.B. (1994) *The Lipid Handbook*, 2nd edn. Chapman & Hall, London.

Minifie, B.W. (1980) Use of lecithin in chocolate and confectionery as an emulsifier and in powdered drinks as a wetting agent. *The Manufacturing Confectioner* **60**, 47–50.

Szuhaj, B.F. and List, G..R. (1985) *Lecithins*. American Oil Chemists Society, Champaign, IL.

NAME:	Mixed acetic and tartaric acid esters of mono- and diglycerides of fatty acids
CATEGORY:	Emulsifier
FOOD USE:	Baked goods/Bread
SYNONYMS:	E472
FORMULA:	$CH_2{\cdot}OC{=}O\text{-}CH{\cdot}O{\cdot}COCH_3{\cdot}CHOCOCH_3{\cdot}COOH{\cdot}CHOH\text{-}CH_2OCO\ (CH_2)_{16}{\cdot}CH_3$ (for stearate)
MOLECULAR MASS IN Daltons:	574
ALTERNATIVE FORMS:	Varies according to levels of esterified acetic and tartaric acids and fatty acid composition
PROPERTIES AND APPEARANCE:	Clear liquid to white powder flakes or sticky liquids
FUNCTION IN FOODS:	Functionality in bread as DATEM E472e. Dough-strengthening properties are excellent Amylose complexing fair
ALTERNATIVES:	DATEM E472e
LEGISLATION:	**USA:** Not listed **AUSTRALIA:** Permitted **UK and EUROPE:** E472f: ADI 0–50 mg/kg body weight EC Directive 95/2 (OJ No. L61, 18.3.95) Miscellaneous Additives (enacted in UK as Statutory Instrument 1995 No. 3187) Schedule 1 (Generally permitted for use in food) and Schedule 7 Purity Criteria laid down in EC Directive 78/663 (OJ No. L223, 14.7.78)
ANY OTHER RELEVANT INFORMATION:	Total tartaric acid min. 20%, max. 40%; Total glycerol min. 12%, max. 27%; Total acetic acid min. 10%, max. 20%

NAME:	Mono- and diglycerides of fatty acids – saturated
CATEGORY:	Emulsifier
FOOD USE:	Baked goods/Cereals and cereal products/Edible oils and fats/Cake batters/Ice-cream/Margarine/Table spreads/Shortening/Bread/Toffees and caramels/Potato products/Extruded snacks
SYNONYMS:	Glyceryl monostearate/E471/GMS/Glyceryl stearate/Glyceryl monopalmitate/Mono-Di
FORMULA:	$CH_2OH\text{-}CHOH\text{-}CH_2OOC\text{-}(CH_2)_{16}\text{-}CH_3$ (for monostearate)
MOLECULAR MASS IN Daltons:	358
ALTERNATIVE FORMS:	Varies according to fatty acid composition. Varies according to monoester content (30 to ≥90%)
PROPERTIES AND APPEARANCE:	White to cream beads, flakes or powder
MELTING RANGE IN °C:	60–72
PURITY %:	Monoester varying from min. 30 to ≥90
WATER CONTENT MAXIMUM IN %:	2
HEAVY METAL CONTENT MAXIMUM IN ppm:	10 (as Pb)
ARSENIC CONTENT MAXIMUM IN ppm:	3
ASH MAXIMUM IN %:	0.5
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** Insoluble **@ 50°C** Dispersible **@ 100°C** Dispersible but may form cubic mesophases
in vegetable oil:	**@ 50°C** Dispersible
in sucrose solution (60%)	Dispersible
in ethanol solution (95%)	Soluble
in propylene glycol:	**@ 50°C** Soluble

FUNCTION IN FOODS:

Aeration in cakes and sponges. Amylose-complexing in cereals and potato products. Crumb softening in bread. Emulsifying in cream liqueurs, margarine. Emulsion stabilising in bakery compounds. Improvement of texture consistency in ice-cream, toffees. Creaming in cake margarine. Reduced stickiness in pasta and potato products, caramels. Extrusion aid in snacks. Lubrication in chewing gum base.

Amylose complexing index:

min. 90% monoester: 87–92 (excellent)

min. 40% monoester: 40–45 (poor)

HLB 3–4 (low polarity)

ALTERNATIVES:

Monoglycerides and diglycerides of fatty acids, unsaturated. Other emulsifying agents in varying respects at different dosages.

TECHNOLOGY OF USE IN FOODS:

When producing an aqueous dispersion for cake aeration it is essential to control temperature to max. 60–65°C, depending on emulsifier type, to ensure correct crystal formation (see Krog *et al.* 1988).

For ice-cream, minimum levels of 0.21% 1-monoglyceride are recommended (see also Flack 1996).

For crumb softening (anti-staling, anti-firming), levels of min. 0.3–0.5% monoglyceride on flour weight are recommended added in the form of a hydrate (see also Flack and Krog 1998).

Improves fat distribution and chewing properties/reduces stickiness in toffees and caramels.

SYNERGISTS:

Alpha-tending emulsifiers (acetic and lactic acid ester and propylene glycol esters) for maintaining crystal form for aeration.

ANTAGONISTS:

In aeration dispersions: acids and alkalis.

FOOD SAFETY ISSUES:

No acute toxic effects at practicable dosage levels. No harmful effects specifically associated with monoglycerides and diglycerides. ADI not limited.

LEGISLATION:

USA:
US FDA 21 CFR §184.1505.
GRAS: dough strengthener, emulsifier, formulation aid, lubricant, surface-active agent, etc.

CANADA:
Permitted in a wide variety of applications

AUSTRALIA/PACIFIC RIM:
Generally permitted in all countries

UK and EUROPE:
E471: ADI no limit
EC Directive 95/2 (OJ No. L61, 18.3.95) Miscellaneous Additives (enacted in UK as Statutory Instrument 1995 No. 3187) Schedule 1 (Generally permitted for use in food) and Schedules 4, 7 and 8 Purity
Criteria laid down in EC Directive 78/663 (OJ No.L223, 14.7.78)

REFERENCES:

FAO/WHO (1973) *Specifications for Identity and Purity of Food Additives. Part V. Emulsifiers*. FAO, Rome, pp. 17–18.

Flack, E. (1996) The role of emulsifiers in low-fat food products. In: Roller, S. and Jones, S.A. (eds) *Handbook of Fat Replacers*. CRC Press, Boca Raton, FL, p. 213.

Flack, E. and Krog, N. (1998) Influence of monoglycerides on staling in wheat bread. In: Turner, A. (ed.) *Food Technology International Europe*. Sterling Publications, London, p. 199.

Krog, N., Rusom, T. and Larsson, K. (1988) Applications in the food industry. In: Becher, P. (ed.) *Encyclopedia of Emulsion Technology*, Vol. 2. Marcel Dekker, New York, p. 321.

ANY OTHER RELEVANT INFORMATION:

Amylose complexing index: see Krog, N. (1970) Interaction of monoglyerides in different physical states with amylose and their anti-firming effects in bread. *Journal of Food Technology* **5**, 77.

Acid value max. 3; Iodine value max. 3

NAME:	Mono- and diglycerides of fatty acids – unsaturated
CATEGORY:	Emulsifier
FOOD USE:	Margarine and table spreads/Bakery compounds/Cake margarine and shortening/Whipped toppings/Coffee whiteners
SYNONYMS:	Glyceryl monostearate/GMS/Mono-Di/E471
FORMULA:	$CH_2OH\text{-}CHOH\text{-}CH_2OOC\text{-}(CH_2)_7\cdot CH{=}CH(CH_2)_7\cdot CH_3$ (for monooleate)
MOLECULAR MASS IN Daltons:	356
ALTERNATIVE FORMS:	Varies according to fatty acid composition. Varies according to monoester content (30% to ≥90%)
PROPERTIES AND APPEARANCE:	Cream to yellow viscous liquids to pastes
MELTING RANGE IN °C:	<20–60
PURITY %:	Monoester varying from min. 30 to ≥90%
WATER CONTENT MAXIMUM IN %:	2
HEAVY METAL CONTENT MAXIMUM IN ppm:	10 (as Pb)
ARSENIC CONTENT MAXIMUM IN ppm:	3
ASH MAXIMUM IN %:	0.5
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** Insoluble **@ 50°C** Dispersible **@ 100°C** Dispersible
in vegetable oil:	**@ 20°C** Dispersible
in ethanol solution (100%):	Soluble
in propylene glycol:	**@ 100°C** Soluble

FUNCTION IN FOODS:

Emulsion stabilising in margarine and spreads, bakery compounds and coffee whiteners. Aeration/creaming in cake margarine and shortening. Foam stabilising in whipped toppings.

Amylose complexing index (min. 90% monoester): 26–35 (poor)

HLB 3–4 (low polarity)

ALTERNATIVES:

Monoglycerides and diglycerides of fatty acids, saturated. Other emulsifying agents in varying respects at different dosages.

TECHNOLOGY OF USE IN FOODS:

For low-fat spreads, unsaturated mono-diglycerides (IV 80–105) are preferred for producing a fine stable dispersion of water droplets. Emulsifier dosage 0.5–1%, possibly in combination with 0.2–0.5% polyglycerol polyricinoleate (IV approx. 85) and hydrocolloids.

For bakery compounds (40–80% soft fat), unsaturated mono/diglycerides (IV 60–80) are recommended at dosages of 1–2% to produce a fine stable dispersion with good shelf-life.

FOOD SAFETY ISSUES:

No acute toxic effects at practicable dosage levels. No harmful effects specifically associated with monoglycerides and diglycerides. ADI not limited.

LEGISLATION:

USA:
US FDA 21 CFR 184.1505.
GRAS: dough strengthener, emulsifiers, formulation aids, lubricants, surface-active agents, etc.

CANADA:
Permitted in a wide variety of applications

UK and EUROPE:
E471: ADI no limit
EC Directive 95/2 (OJ No. L61, 18.3.95) Schedule 1 (enacted in UK as Statutory Instrument 1995 No. 3187) Miscellaneous additives generally permitted for use
Also schedules 4, 7 and 8 (parts 1, 2, 3 and 4) Purity Criteria laid down in EC Directive 78/663 (OJ L223, 14/8/78)

REFERENCES:

FAO/WHO (1973) *Specifications for Identity and Purity of Food Additives. Part V. Emulsifiers*. FAO, Rome, pp. 17–18.

Flack, E. (2010) Butter, margarine, spreads and baking fats. In: Gunstone, F.D. and Padley, F.B. (eds) *Handbook of Lipid Technology*. CRC Press, Boca Raton, FL.

Madsen, J. (1989) Low-calorie spread and melange production in Europe. In: *World Conference on Edible Oils and Fats*. AOCS, Maastricht, October.

ANY OTHER RELEVANT INFORMATION:

Acid value max. 3; Iodine value 40–105

NAME:	Polyglycerol esters of fatty acids
CATEGORY:	Emulsifier
FOOD USE:	Baked goods/Cake batters/Cake fillings/Cake margarine/Spreads/Shortenings/Synthetic cream/Toppings/Confectionery/Egg products/Emulsified liquers
SYNONYMS:	E475/Polyglyceryl esters of fatty acids/Polyglycerolesters of non-polymerised fatty acids/PGE
FORMULA:	$CH_2OH\text{-}CHOH\text{-}CH_2\text{-}O\text{-}CH_2\cdot CHOH\cdot CH_2\cdot O\cdot CH_2\cdot CHOH\cdot CH_2\cdot O\cdot CO\cdot (CH_2)_{16}\cdot CH_3$ (for triglycerol stearate)
MOLECULAR MASS IN Daltons:	506
ALTERNATIVE FORMS:	Varies according to degree of polymerisation and fatty acid composition
PROPERTIES AND APPEARANCE:	Cream to light brown pastes, flakes, beads or powder
MELTING RANGE IN °C	30–58
PURITY %:	Total fatty acid ester content min. 90
WATER CONTENT MAXIMUM IN %:	2
HEAVY METAL CONTENT MAXIMUM IN ppm:	10 (as Pb)
ARSENIC CONTENT MAXIMUM IN ppm:	3
ASH MAXIMUM IN %:	0.5
FUNCTION IN FOODS:	Generally more hydrophilic than monoglycerides. Improves cake batter performance, namely crumb structure and cake volume. Used as aerating agents, dough conditioners, humectants, defoaming agents and anti-spattering agents. Often used together with distilled monoglycerides. Amylose complexing index 30–34 (poor) HLB 5–13 (medium polarity)
ALTERNATIVES:	Mono- and diglycerides/polysorbates

LEGISLATION:	**USA:** US FDA 21 CFR §172.854 Emulsifier, cloud inhibitor in salad oils GMP **CANADA:** Permitted	**UK and EUROPE:** E475: ADI 0–25 mg/kg body weight EC Directive 95/2 (OJ No. L61, 18.3.95) Miscellaneous Additives (enacted in UK as Statutory Instrument 1995 No.3187) Schedule 3 (Other permitted Miscellaneous Additives) and Schedule 4 Purity Criteria laid down in EC Directive 78/663 (OJ No. L223, 14.7.78)
ANY OTHER RELEVANT INFORMATION:	Acid value max. 3; Iodine value 0–80; Total glycerol + polyglycerol min. 18%, max. 60%	

NAME:	Polyglycerol polyricinoleate
CATEGORY:	Emulsifier
FOOD USE:	Chocolate/Coatings/Tin-greasing emulsions/Couverture/Pan release/Dressings
SYNONYMS:	E476/Polyglycerol esters of polycondensed fatty acids of castor oil/Partial polyglycerol esters of polyricinoleic acid/PGPR
FORMULA:	$CH_2OH\text{-}CHOH\text{-}CH_2\cdot O\cdot CH_2\cdot CHOH\cdot CH_2\cdot O\cdot CH_2\cdot CHOH\cdot CH_2\cdot O\cdot CO\cdot(CH_2)_7CH{=}CHCH_2\cdot CHOH(CH_2)_5\cdot CH_3$
MOLECULAR MASS IN Daltons:	520
PROPERTIES AND APPEARANCE:	Brown viscous liquid
MELTING RANGE IN °C:	Liquid at room temperature
PURITY %:	Polyglycerols equal to or higher than heptaglycerol max. 10. Total fatty acid ester content min. 90
WATER CONTENT MAXIMUM IN %:	2
HEAVY METAL CONTENT MAXIMUM IN ppm:	10 (as Pb)
ARSENIC CONTENT MAXIMUM IN ppm:	3
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** Insoluble **@ 50°C** Insoluble
in vegetable oil:	**@ 20°C** Soluble
FUNCTION IN FOODS:	Reduces casson plastic viscosity and yield value in chocolate when used at 0.1–0.5%. Creates very stable water-in-oil emulsions when used at 2–5%.
ALTERNATIVES:	Lecithin and emulsifier YN in chocolate. Thermally oxidised soybean oil for tin greases.
TECHNOLOGY OF USE IN FOODS:	Water-in-oil emulsions stable at high temperatures; thus, valuable as baking release agents.

LEGISLATION:	**USA:** Not listed **CANADA:** Permitted **AUSTRALIA:** Permitted	**UK and EUROPE:** E476: ADI 0–7.5 mg/kg body weight EC Directive 95/2 (OJ No. L61, 18.3.95) Miscellaneous Additives (enacted in UK as Statutory Instrument 1995 No.3187) Schedule 3 (Other permitted Miscellaneous Additives) Includes specific purity criteria (Schedule 5)
REFERENCE:	Chevalley, J. (1994) Chocolate flow properties. In: Beckett, S.T. (ed.) *Industrial Chocolate Manufacture and Use*, 2nd edn. Blackie, Glasgow.	
ANY OTHER RELEVANT INFORMATION:	Acid value max. 6; Iodine value 72–103; Hydroxyl value 80–100	

NAME:	Polysorbates
CATEGORY:	Emulsifier
FOOD USE:	Baked goods/Bread/Cake batters/Cake fillings/Ice-cream/Margarine/Salad dressings/Sauces/Soups/ Confectionery
SYNONYMS:	Polyoxyethylene (20) sorbitan esters/PEG20 sorbitan esters/POE20 sorbitan esters/Tweens
FORMULA:	$C_{64}H_{126}O_{26}$ (empirical) complex (for monostearate)
MOLECULAR MASS IN Daltons:	1310 (for monostearate)
ALTERNATIVE FORMS:	Varies according to fatty acid composition
PROPERTIES AND APPEARANCE:	Yellow to orange viscous liquid, or soft gel to waxy paste
MELTING RANGE IN °C:	Liquid to 45°C
WATER CONTENT MAXIMUM IN %:	3
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ARSENIC CONTENT MAXIMUM IN ppm:	3
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	Soluble in cold and hot water
in vegetable oil:	Insoluble
FUNCTION IN FOODS:	Emulsifier: HLB 10–16 (high polarity) Solubiliser and wetting agent; solvent/diluent Amylose complexing index 28–32 (poor)
ALTERNATIVES:	Sucrose esters
FOOD SAFETY ISSUES:	Extensive toxicological testing has established no untoward effects (FAO/WHO Report Series No. 53a, 1974).

LEGISLATION:	**USA:** US FDA 21 CFR §172.515 (polysorbate 20-monolaurate), §172.836 (60-tristearate), §172.838 (65-tristearate), §172.840 (80-monooleate) **CANADA:** Permitted	**UK and EUROPE:** E432 (polysorbate 20-monolaurate), E433 (80-monooleate), E434 (40-monopalmitate), E435 (60-monostearate), E436 (65-tristearate) ADI 0–25 mg/kg body weight Directive 95/2 (OJ No. L61, 18.3.95) Miscellaneous Additives (enacted in UK as Statutory Instrument 1995 No.3187) Schedule 3 (Other Permitted Miscellaneous Additives) and Schedule 4 Purity Criteria for Polysorbates 20, 80, 60 and 65 refer to *Food Chemicals Codex* 1981, pp. 234–236 with the exception (for 20, 80, 60 and 65) of the descriptions relating to conforming to FDA specifications for fats and fatty acids. For purity criteria for polysorbate 40 refer to FAO Food and Nutrition Paper No. 4, 1978, p. 278
REFERENCE:	Del Vecchio, A.J. (1975) Emulsifiers and their use in soft wheat products. *Bakers Digest* **49**(4), 28.	
ANY OTHER RELEVANT INFORMATION:	Acid value max. 2; Saponification value 40–98; Hydroxyl value 44–108	

NAME:	Propylene glycol esters of fatty acids
CATEGORY:	Emulsifier
FOOD USE:	Cake batters/Margarine/Shortening/Powdered desserts/Toppings/Synthetic cream/Confectionery
SYNONYMS:	Propane-1,2-diolesters of fatty acids/PGMS/E477/PGME/Propylene glycol mono- and diesters of fatty acids
FORMULA:	CH_3-CHOH-$CH_2O{\cdot}CO{\cdot}(CH_2)_{16}{\cdot}CH_3$ (for stearate)
MOLECULAR MASS IN Daltons:	330
ALTERNATIVE FORMS:	Varies according to fatty acid composition and monoester content
PROPERTIES AND APPEARANCE:	White to yellowish-white waxy paste, flakes or beads
MELTING RANGE IN °C:	36–45
PURITY %:	Total fatty acid ester, min. 85; dimer + trimer of propane 1,2-diol, max. 0.4; Total propane 1,2-diol min. 11, max. 31
HEAVY METAL CONTENT MAXIMUM IN ppm:	10 (as Pb)
ARSENIC CONTENT MAXIMUM IN ppm:	3
ASH MAXIMUM IN %:	0.5
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** Insoluble **@ 50°C** Dispersible
in vegetable oil:	**@ 20°C** Soluble
FUNCTION IN FOODS:	Alpha-tending. Excellent aerating and foam-stabilising properties in whipped dessert and topping powders. Effective aerating agent in baked goods, especially in combination with distilled monoglycerides and in shortenings. Component and co-emulsifier with distilled monoglycerides in cake improver gels. Amylose complexing <20 (poor) HLB 3–4 (low polarity)
ALTERNATIVES:	Acetylated monoglycerides/Lactic acid esters

TECHNOLOGY OF USE IN FOODS:

Modifies the crystallisation behaviour of fats and improves their aeration effect in batters and creams. Stabilises monoglycerides in α crystal form in cake improver gels.

LEGISLATION:

USA:
US FDA 21 CFR §172.856 GMP

CANADA:
Permitted at 0.35% of ice cream mixes and GMP in unstandardised foods

AUSTRALIA:
Permitted

UK and EUROPE:
E477: ADI 0–25 mg/kg body weight
EC Directive 95/2 (OJ No. L61, 18.3.95) Miscellaneous Additives (enacted in UK as Statutory Instrument 1995 No.3187) Schedule 3 (Other Permitted Miscellaneous Additives) Purity Criteria laid down in EC Directive 78/663 (OJ No.L223, 14.7.78)

REFERENCES:

Buchheim, W., Barfod, N. and Krog, N. (1985) Relation between microstructure destabilisation phenomena and rheological properties of whippable emulsions. *Food Microstructure* **4**, 221–232.

Westerbeek, J.M.M. and Prins, A. (1990) Function of α-tending emulsifiers and proteins in whippable emulsions. In: Dickensen, E. (ed.) *Food Polymers, Gels and Colloids*. Royal Society of Chemistry, London, Special Publication No. 82.

NAME:	Sodium, potassium, calcium and magnesium salts of fatty acids
CATEGORY:	Emulsifier
FOOD USE:	Cakes/Bread/Biscuits/Dairy products/Margarines/Spreads/Confectionery
SYNONYMS:	Salts of myristic, palmitic and stearic acids/Salts of fatty acids/Stearates/Soaps
FORMULA:	Varies according to fatty acid composition
MOLECULAR MASS IN Daltons:	Varies according to fatty acid composition
PROPERTIES AND APPEARANCE:	White or creamy white to yellow solids or semi-solid
PURITY %:	Fatty acid salts: min. 95
HEAVY METAL CONTENT MAXIMUM IN ppm:	10 (as Pb)
ARSENIC CONTENT MAXIMUM IN ppm:	3
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	Sodium and potassium salts are soluble in water Calcium and magnesium salts are insoluble in water
FUNCTION IN FOODS:	Used alone or with other fatty acid based emulsifiers.
ALTERNATIVES:	Lecithins
LEGISLATION:	**USA:** US FDA 21 CFR 172.863 **UK and EUROPE:** E470a; E470b – ADI not specified
REFERENCE:	European Food Emulsifier Manufacturers' Association (EFEMA) (2009) *EFEMA Index of Food Emulsifiers*. EFEMA, Brussels, pp. 41–50.

NAME:	Sodium stearoyl lactylate
CATEGORY:	Emulsifier
FOOD USE:	Baked goods/Bread/Shortening/Coffee whiteners/Biscuits/Confectionery
SYNONYMS:	E481/SSL/Sodium stearyl-2-lactylate
FORMULA:	$CH_3{\cdot}CHOCO[CHOCO(CH_2)_{16}{\cdot}CH_3)]CH_3{\cdot}COONa$
MOLECULAR MASS IN Daltons:	459
PROPERTIES AND APPEARANCE:	White powder, flakes or beads
MELTING RANGE IN °C:	42–52
PURITY %:	Total lactic acid (free + combined) min. 15, max. 40; sodium min. 2.5, max. 5
HEAVY METAL CONTENT MAXIMUM IN ppm:	10 (as Pb)
ARSENIC CONTENT MAXIMUM IN ppm:	3
FUNCTION IN FOODS:	Excellent dough strengthener and crumb softener in bread (see also references to DATEM and distilled monoglycerides). Improves fat particle distribution in coffee whiteners and improves whitening effect. Effective in reduction of fat in biscuits. Amylose complexing index 72 (very good) HLB 10–12 (medium polarity)
ALTERNATIVES:	Combination of DATEM and distilled monoglycerides/sucrose esters.
TECHNOLOGY OF USE IN FOODS:	In bread: dough strengthener and crumb softener when used at levels of 0.3–0.5%. Fat-reducing agent in biscuits (use at 0.125–0.5%).

LEGISLATION:

USA:
US FDA 21 CFR §173.846 Dough strengthener, emulsifier, processing aid, surface-active agent, stabiliser, formulation aid, texturiser max. 0.5% on flour weight in bread. GMP in non-standardised products

CANADA:
Max. 0.375% on flour weight in bread

UK and EUROPE:
E481: ADI 0–20 mg/kg body weight
EC Directive 95/2 (OJ No. L61, 18.3.95) Miscellaneous Additives (enacted in UK as Statutory Instrument 1995 No.3187) Schedule 3 (Other Permitted Miscellaneous Additives) Purity Criteria laid down in EC Directive 78/663 (OJ No. L223, 14.7.78)

REFERENCE:

Flack, E. (1996) The role of emulsifiers in low-fat food products. In: Roller, S. and Jones, S.A. (eds) *Handbook of Fat Replacers*. CRC Press, Boca Raton, FL, pp. 213–234.

ANY OTHER RELEVANT INFORMATION:

Acid value 60–130

NAME:	Sorbitan esters of fatty acids
CATEGORY:	Emulsifier
FOOD USE:	Cakes/Chocolate/Toppings/Dry yeast/Margarine/Coatings/Coffee whiteners/Confectionery/Chewing gum/Sauces
SYNONYMS:	Anhydrosorbitol esters/SPANS
FORMULA:	CH_2-CHOH-CHOHC[CHOH-CH_2-OOC$(CH_2)_{16}$-CH_3]O
MOLECULAR MASS IN Daltons:	430
ALTERNATIVE FORMS:	Varies according to fatty acid composition
PROPERTIES AND APPEARANCE:	Amber liquid to tan beads/flakes
MELTING RANGE IN °C:	Liquid to 57°C, depending on fatty acid
WATER CONTENT MAXIMUM IN %:	1.5
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ARSENIC CONTENT MAXIMUM IN ppm:	3
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	Insoluble in cold water, but dispersible in hot water
in vegetable oil:	Soluble above melting point of ester
FUNCTION IN FOODS:	Emulsifier (water-in-oil emulsions) Crystal modifier in margarine, chocolate and cooking oils Amylose complexing index <20 (poor) HLB 3–5 (low polarity)
SYNERGISTS:	In blends with polysorbates to achieve specific HLB values.

LEGISLATION:

USA:
US FDA 21 CFR §172.842 (monostearate) §175.320

CANADA:
Permitted in a wide variety of applications

AUSTRALIA/PACIFIC RIM:
Japan: listed for use in chewing gum base, emulsifier, plastifier for chewing gum

UK and EUROPE:
E491 (sorbitan monostearate), E492 (tristearate), E493 (monolaurate), E494 (monooleate), E495 (monopalmitate)
ADI 0–25 mg/kg body weight
EC Directive 95/2 (OJ No. L61, 18.3.95) Miscellaneous Additives (enacted in UK as Statutory Instrument 1995 No. 3187)
Schedule 3 (Other permitted Miscellaneous Additives) and Schedule 4 Purity Criteria laid down in SI 1995 No. 3187 refers to E491 (*Food Chemicals Codex* 1981, p. 307); E492/E495:(FAO Food and Nutrition Paper No. 4, pp. 293–7); E493/E494 (BPC 1973, pp. 465–6)

REFERENCES:

Chislett, L.R. and Walford, J. (1976) Sorbitan and polyoxyethylene sorbitan esters in food products. *Flavours* March/April, 61.
Nielsen, M. (1995) Sorbitan tristearate anticrystalliser in palm olein. Presented at 21st ISF World Congress, The Hague. Danisco Technical Paper TP1502-le.
Weyland, M. (1994) Functional effects of emulsifiers in chocolate. *Manufacturing Confectioner* May, 111–117.

ANY OTHER RELEVANT INFORMATION:

Acid value 5–15; Saponification value 140–188; Hydroxyl value 66–358

NAME:	Stearyl tartrate	
CATEGORY:	Emulsifier	
FOOD USE:	Baked goods/Bread	
SYNONYMS:	E483	
PROPERTIES AND APPEARANCE:	Cream to pale yellow paste	
MELTING RANGE IN °C:	67–77	
PURITY %:	Total tartaric acid min. 18, max. 35	
HEAVY METAL CONTENT MAXIMUM IN ppm:	10 (as Pb)	
ASH MAXIMUM IN %:	5	
FUNCTION IN FOODS:	Dough conditioning function very good; crumb softening function fair.	
ALTERNATIVES:	DATEM/SSL/CSL	
LEGISLATION:	**USA:** Not listed	**UK and EUROPE:** E483: ADI 0-20 mg/kg body weight EC Directive 95/2 (OJ No. L61, 18.3.95) Miscellaneous Additives (enacted in UK as Statutory Instrument 1995 No. 3187) Schedule 3 (Other Permitted Miscellaneous Additives) Purity Criteria laid down in EC Directive 78/663 (OJ No. L223, 14.7.78)
ANY OTHER RELEVANT INFORMATION:	Acid value max. 6; Unsaponifiable matter 77–83%; Iodine value max. 4 Listed in EC, but rarely used. DATEM preferred	

NAME:	Succinic acid esters of mono- and diglycerides of fatty acids
CATEGORY:	Emulsifier
FOOD USE:	Bread
SYNONYMS:	Succinylated monoglycerides/SMG
FORMULA:	$CH_2{\cdot}O{\cdot}C{=}O\text{-}CH_2\text{-}CH_2\text{-}COOH\text{-}CHOH\text{-}CH_2{\cdot}O{\cdot}CO{\cdot}(CH_2)_{16}{\cdot}CH_3$
MOLECULAR MASS IN Daltons:	458 (for monostearate)
PROPERTIES AND APPEARANCE:	White beads
MELTING RANGE IN °C:	55–60
PURITY %:	Monoester content 12–20; SMG min. 55
WATER CONTENT MAXIMUM IN %:	2
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ARSENIC CONTENT MAXIMUM IN ppm:	3
FUNCTION IN FOODS:	Dough conditioner and crumb softener in bread and fermented doughs. Amylose complexing index 63 (good) HLB 5–7 (medium polarity)
ALTERNATIVES:	DATEM stearoyl lactylates/Sucrose esters
TECHNOLOGY OF USE IN FOODS:	Dough conditioner in bread. Melt into fat (shortening) before addition to dough at 0.125–0.25% of flour weight.

LEGISLATION:	**USA:** US FDA 21 CFR §172.830 Regulated emulsifier in shortenings, dough conditioner. Limitation 0.5–3.0% in bread: max. 0.5% on flour weight alone or in combination with stearoyl lactylates, Polysorbate 60 or ethoxylated monoglycerides	**UK and EUROPE:** Not listed; not permitted
ANY OTHER RELEVANT INFORMATION:	Acid value 70–120; Iodine value max. 3; Hydroxyl value 138–152	

NAME:	Sucrose esters of fatty acids
CATEGORY:	Emulsifier
FOOD USE:	Bread/Cakes/Coffee milk drinks/Ice-cream/Spreads/Yoghurt/Toppings/Noodles/Colour solvent/ Confectionery/Sauces/Soups
SYNONYMS:	Sucrose fatty acid esters/Saccharose esters/Sucroesters/Sugar esters
FORMULA:	Widely varying (empirical $C_{30}H_{56}O_{12}$ for sucrose monostearate)
MOLECULAR MASS IN Daltons:	508 (for monostearate)
ALTERNATIVES FORMS:	Varies according to fatty acid composition. Varies according to degree of esterification from mono- to octa-esters
PROPERTIES AND APPEARANCE:	White to cream powders (saturated); yellowish pastes to waxes (unsaturated)
PURITY %:	Total sucrose fatty acid ester content min. 80; total glyceride content max. 20 (Dimethyl formamide content 1 mg/kg max.)
HEAVY METAL CONTENT MAXIMUM IN ppm:	10 (as Pb)
ARSENIC CONTENT MAXIMUM IN ppm:	3
ASH MAXIMUM IN %:	2
FUNCTION IN FOODS:	Wide range of usages in Japan which are mostly fulfilled by other types of emulsifiers in other countries, often at lower cost. Strongly hydrophilic types produce very stable oil-in-water emulsions. Used for aerating and starch complexing agents, improving fat dispersions and stability. Amylose complexing index <25 (poor) HLB 7–16 (high polarity)

LEGISLATION:

USA:
US FDA 21 CFR §172.859
GMP: emulsifier, stabiliser, texturiser, coating for fruits

AUSTRALIA/PACIFIC RIM:
Japan: widely accepted

CANADA:
Permitted at max. 1.5% of carotenoid colour preparations

UK and EUROPE:
E473: ADI 0–30 mg/kg body weight
EC Directive 95/2 (OJ No. L61, 18.3.95) Miscellaneous Additives (Enacted in UK as Statutory Instrument 1995 No. 3187)
Schedule 3 (Other Permitted Miscellaneous Additives) and Schedule 4 Purity Criteria laid down in EC Directive 78/663 (OJ No. L223, 14.7.78)

REFERENCES:

Pomeranz, Y. (1994) Sucrose esters in baked goods. In: Akoh, C.C. and Swanson, B.G. (eds) *Carbohydrate Polyesters as Fat Substitutes*. Marcel Dekker, New York, pp. 137–148.

Yin, Y., Walker, C.E. and Deffenbaugh, L.B. (1994) Emulsification properties of sugar esters. In: Akoh, C.C. and Swanson, B.G. (eds) *Carbohydrate Polyesters as Fat Substitutes*. Marcel Dekker, New York, pp. 111–136.

ANY OTHER RELEVANT INFORMATION:

Acid value max. 6

NAME:	Tartaric acid esters of mono- and diglycerides of fatty acids	
CATEGORY:	Emulsifier	
FOOD USE:	Bread	
SYNONYMS:	E472d	
ALTERNATIVE FORMS:	Varies according to level of tartaric acid (15–50%) and fatty acid composition	
PROPERTIES AND APPEARANCE:	Yellowish viscous liquid to hard wax	
PURITY %:	Total glycerol min. 12, max. 29	
WATER CONTENT MAXIMUM IN %:	2	
HEAVY METAL CONTENT MAXIMUM IN ppm:	10 (as Pb)	
ARSENIC CONTENT MAXIMUM IN ppm:	3	
ASH MAXIMUM IN %:	0.5	
FUNCTION IN FOODS:	Dough conditioning effect in fermented doughs, but DATEM preferred. Has EC listing, but rarely used.	
ALTERNATIVES:	DATEM	
LEGISLATION:	**USA:** Not listed	**UK and EUROPE:** E472d: ADI not specified EC Directive 95/2 (OJ No. L61, 18.3.95) Miscellaneous Additives (enacted in UK as Statutory Instrument 1995 No. 3187) Schedule 1 (Generally permitted for use in food) and Schedule 7 Purity Criteria laid down in EC Directive 78/663 (OJ No. L223, 14.7.78)
ANY OTHER RELEVANT INFORMATION:	Acid value max. 30	

Part 5

Enzymes

Jim Smith

Food Additives Data Book, Second Edition. Edited by Jim Smith and Lily Hong-Shum.

NAME:	Alpha-amylase
CATEGORY:	Enzymes
FOOD USE:	Cereals and starches/Alcoholic beverages/Non-alcoholic beverages/Fruit and vegetable juices
SYNONYMS:	1,4-α-D-glucan glucanhydrolase/EC 3.2.1.1/CAS 9000-90-2/EINECS 232-565-6
PROPERTIES AND APPEARANCE:	Off-white powder or suspension
SOLUBILITY (%) AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	Soluble
in sucrose solution:	Soluble
in sodium chloride solution:	Soluble
pH OPTIMUM:	Cereals 5–6; pancreas 6.5; *Aspergillus niger* 5
TEMPERATURE OPTIMUM °C:	Cereals 50; pancreas 40; *A. niger* 55
SIDE ACTIVITIES:	Cereals: β-amylase, β-glucanase, neutral acid protease Pancreas: esterase, lipase, protease *Aspergillus niger*: cellulase, hemicellulase, acid protease, xylanase
FUNCTION IN FOODS:	Conversion of starch to glucose sugar in syrups (especially corn syrups); baking (to improve crumb softness and shelf-life); brewing, distilling
TECHNOLOGY OF USE IN FOODS:	Baking: acceleration of fermentation. Improves bread flour to yield loaves of increased volume, improves crust colour and crumb structure: 0.002–0.006% of the flour Starch liquefaction: reduction of maltose, as liquid for jet cooking, 0.05–0.07% DS; as enzyme/enzyme liquid, 0.05–0.1% DS Alcoholic beverages-brewing: reduces viscosity of mash, as liquid, 0.025%, conversion of starch to sugars for fermentation, as liquid, 0.003% Fruit and vegetable juices: removes starch to improve appearance and extraction, as liquid or powder, 0.0005–0.002% w/v, preparation of purées and tenderisation, mostly as liquid

SYNERGISTS:

Cereals: activated by calcium ions
Pancreas: heat stability increased by calcium salts
Aspergillus niger: activated by calcium ions

ANTAGONISTS:

Cereals: inhibited by oxidising agents

LEGISLATION:

USA:
ENZ, REG, used to modify food starch (172.892)

UK and EUROPE:
The enzyme from specified sources may be used in certain products using GMP

CANADA:
The enzyme from specified sources may be used in certain products using GMP

AUSTRALIA/NZ:
Permitted to be added to any food as long as the source is listed in the regulations

REFERENCES:

http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.
www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010.
www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010.
www.foodstandards.gov.au/_srcfiles/Standard_1_3_3_Processing_Aids_v113.pdf. Accessed 4 May 2010.
www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010.
O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

NAME:	Alpha-galactosidase
CATEGORY:	Enzymes
FOOD USE:	Sugar beet
SYNONYMS:	α-D-galactoside galactohydrolase/EC 3.2.1.22/EINECS 232-792-0
pH OPTIMUM:	*Aspergillus niger* 4.5; *Saccharomyces* spp. 5
TEMPERATURE OPTIMUM °C:	*Aspergillus niger* 65; *Saccharomyces* spp. 50
SIDE ACTIVITIES:	*Aspergillus niger*: glucosidase, hemicellulase *Saccharomyces* spp.: glucosidase, invertase
FUNCTION IN FOODS:	Exo-hydrolysis of terminal non-reducing α-D-galactoside residues of polysaccharides, oligosaccharides, galactomannans, galactolipids. Enzyme used in production of sugar from sugar beets; production aid
TECHNOLOGY OF USE IN FOODS:	Enzyme used in production of sugar from sugar beets; production aid
SYNERGISTS:	*Aspergillus niger*; *Saccharomyces* spp.
ANTAGONISTS:	*Aspergillus niger*; *Saccharomyces* spp.
LEGISLATION:	**USA:** ENZ, REG No residue in finished product Used in the production of sugar (sucrose) from sugar beets and increased sucrose yield in molasses (173.145) **CANADA:** The enzyme from specified sources may be used in certain products using GMP **UK and EUROPE:** The enzyme from specified sources may be used in certain products using GMP **AUSTRALIA/NZ:** Permitted to be added to any food as long as the source is listed in the regulations
REFERENCES:	http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010.
www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010.
www.foodstandards.gov.au/_srcfiles/Standard_1_3_3_Processing_Aids_v113.pdf. Accessed 4 May 2010.
www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010.
O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

ANY OTHER RELEVANT INFORMATION: *Aspergillus niger* acts on many galactosides; *Saccharomyces* spp. low galactomannase activity

NAME:	Amyloglucosidase
CATEGORY:	Enzymes
FOOD USE:	Cereals and starches/Alcoholic beverages/Non-alcoholic beverages/Fruit and vegetable juices
SYNONYMS:	14-α-D-glucanohydrolase/EC 3.2.1.3/CAS 9032-08-0
PROPERTIES AND APPEARANCE:	Powder
pH OPTIMUM:	*Aspergillus oryzae* 4–5; *Aspergillus niger* 4–5; *Rhizopus* spp. 4–5; *Trichoderma viridue* -; *Aspergillus oryzae* 5; *Bacillus subtilis* 6-7; *Bacillus licheniformis* 7-8
TEMPERATURE OPTIMUM °C:	*Aspergillus oryzae* 55; *Aspergillus niger* 55; *Rhizopus* spp. 55; *Trichderma viride* –; *Aspergillus oryzae* 55; *Bacillus subtilis* 70–80; *Bacillus licheniformis* 90–95
SIDE ACTIVITIES:	*Aspergillus oryzae* also hydrolyses α-1,6 bonds in starch *Aspergillus niger* – *Rhizopus* spp. – *Trichoderma viride* – *Aspergillus oryzae*: glucoamylase, acid protease *Bacillus subtilis*: β-glucanase, acid and neutral protease *Bacillus licheniformis*: β-glucanase, acid and neutral protease (both of these are thermolabile and rapidly inactivated at temperature of amylase use)
FUNCTION IN FOODS:	Enzyme, degrading agent; degrades gelatinised starch into sugars in production of distilled spirits and vinegar
TECHNOLOGY OF USE IN FOODS:	Baking: acceleration of fermentation. Improves bread flour to yield loaves of increased volume, improves crust colour and crumb structure, 0.002–0.006% of the flour Starch liquefaction: reduction of maltose, as liquid for jet cooking, 0.05–0.07% DS; as enzyme/enzyme liquid, 0.05–0.1% DS; production of glucose, liquid with syrup or without other enzymes 0.06–0.131% DS Alcoholic beverages-brewing: reduces viscosity of mash, as liquid, 0.025%; conversion of starch to sugars for fermentation, as liquid, 0.003%; in wine, removes haze and improves filtration, liquid or powder 0.002% w/v Fruit and vegetable juices: removes starch to improve appearance and extraction, as liquid or powder, 0.0005–0.002% w/v, preparation of purées and tenderisation, mostly as liquid

SYNERGISTS: *Aspergillus oryzae* –; *Aspergillus niger* –; *Rhizopus* spp. –; *Trichoderma viride* –; *Aspergillus oryzae* activated by calcium ions; *Bacillus subtilis* activated by calcium ions; *Bacillus licheniformis* low calcium dependence, especially in presence of high substrate

ANTAGONISTS: *Aspergillus oryzae* –; *Aspergillus niger* –; *Rhizopus* spp. –; *Trichoderma viride* –; *Aspergillus oryzae* –; *Bacillus subtilis* inhibited by chelating agents; *Bacillus licheniformis* –

LEGISLATION:

USA:
ENZ, REG, <0.1% by weight of gelatinised starch (173.110)
Degrading gelatinised starch into constituent sugars in the production of distilled spirits and vinegar

AUSTRALIA/NZ:
Permitted to be added to any food as long as the source is listed in the regulations

UK and EUROPE:
The enzyme from specified sources may be used in certain products using GMP

CANADA:
The enzyme from specified sources may be used in certain products using GMP

REFERENCES:

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www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010.
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ANY OTHER RELEVANT INFORMATION: Derived from *Rhizopus niveus* with diatomaceous earth as carrier

NAME:	Anthocyanase
CATEGORY:	Enzymes
FOOD USE:	Alcoholic beverages/Wine
SYNONYMS:	Anthocyanin-β-glucosidase
pH OPTIMUM:	*Aspergillus niger* 3–9
TEMPERATURE OPTIMUM °C:	*Aspergillus niger* 50
SIDE ACTIVITIES:	*Aspergillus niger* β-glucosidase
FUNCTION IN FOODS:	Decolorises wines
TECHNOLOGY OF USE IN FOODS:	Alcoholic beverages. Decolorises wines as powder or liquid at 0.1–0.3%
REFERENCE:	Owusu-Ansah, Y.J. (1991) Enzymes. In: Smith, J. (ed.) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow, pp. 120–150.

NAME:	Asparaginase
CATEGORY:	Enzymes
FOOD USE:	Baked products/Fried products
SYNONYMS:	Asparaginase II/L-asparaginase/α-asparaginase/L-asparagine amidohydrolase/EC 3.5.1.1/CAS 9015-68-3
PROPERTIES AND APPEARANCE:	From *Aspergillus niger* expressed in *A. niger* or from *Aspergillus oryzae* expressed in *A. oryzae*. *Aspergillus niger*: asparaginase is produced by submerged fed-batch fermentation of a genetically modified strain of *A. niger* that contains the asparaginase gene derived from *A. niger*. The enzyme is isolated from the fermentation broth by filtration to remove the biomass and concentrated by ultrafiltration. The enzyme concentrate is subjected to germ filtration and is subsequently formulated and standardised to the desired activity using food-grade compounds *Aspergillus oryzae*: asparaginase is produced by submerged fed-batch fermentation of a genetically modified strain of *A. oryzae* that has a reduced capability for producing secondary metabolites and contains the asparaginase gene derived from *A. oryzae*. The enzyme is isolated from the fermentation broth by filtration to remove the biomass and concentrated by ultrafiltration and/or evaporation. The residual production microorganism is removed from the enzyme concentrate by germ filtration. The final product is formulated using food-grade stabilising and preserving agents and standardised to the desired activity Reactions catalysed: hydrolysis of L-asparagine to L-aspartic acid and ammonia. No significant levels of secondary enzyme activities Yellow to brown clear liquid or off-white granulates
FUNCTION IN FOODS:	Used in food processing to reduce the formation of acrylamide from asparagine and reducing sugars during baking or frying
LEGISLATION:	**USA:** GRAS **CANADA:** The enzyme from specified sources may be used in certain products using GMP **UK and EUROPE:** The enzyme from specified sources may be used in certain products using GMP **AUSTRALIA/NZ:** Permitted to be added to any food as long as the source is listed in the regulations

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www.fao.org/ag/agn/jecfa-additives/specs/monograph5/additive-504-m5.pdf.

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www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010.

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www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010.

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Owusu-Ansah, Y.J. (1991) Enzymes. In: Smith, J. (ed.) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow, pp. 120–150.

NAME:	Beta-amylase
CATEGORY:	Enzymes
FOOD USE:	Cereals and starches/Alcoholic beverages/Non-alcoholic beverages/Fruit and vegetable juices
SYNONYMS:	1,4-α-D-glucan maltohydrolase/EC 3.2.1.2/CAS 9001-91-3/EINECS 232-566-1
pH OPTIMUM:	Cereals 5.5; soya bean 4–7; *Bacillus* spp. 5–7
TEMPERATURE OPTIMUM °C:	Cereals 55; soya bean 55; *Bacillus* spp. 60
SIDE ACTIVITIES:	Cereals: α-amylase Soya bean: α-amylase, lipoxygenase *Bacillus* spp.: α-amylase, β-glucanase, neutral protease
FUNCTION IN FOODS:	Baking: acceleration of fermentation. Improves bread flour to yield loaves of increased volume, improves crust colour and crumb structure Starch liquefaction: reduction of maltose, as liquid for jet cooking Alcoholic beverages-brewing: reduces viscosity of mash, conversion of starch to sugars for fermentation Fruit and vegetable juices: removes starch to improve appearance and extraction. Preparation of purées and tenderisation, mostly as liquid
TECHNOLOGY OF USE IN FOODS:	Baking: acceleration of fermentation. Improves bread flour to yield loaves of increased volume, improves crust colour and crumb structure, 0.002–0.006% of the flour Starch liquefaction: reduction of maltose; as liquid for jet cooking, 0.05–0.07% DS; as enzyme/enzyme liquid, 0.05–0.1% DS Alcoholic beverages-brewing: reduces viscosity of mash, as liquid, 0.025%; conversion of starch to sugars for fermentation, as liquid, 0.003% Fruit and vegetable juices: removes starch to improve appearance and extraction; as liquid or powder, 0.0005–0.002% w/v. Preparation of purées and tenderisation, mostly as liquid
SYNERGISTS:	Cereals: activated by reducing agents Soya bean – acid tolerant *Bacillus* spp.
ANTAGONISTS:	Cereals; soya bean; *Bacillus* spp.

LEGISLATION:

USA:
Not permitted

CANADA:
The enzyme from specified sources may be used in certain products using GMP

UK and EUROPE:
The enzyme from specified sources may be used in certain products using GMP

AUSTRALIA/NZ:
Permitted to be added to any food as long as the source is listed in the regulations

REFERENCES:

http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.

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Owusu-Ansah, Y.J. (1991) Enzymes. In: Smith, J. (ed.) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow, pp. 120–150.

NAME:	Beta-galactosidase
CATEGORY:	Enzymes
FOOD USE:	Milk and milk products
SYNONYMS:	Lactase
pH OPTIMUM:	*Aspergillus niger* 4.5; *Aspergillus oryzae* 4.5; *Bacillus* spp. 7.3; *Kluyveromyces* spp. 6.5; *Saccharomyces* spp. 6.5
TEMPERATURE OPTIMUM °C:	*Aspergillus niger* 55; *Aspergillus oryzae* 55; *Bacillus* spp. 60; *Kluyveromyces* spp. 45; *Saccharomyces* spp. 40
SIDE ACTIVITIES:	*Aspergillus niger*: α-L-arabinase, glucanase, glucosidase, transferase, invertase, acid protease *Aspergillus oryzae*: α-L-arabinase, glucanase, glucosidase, transferase, invertase, acid protease *Bacillus* spp.: amylase, glucosidase, protease, transferase *Kluyveromyces* spp.: glucosidase, invertase, protease, transferase *Saccharomyces* spp.: glucosidase, invertase, protease, transferase
FUNCTION IN FOODS:	Hydrolysis of terminal non-reducing β-D-galactose residues
TECHNOLOGY OF USE IN FOODS:	Milk and milk products: prevents grainy texture, stabilisation of proteins during freezing, removal of lactase for lactose-free products, soluble or immobilised
SYNERGISTS:	*Aspergillus niger*; *Aspergillus oryzae*; *Bacillus* spp.; *Kluyveromyces* spp.; *Saccharomyces* spp.
ANTAGONISTS:	*Aspergillus niger*, glucose, galactose; *Aspergillus oryzae*, glucose, galactose; *Bacillus* spp., glucose, galactose; *Kluyveromyces* spp., glucose, galactose; *Saccharomyces* spp., glucose, galactose
LEGISLATION:	**USA:** Not permitted **CANADA:** The enzyme from specified sources may be used in certain products using GMP **UK and EUROPE:** The enzyme from specified sources may be used in certain products using GMP **AUSTRALIA/NZ:** Permitted to be added to any food as long as the source is listed in the regulations

REFERENCES:

http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010.

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NAME:	Beta-glucanase
CATEGORY:	Enzymes
FOOD USE:	Hydrolyses cellulose in brewing worts
SYNONYMS:	Endo-1,3(4)-β-D-glucanase/EC 3.2.1.6/CAS 9074-99-1 (b- from *Aspergillus niger*), 9012-54-8 (from *Bacillus subtilis*)/Laminarinase/EINECS 232-980-2, 232-734-4 resp.
pH OPTIMUM:	*Aspergillus niger* 5; *Bacillus subtilis* 7; *Penicillium emersonii* 4
TEMPERATURE OPTIMUM °C:	*Aspergillus niger* 60; *Bacillus subtilis* 50–60; *Penicillium emersonii* 70
SIDE ACTIVITIES:	*Aspergillus niger*: amylase, glucoamylase, glucosidase *Bacillus subtilis*: amylase, glucosidase, protease *Penicillium emersonii*: amylase, dextranase, protease
FUNCTION IN FOODS:	Endo-hydrolysis of terminal 1,4-α-D-glucose residues from non-reducing end of polyglucoside chains. Enzyme for beer filtration
TECHNOLOGY OF USE IN FOODS:	Hydrolyses cellulose in brewing worts
LEGISLATION:	**USA:** ENZ, REG, <0.1% by weight. of gelatinised starch (173.110) Degrading gelatinised starch into constituent sugars in the production of distilled spirits and vinegar **CANADA:** The enzyme from specified sources may be used in certain products using GMP **UK and EUROPE:** The enzyme from specified sources may be used in certain products using GMP **AUSTRALIA/NZ:** Permitted to be added to any food as long as the source is listed in the regulations
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Owusu-Ansah, Y.J. (1991) Enzymes. In: Smith, J. (ed.) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow, pp. 120–150.

ADDITIONAL INFORMATION:

Aspergillus niger: broad range with low specificity
Bacillus subtilis: narrow range with higher specificity
Penicillium emersonii: tolerant of low pH in some variants

NAME:	Beta-glucosidase
CATEGORY:	Enzymes
FOOD USE:	Sugar beet/Beer
SYNONYMS:	β-D-glucoside hydrolase/EC 3.2.1.21
pH OPTIMUM:	*Aspergillus niger* 5; *Aspergillus oryzae* 5; *Bacillus* spp. 7; *Clostridium thermocellum* 9; *Saccharomyces* spp. 7; Sweet almond 7; *Trichoderma viride* 5
TEMPERATURE OPTIMUM °C:	*Aspergillus niger* 60; *Aspergillus oryzae* 65; *Bacillus* spp. 70; *Clostridium thermocellum* 60; *Saccharomyces* spp. 45; Sweet almond 50; *Trichoderma viride* 65
SIDE ACTIVITIES:	*Aspergillus niger*: amylase, glucoamylase, protease *Aspergillus oryzae*: amylase, glucoamylase, protease *Bacillus* spp.: amylase, glucanase, protease *Clostridium thermocellum*: protease *Saccharomyces* spp.: glucanase, protease Sweet almond: usually very pure *Trichoderma viride*: hemicellulase
FUNCTION IN FOODS:	Used in the final stages of starch and cellulose hydrolysis
TECHNOLOGY OF USE IN FOODS:	Used with other saccharolytic enzymes to release glucose from dextrans
LEGISLATION:	**USA:** Not permitted **CANADA:** The enzyme from specified sources may be used in certain products using GMP **UK and EUROPE:** The enzyme from specified sources may be used in certain products using GMP **AUSTRALIA/NZ:** Permitted to be added to any food as long as the source is listed in the regulations
REFERENCES:	http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010. www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010.

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Owusu-Ansah, Y.J. (1991) Enzymes. In: Smith, J. (ed.) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow, pp. 120–150.

ANY OTHER RELEVANT INFORMATION:

Aspergillus niger: used to reduce cellobiose inhibition on cellulase
Aspergillus oryzae: broad specificity, unusually high thermotolerance
Bacillus spp.: narrow specificity
Clostridium thermocellum: very active on β-1,3-bonds
Saccharomyces spp.: broad specificity
Sweet almond: broad specificity
Trichoderma viride: broad specificity

NAME:	Bromelain
CATEGORY:	Enzymes
FOOD USE:	Meat and other proteinaceous foods/Meat and fish/Eggs and egg products
SYNONYMS:	CAS 37189-34-7/EINECS 253-387-5/Bromelin
pH OPTIMUM:	5.5–7.0
TEMPERATURE OPTIMUM °C:	50
FUNCTION IN FOODS:	Chillproofing of beer. Natural enzyme, meat tenderising. Preparation of precooked cereals, processing aid, tissue softening agent. Used in beer, bread, cereals, meat, poultry and wine
TECHNOLOGY OF USE IN FOODS:	Meat and other proteinaceous foods. Meat and fish: tenderisation of meat as liquid; produces fish hydrolysates as liquid at 2% of protein; enhances fish stick-water effluent treatment as liquid at 0.2%; removal of oil from tissues as liquid Eggs and egg products: improves drying properties as liquid/powder
LEGISLATION:	**USA:** MISC, MIA To soften tissue of meats ENZ, REG As an enzyme preparation (optional ingredient) in bakery products (136) **CANADA:** The enzyme from specified sources may be used in certain products using GMP **UK and EUROPE:** The enzyme from specified sources may be used in certain products using GMP **AUSTRALIA/NZ:** Permitted to be added to any food as long as the source is listed in the regulations
REFERENCES:	http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010. www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010. www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010.

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Owusu-Ansah, Y.J. (1991) Enzymes. In: Smith, J. (ed.) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow, pp. 120–150.

NAME:	Catalase
CATEGORY:	Enzymes
FOOD USE:	Non-alcoholic beverages/Soft drinks/Milk
SYNONYMS:	Hydrogen peroxide oxidoreductase/EC 1.11.1.6/CAS 9001-05-2/EINECS 232-577-1
pH OPTIMUM:	*Aspergillus niger* 5–8; bovine liver 7
TEMPERATURE OPTIMUM °C:	*Aspergillus niger* 35; bovine liver 45
SIDE ACTIVITIES:	*Aspergillus niger*: usually very pure Bovine liver: usually very pure
FUNCTION IN FOODS:	Enzyme; in food preservation; production aid in cheese; in decomposing residual hydrogen peroxide in cheese manufacture, bleaching and oxidising processes
TECHNOLOGY OF USE IN FOODS:	Non-alcoholic beverages: soft drinks, stabilisation of citrus terpenes as powder or liquid, combined with glucose oxidase Milk: removal of hydrogen peroxide as liquid or powder
SYNERGISTS:	*Aspergillus niger* stable at low pH; bovine liver –
ANTAGONISTS:	*Aspergillus niger* –; bovine liver, inactivated by alkali
LEGISLATION:	**USA:** ENZ, REG/FS, <20 ppm of the weight of the milk treated. To destroy hydrogen peroxide in manufacture of cheese: 173.135;133.113 **CANADA:** The enzyme from specified sources may be used in certain products using GMP **UK and EUROPE:** The enzyme from specified sources may be used in certain products using GMP **AUSTRALIA/NZ:** Permitted to be added to any food as long as the source is listed in the regulations
REFERENCES:	http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.

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Owusu-Ansah, Y.J. (1991) Enzymes. In: Smith, J. (ed.) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow, pp. 120–150.

ANY OTHER RELEVANT INFORMATION: Molecular mass 240 kDa

NAME:	Cellobiase (*Aspergillus niger*)
CATEGORY:	Enzymes
FOOD USE:	Sugar manufacture
SYNONYMS:	β-D-glucoside glucohydrolase/EC 3.2.1.21
pH OPTIMUM:	5
TEMPERATURE OPTIMUM °C:	60
SIDE ACTIVITIES:	Amylase, glucoamylase, protease, hemicellulase
FUNCTION IN FOODS:	Exo-hydrolysis of terminal non-reducing 1,4-α-D-glucose residues. Used to reduce product inhibition of cellobiose when cellulases used
TECHNOLOGY OF USE IN FOODS:	Cleaves cellobiose units from the non-reducing ends of cellulose polymers
LEGISLATION:	**USA:** Not approved **CANADA:** The enzyme from specified sources may be used in certain products using GMP **UK and EUROPE:** The enzyme from specified sources may be used in certain products using GMP **AUSTRALIA/NZ:** Permitted to be added to any food as long as the source is listed in the regulations
REFERENCES:	http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010. www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010. www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010. www.foodstandards.gov.au/_srcfiles/Standard_1_3_3_Processing_Aids_v113.pdf. Accessed 4 May 2010. www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010.

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Owusu-Ansah, Y.J. (1991) Enzymes. In: Smith, J. (ed.) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow, pp. 120–150.

NAME:	Cellulase
CATEGORY:	Enzymes
FOOD USE:	Alcoholic beverages/Non-alcoholic beverages/Fruit and vegetable juices/Fats and oils
SYNONYMS:	1,4-(1,3; 1,4)-β-D-glucan 4-glucanohydrolase/EC 3.2.1.4/CAS 9012-54-81/EINECS 232-734-4
PROPERTIES AND APPEARANCE:	Off-white powder
pH OPTIMUM:	*Aspergillus niger* 5; *Basidiomycetes* spp. 4; *Penicillium funiculosum* 5; *Rhizopus* spp. 4; *Trichoderma* spp. 5
TEMPERATURE OPTIMUM °C:	*Aspergillus niger* 45; *Basidiomycetes* spp. 50; *Penicillium funiculosum* 65; *Rhizopus* spp. 45; *Trichoderma* spp. 55
SIDE ACTIVITIES:	*Aspergillus niger*: amylase, cellobiase, glucosidase, glucoamylase *Basidiomycetes* spp.: hemicellulase, protease *Penicillium funiculosum*: amylase, glucoamylase, cellobiase *Rhizopus* spp.: amylase, glucoamylase, protease *Trichoderma* spp.: hemicellulase
FUNCTION IN FOODS:	Endo-hydrolysis of 1,4-β-glucosidic links of cereal glucans, cellulose, lichenin. Enzyme; digestive aid in medicine and brewing industry; aids bacteria in the hydrolysis of cellulose; aids in removal of visceral masses during clam processing and of shells in shrimp processing
TECHNOLOGY OF USE IN FOODS:	Fruit and vegetable juices: removes starch to improve appearance and extraction as liquid or powder at 0.0005–0.002% w/v Fats and oils: in vegetable oil extractions, hydrolyses cell wall materials, as liquid or powder at 0.5–2% DS Alcoholic beverages: assists in filtration by hydrolysing complex cell wall materials as liquid or powder at 0.1% DS Non-alcoholic beverages: in coffee, cellulose breakdown during drying, as liquid or powder; tea: cellulose breakdown during fermentation
SYNERGISTS:	*Aspergillus niger*; *Basidiomycetes* spp.; *Penicillium funiculosum*; *Rhizopus* spp.; *Trichoderma* spp.
ANTAGONISTS:	*Aspergillus niger*; *Basidiomycetes* spp.; *Penicillium funiculosum*; *Rhizopus* spp.; *Trichoderma* spp.

LEGISLATION:

USA:
ENZ, REG, GMP For removal of visceral mass in clam processing and shell from shrimp (173.120)

CANADA:
The enzyme from specified sources may be used in certain products using GMP

UK and EUROPE:
The enzyme from specified sources may be used in certain products using GMP

AUSTRALIA/NZ:
Permitted to be added to any food as long as the source is listed in the regulations

REFERENCES:

http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010.

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Owusu-Ansah, Y.J. (1991) Enzymes. In: Smith, J. (ed.) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow, pp. 120–150.

ANY OTHER RELEVANT INFORMATION:

Aspergillus niger: generally low in C1-type activity
Basidiomycetes spp.: good C1-type with broad specificity
Penicillium funiculosum: product inhibition is usually low
Rhizopus spp.: broad specificity
Trichoderma spp.: high C1 activity.
Molecular mass 31 kDa

NAME:	Chymosin A
CATEGORY:	Enzymes
FOOD USE:	Dairy products/Cheese
SYNONYMS:	Rennin/Milk-clotting enzyme/Aspartyl protease/EC 3.4.23.4
PROPERTIES AND APPEARANCE:	Chymosin A from *Escherichia coli* K-12 containing the prochymosin A gene (CAS 84484-18-4): produced intracellularly by the controlled fermentation of *E. coli* K-12 containing the bovine prochymosin A gene. The strain is non-pathogenic and non-toxicogenic (e.g. JA198). Prochymosin is liberated by cell disruption followed by harvesting of the prochymosin by centrifugation or membrane concentration and washing with buffer solution. The residual production cells are inactivated by acid treatment, then the prochymosin is dissolved in buffer solution and after pH adjustment the solution is filtered. Prochymosin is activated to chymosin by acid treatment, followed by final purification via anion-exchange chromatography and elution with a buffered salt solution. Chymosin B from *Aspergillus niger* var. *awamori* containing the prochymosin B gene (CAS 85713-24-2): produced extracellularly by the controlled fermentation of *A. niger* var. *awamori* containing the bovine prochymosin B gene. The strain is non-pathogenic and non-toxicogenic (e.g. NRRL 3112). After inactivation of the production organism, the cellular material is removed by centrifugation or filtration. The enzyme is purified by extraction with polyethylene glycol, followed by clarification with activated carbon and separation from the solvent by cation exchange chromatography Clear, colourless or slightly coloured aqueous solution containing the active enzyme; preparations may contain caramel colour to facilitate their identification in cheese manufacture
FUNCTION IN FOODS:	Cleaves a single bond in κ-casein. Used in clotting of milk for cheese production
LEGISLATION:	**USA:** ENZ, GRAS, GMP, as a stabiliser and thickener 184.1685; derived from *Aspergillus niger* **CANADA:** The enzyme from specified sources may be used in certain products using GMP **UK and EUROPE:** The enzyme from specified sources may be used in certain products using GMP **AUSTRALIA/NZ:** Permitted to be added to any food as long as the source is listed in the regulations

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http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.

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www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010.

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Owusu-Ansah, Y.J. (1991) Enzymes. In: Smith, J. (ed.) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow, pp. 120–150.

NAME:	Chymotrypsin (pancreatic)
CATEGORY:	Enzymes
FOOD USE:	Baked goods/Alcoholic beverages, beer
SYNONYMS:	EC 3.4.21.1
pH OPTIMUM:	8–9
TEMPERATURE OPTIMUM °C:	35
SIDE ACTIVITIES:	Amylase, lipase, esterase
FUNCTION IN FOODS:	Preferential cleavage of tyrosine, tryptophan, phenylalanine, leucine residues
TECHNOLOGY OF USE IN FOODS:	Baked goods: modification of gluten in baking of biscuits as powder at up to 0.25% of flour; to reduce mixing time of dough as tablets at 75 HU per 100 g flour Alcoholic beverages (beer): to provide nitrogen for yeast growth and aid in filtration and chillproofing as liquid or powder at 0.3% DS
ANTAGONISTS:	Inhibited by compounds in cereals, beans, potato, egg
LEGISLATION:	**USA:** GRAS **CANADA:** The enzyme from specified sources may be used in certain products using GMP **UK and EUROPE:** The enzyme from specified sources may be used in certain products using GMP **AUSTRALIA/NZ:** Permitted to be added to any food as long as the source is listed in the regulations
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Owusu-Ansah, Y.J. (1991) Enzymes. In: Smith, J. (ed.) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow, pp. 120–150.

ANY OTHER RELEVANT INFORMATION: Bovine chymotrypsin is more thermotolerant

NAME:	Dextranase (*Penicillium* spp.)
CATEGORY:	Enzymes
FOOD USE:	Used to hydrolyse dextrans from starch
SYNONYMS:	1,6-α-D-glucan 6-glucanohydrolase/EC 3.2.1.11/CAS 9025-70-1/EINECS 232-803-9
pH OPTIMUM:	5
TEMPERATURE OPTIMUM °C:	55
SIDE ACTIVITIES:	Cellulase, hemicellulase
FUNCTION IN FOODS:	Endo-hydrolysis of dextrans
TECHNOLOGY OF USE IN FOODS:	Used to hydrolyse dextrans from starch
LEGISLATION:	**USA:** GRAS **CANADA:** The enzyme from specified sources may be used in certain products using GMP **UK and EUROPE:** The enzyme from specified sources may be used in certain products using GMP **AUSTRALIA/NZ:** Permitted to be added to any food as long as the source is listed in the regulations
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Owusu-Ansah, Y.J. (1991) Enzymes. In: Smith, J. (ed.) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow, pp. 120–150.

ANY OTHER RELEVANT INFORMATION: Products are isomaltose and isomaltotriose

NAME:	Diacetyl reductase (*Aerobacter aerogenes*)
CATEGORY:	Enzymes
FOOD USE:	Alcoholic beverages
SYNONYMS:	Anthocyanin-β-glycosidase
pH OPTIMUM:	6–8
TEMPERATURE OPTIMUM °C:	30
FUNCTION IN FOODS:	Removal of diacetyls in beer as liquid
TECHNOLOGY OF USE IN FOODS:	Removal of diacetyls in beer as liquid
SYNERGISTS:	Activated by NADH
ANTAGONISTS:	Inhibited by ethanol
LEGISLATION:	**USA:** GRAS **CANADA:** The enzyme from specified sources may be used in certain products using GMP **UK and EUROPE:** The enzyme from specified sources may be used in certain products using GMP **AUSTRALIA/NZ:** Permitted to be added to any food as long as the source is listed in the regulations
REFERENCES:	http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010. www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010. www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010. www.foodstandards.gov.au/_srcfiles/Standard_1_3_3_Processing_Aids_v113.pdf. Accessed 4 May 2010. www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010.

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NAME:	Ficin (*Ficus* spp.)
CATEGORY:	Enzymes
FOOD USE:	Meat and other proteinaceous foods/Meat and fish/Eggs and egg products
SYNONYMS:	EC 3.4.22.3/CAS 9001-33-6/EINECS 232-599-1/Debricin/Ficus protease/Ficus proteinase
PROPERTIES AND APPEARANCE:	White powder
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	Very soluble
pH OPTIMUM:	5–7
TEMPERATURE OPTIMUM °C:	65
SIDE ACTIVITIES:	Lysozyme, esterase, peroxidase
FUNCTION IN FOODS:	Enzyme for chillproofing of beer. Meat tenderising. Preparation of precooked cereals. Processing aid; tenderising agent; tissue softening agent. Preferential cleavage of lysine, alanine, tyrosine, glycine, asparagine, leucine, valine.
TECHNOLOGY OF USE IN FOODS:	Meat and other proteinaceous foods. Meat and fish: tenderisation of meat as liquid, produces fish hydrolysates as liquid at 2% of protein, enhances fish stick-water effluent treatment as liquid at 0.2%, removal of oil from tissues as liquid. Eggs and egg products: improves drying properties as liquid/powder.
SYNERGISTS:	Reducing compounds
ANTAGONISTS:	Oxidising agents
LEGISLATION:	**USA:** GRAS FDA 21 CFR § 184.1316 **CANADA:** The enzyme from specified sources may be used in certain products using GMP **UK and EUROPE:** The enzyme from specified sources may be used in certain products using GMP **AUSTRALIA/NZ:** Permitted to be added to any food as long as the source is listed in the regulations

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Owusu-Ansah, Y.J. (1991) Enzymes. In: Smith, J. (ed.) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow, pp. 120–150.

NAME:	Glucoamylase
CATEGORY:	Enzymes
FOOD USE:	Cereals and starches/Alcoholic beverages/Non-alcoholic beverages/Fruit and vegetable juices
SYNONYMS:	1,4-α-D-glucan glucanohydrolase/EC 3.2.1.3/CAS 9032-08-0/EINECS 232-877-2
PROPERTIES AND APPEARANCE:	Powder
pH OPTIMUM:	*Aspergillus awamori* 4–5; *Aspergillus niger* 3–5; *Aspergillus oryzae* 4.5; *Rhizopus* spp. 2.5–5
TEMPERATURE OPTIMUM °C:	*Aspergillus awamori* 60; *Aspergillus niger* 65; *Aspergillus oryzae* 60; *Rhizopus* spp. 55
SIDE ACTIVITIES:	*Aspergillus awamori*: amylase, glucanase, cellulase, hemicellulase, protease *Aspergillus niger*: amylase, glucanase, cellulase, hemicellulase, protease *Aspergillus oryzae*: amylase, glucanase, cellulase, hemicellulase, protease *Rhizopus* spp.: amylase, glucanase, cellulase, hemicellulase, protease
FUNCTION IN FOODS:	Hydrolysis of starch dextrins to glucose. Food processing, low-carbohydrate beer. Exo-hydrolysis of terminal 1,4-α-D-glucose residues from non-reducing end of polyglucoside chains
TECHNOLOGY OF USE IN FOODS:	Baking: acceleration of fermentation. Improves bread flour to yield loaves of increased volume, improves crust colour and crumb structure, 0.002–0.006% of the flour Starch liquefaction: reduction of maltose, as liquid for jet cooking, 0.05–0.07% DS; as enzyme/enzyme liquid, 0.05–0.1% DS; production of glucose, liquid with syrup or without other enzymes 0.06–0.131% DS Alcoholic beverages-brewing: reduces viscosity of mash, as liquid, 0.025%; conversion of starch to sugars for fermentation, as liquid, 0.003%; in wine, removes haze and improves filtration, liquid or powder 0.002% w/v Fruit and vegetable juices: removes starch to improve appearance and extraction, as liquid or powder, 0.0005–0.002% w/v. Preparation of purées and tenderisation, mostly as liquid
SYNERGISTS:	*Aspergillus awamori*; *Aspergillus niger*; *Aspergillus oryzae*; *Rhizopus* spp.
ANTAGONISTS:	*Aspergillus awamori*; *Aspergillus niger*; *Aspergillus oryzae*; *Rhizopus* spp.

LEGISLATION:

USA:
GRAS

CANADA:
The enzyme from specified sources may be used in certain products using GMP

UK and EUROPE:
The enzyme from specified sources may be used in certain products using GMP

AUSTRALIA/NZ:
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Owusu-Ansah, Y.J. (1991) Enzymes. In: Smith, J. (ed.) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow, pp. 120–150.

ANY OTHER RELEVANT INFORMATION:

Acid tolerance and thermotolerance vary between sources
Molecular mass 97 kDa

NAME:	Glucose isomerase
CATEGORY:	Enzymes
FOOD USE:	Conversion of glucose to fructose
SYNONYMS:	D-Xylose ketol isomerase/EC 5.3.1.5
pH OPTIMUM:	*Actinoplanes missouriensis* 7.5; *Bacillus coagulans* 8; *Streptomyces* spp. 8; *Streptomyces albus* 6–7
TEMPERATURE OPTIMUM °C:	*Actinoplanes missouriensis* 60; *Bacillus coagulans* 60; *Streptomyces* spp. 63; *Streptomyces albus* 60–75
SIDE ACTIVITIES:	*Actinoplanes missouriensis*: usually none *Bacillus coagulans*: usually none *Streptomyces* spp.: usually none *Streptomyces albus*: usually none
FUNCTION IN FOODS:	A true xylose isomerase acting on glucose at high substrate concentration. Enzyme which converts glucose to fructose; used in production of high-fructose corn syrup
TECHNOLOGY OF USE IN FOODS:	Immobilised 0.0015–0.03% DS; fixed bed 0.16 DS batch
SYNERGISTS:	In the immobilised form activated by magnesium and cobalt (the need for cobalt varies with preparation); magnesium is competed for by calcium and must therefore be in excess
LEGISLATION:	**USA:** GRAS **CANADA:** The enzyme from specified sources may be used in certain products using GMP **UK and EUROPE:** The enzyme from specified sources may be used in certain products using GMP **AUSTRALIA/NZ:** Permitted to be added to any food as long as the source is listed in the regulations
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Owusu-Ansah, Y.J. (1991) Enzymes. In: Smith, J. (ed.) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow, pp. 120–150.

NAME:	Glucose oxidase
CATEGORY:	Enzymes
FOOD USE:	Alcoholic beverages/Non-alcoholic beverages/Fruits and vegetables/Meat and other proteinaceous foods
SYNONYMS:	β-D-glucose, oxygen 1-oxidoreductase/EC 1.1.3.4
pH OPTIMUM:	*Aspergillus niger* 4.5; *Aspergillus* spp. 2.5–8; *Penicillium notatum* 3–7
TEMPERATURE OPTIMUM °C:	*Aspergillus niger* 50; *Aspergillus* spp. 15–70; *Penicillium notatum* 50
SIDE ACTIVITIES:	*Aspergillus niger*: catalase *Aspergillus* spp.: catalase *Penicillium notatum*: catalase
FUNCTION IN FOODS:	Enzyme which converts glucose to fructose; used in production of high-fructose corn syrup
TECHNOLOGY OF USE IN FOODS:	Alcoholic beverages: in wine, removes oxygen as powder or liquid at 10–70 GOU/l Non-alcoholic beverages: in soft drinks, stabilisation of citrus terpenes as powder or liquid at 20–90 GOU/l Fruits and vegetables: in juices, removes oxygen as powder/liquid at 20–200 GOU/l Meat and other proteinaceous foods: in eggs and egg products, glucose removal from dried eggs as powder or liquid at 150–225 GOU/l white, 300–375 GOU/l whole
SYNERGISTS:	*Aspergillus niger* –; *Aspergillus* spp. acid tolerant, thermotolerant; *Penicillium notatum* –
ANTAGONISTS:	*Aspergillus niger*; *Aspergillus* spp.; *Penicillium notatum*
LEGISLATION:	**USA:** GRAS - *Aspergillus niger* FDA 21 CFR § 184.1372 **CANADA:** Source permitted, *Aspergillus niger* - permitted in or upon soft drinks, liquid whole egg, egg white and liquid egg yolk destined for drying **UK and EUROPE:** UK: *Aspergillus niger* **AUSTRALIA/PACIFIC RIM:** Japan: approved

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Owusu-Ansah, Y.J. (1991) Enzymes. In: Smith, J. (ed.) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow, pp. 120–150.

NAME:	**Hemicellulase (*Aspergillus* spp.)**
CATEGORY:	Enzymes
SYNONYMS:	Endo-1,4-β-D-mannan hydrolase (EC 3.2.1.78)/Exo-α-L-arabinofuran hydrolase (EC 3.2.1.55)/ Exo-1,3-β-D-xylan hydrolase (EC 3.2.1.72)
pH OPTIMUM:	3–6
TEMPERATURE OPTIMUM °C:	70
SIDE ACTIVITIES:	Cellulase, glucosidase, pectinase, pentosanase
FUNCTION IN FOODS:	Enzyme which converts glucose to fructose; used in production of high-fructose corn syrup Hydrolyses coffee gums; used in the extraction of essential oils and plant extracts
TECHNOLOGY OF USE IN FOODS:	Hydrolyses coffee gums; used in the extraction of essential oils and plant extracts
LEGISLATION:	**USA:** GRAS **CANADA:** The enzyme from specified sources may be used in certain products using GMP **UK and EUROPE:** The enzyme from specified sources may be used in certain products using GMP **AUSTRALIA/NZ:** Permitted to be added to any food as long as the source is listed in the regulations
REFERENCES:	http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010. www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010. www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010. www.foodstandards.gov.au/_srcfiles/Standard_1_3_3_Processing_Aids_v113.pdf. Accessed 4 May 2010. www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010. Ash, M. and Ash, I. (1995) *Food Additives*. Gower Publishing, Brookfield, VT.

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Owusu-Ansah, Y.J. (1991) Enzymes. In: Smith, J. (ed.) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow, pp. 120–150.

ANY OTHER RELEVANT INFORMATION: These are complex enzyme systems that require specific substrates to identify and distinguish them

NAME:	Hexose oxidase
CATEGORY:	Enzymes
FOOD USE:	Bread/Cheese/Potato chips/Egg white powder/Whey protein isolates/Cottage cheese/Tofu/Ketchup mayonnaise/Salad dressings
SYNONYMS:	Hox/D-hexose:oxygen 1-oxidoreductase/EC 1.1.3.5/CAS 9028-75-5
PROPERTIES AND APPEARANCE:	From *Chondrus crispus* expressed in *Hansenula polymorpha*: produced by a submerged fermentation of a pure culture of a non-pathogenic and non-toxigenic genetically modified strain of *H. polymorpha* containing the hexose oxidase gene derived from *C. crispus*. The enzyme is produced intracellularly and upon cell disruption is released into the fermentation broth and is subsequently separated from the yeast cells and subjected to ultrafiltration and diafiltration to obtain the concentrated hexose oxidase. It is then spray-dried onto a suitable food-grade carrier such as wheat starch Reactions catalysed: oxidation of hexose sugars to their corresponding lactones and hydrogen peroxide Off-white to brownish microgranules
FUNCTION IN FOODS:	Used in bread dough to strengthen the gluten network; in products like shredded cheese, potato chips, egg white powder and whey protein isolates to minimise Maillard reactions; in cottage cheese and tofu to facilitate curd formation and in products like ketchup, mayonnaise and salad dressings to scavenge oxygen
LEGISLATION:	**USA:** GRAS **CANADA:** The enzyme from specified sources may be used in certain products using GMP **UK and EUROPE:** The enzyme from specified sources may be used in certain products using GMP **AUSTRALIA/NZ:** Permitted to be added to any food as long as the source is listed in the regulations
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Owusu-Ansah, Y.J. (1991) Enzymes. In: Smith, J. (ed.) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow, pp. 120–150.

NAME:	Inulinase
CATEGORY:	Enzymes
FOOD USE:	Jerusalem artichoke/Manufacture of fructose
SYNONYMS:	2,1-β-D-fructan fructanhydrolase/EC 3.2.1.7
pH OPTIMUM:	*Aspergillus* spp. 4.5; *Candida* spp. 5
TEMPERATURE OPTIMUM °C:	*Aspergillus* spp. 60; *Candida* spp. 40
SIDE ACTIVITIES:	*Aspergillus* spp.: amylase, invertase, glucoamylase, protease *Candida* spp.: amylase, invertase, glucoamylase, protease
FUNCTION IN FOODS:	Endo-hydrolysis of inulin
TECHNOLOGY OF USE IN FOODS:	Endo-hydrolysis of inulin in Jerusalem artichoke for production of fructose
SYNERGISTS:	*Aspergillus* spp. –; *Candida* spp. –
ANTAGONISTS:	*Aspergillus* spp. –; *Candida* spp. –
LEGISLATION:	**USA:** GRAS **CANADA:** The enzyme from specified sources may be used in certain products using GMP **UK and EUROPE:** The enzyme from specified sources may be used in certain products using GMP **AUSTRALIA/NZ:** Permitted to be added to any food as long as the source is listed in the regulations
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Owusu-Ansah, Y.J. (1991) Enzymes. In: Smith, J. (ed.) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow, pp. 120–150.

NAME:	Invertase
CATEGORY:	Enzymes
FOOD USE:	Confectionery
SYNONYMS:	β-D-fructofuranoside fructohydrolase/EC 3.2.1.26/Sucrase/Invertin
pH OPTIMUM:	*Candida* spp. 4.5; *Saccharomyces* spp. 4.5
TEMPERATURE OPTIMUM °C:	*Candida* spp. 50; *Saccharomyces* spp. 55
SIDE ACTIVITIES:	*Candida* spp.: proteases *Saccharomyces* spp.: proteases
FUNCTION IN FOODS:	Hydrolysis of sucrose to glucose and fructose
TECHNOLOGY OF USE IN FOODS:	Used to hydrolyse sucrose to glucose and fructose, to prevent crystallisation in confectionery and to increase sweetness and liquidity in confectionery soft centres
SYNERGISTS:	*Candida* spp.; *Saccharomyces* spp.
ANTAGONISTS:	*Candida* spp.; *Saccharomyces* spp.
LEGISLATION:	**USA:** GRAS **CANADA:** The enzyme from specified sources may be used in certain products using GMP **UK and EUROPE:** The enzyme from specified sources may be used in certain products using GMP **AUSTRALIA/NZ:** Permitted to be added to any food as long as the source is listed in the regulations
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ANY OTHER RELEVANT INFORMATION:

Candida spp. maximum activity is shown at low substrate levels; *Saccharomyces* spp. all contain a bound mannan

NAME:	Isoamylase
CATEGORY:	Enzymes
FOOD USE:	Starch processing
SYNONYMS:	Glycogen α-1,6-glucanohydrolase/EC 3.2.1.68/CAS 9067-73-6
PROPERTIES AND APPEARANCE:	From *Pseudomonas amyloderamosa*: isoamylase is produced by submerged fed-batch pure culture fermentation of *Ps. amyloderamosa*. The enzyme is isolated from the fermentation broth by filtration to remove the biomass and concentrated by ultrafiltration. The final product is formulated using food-grade stabilising and preserving agents Reactions catalysed: hydrolysis of α-1,6-D-glucosidic linkages in glycogen, amylopectin and their β-limit dextrins Secondary enzyme activities: low levels of cellulase, lipase and protease Yellow to brownish liquid
FUNCTION IN FOODS:	Used in the production of food ingredients from starch
LEGISLATION:	**USA:** GRAS **CANADA:** The enzyme from specified sources may be used in certain products using GMP **UK and EUROPE:** The enzyme from specified sources may be used in certain products using GMP **AUSTRALIA/NZ:** Permitted to be added to any food as long as the source is listed in the regulations
REFERENCES:	http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010. www.fao.org/ag/agn/jecfa-additives/specs/monograph4/additive-499-m4.pdf. www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010. www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010. www.foodstandards.gov.au/_srcfiles/Standard_1_3_3_Processing_Aids_v113.pdf. Accessed 4 May 2010. www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010.

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NAME:	Laccase
CATEGORY:	Enzymes
FOOD USE:	Beer
SYNONYMS:	Urishiol oxidase/Benzenediol:oxygen oxidoreductase/p-diphenol oxidase/EC 1.10.3.2/CAS 80498-15-3
PROPERTIES AND APPEARANCE:	From *Myceliophthora thermophila* expressed in *Aspergillus oryzae*: produced by submerged fed-batch pure culture fermentation of a genetically modified strain of *A. oryzae* containing the laccase gene derived from *M. thermophila*, using recombinant DNA techniques and traditional mutagenesis. The enzyme is isolated from the fermentation broth by filtration to remove the biomass and concentrated by ultrafiltration and/or evaporation. Residual production microorganisms are removed from the enzyme concentrate by germ filtration. The final product is formulated using food-grade stabilising and preserving agents Oxidation of a range of phenolic substances with concomitant reduction of oxygen to water Brown liquid
FUNCTION IN FOODS:	Used in the brewing of beer to prevent the formation of off-flavour compounds such as *trans*-2-nonenal. Scavenges oxygen that otherwise would react with fatty acids, amino acids, proteins and alcohols to form off-flavour precursors
TECHNOLOGY OF USE IN FOODS:	Laccase can be used as a substitute for pancreatin and pancreatic trypsin in vegetarian products
SYNERGISTS:	Laccase has a good synergistic action with plant proteases such as papain and bromelain
ANTAGONISTS:	Temperature above 50°C
LEGISLATION:	**USA:** GRAS **CANADA:** The enzyme from specified sources may be used in certain products using GMP **UK and EUROPE:** The enzyme from specified sources may be used in certain products using GMP **AUSTRALIA/NZ:** Permitted to be added to any food as long as the source is listed in the regulations

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Owusu-Ansah, Y.J. (1991) Enzymes. In: Smith, J. (ed.) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow, pp. 120–150.

NAME:	Lipase
CATEGORY:	Enzymes
FOOD USE:	Cheese/Eggs and egg products/Oils
SYNONYMS:	Triacylglycerol acylhydrolase, EC 3.1.1.3 (*Aspergillus niger*, *Candida cylindraceae*, *Mucor miehei*); fatty acid esterase, carboxylic-ester hydrolase, EC 3.1.1.1 (pancreatic lipase); aryl ester hydrolase, EC 3.1.1.2 (pregastric esterase, *Rhizopus* spp.)/CAS 9001-62-1/EINECS 232-619-9
pH OPTIMUM:	*Aspergillus niger* 5–7; *Candida cylindraceae* 8; *Mucor miehei* 7.5; pancreatic lipase 7.5–8; pregastric esterase 5.5–7; *Rhizopus* spp. 5–8
TEMPERATURE OPTIMUM °C:	*Aspergillus niger* 40; *Candida cylindraceae* 50; *Mucor miehei* 50; pancreatic lipase 40; pregastric esterase 30–60; *Rhizopus* spp. 40
SIDE ACTIVITIES:	*Aspergillus niger*: amylase, cellulase, esterase, hemicellulase, pectinase, protease *Candida cylindraceae*: esterase, protease *Mucor miehei*: esterase, protease Pancreatic lipase: amylase, protease Pregastric esterase: amylase *Rhizopus* spp.: amylase, cellulase, esterase, protease
FUNCTION IN FOODS:	Hydrolyses fat to glycerol and fatty acid
TECHNOLOGY OF USE IN FOODS:	Cheese: flavour development as liquid or powder at 1% DS Eggs and egg products: improves emulsification and whipping properties as powder or immobilised Oils: oil hydrolysis, to produce free fatty acids at 2% DS, and inter-esterification. Production of value-added triacylglycerols from less-valued feedstock, mostly immobilised systems at 1–5% E/S
SYNERGISTS:	*Aspergillus niger*; *Candida cylindraceae*; *Mucor miehei*; pancreatic lipase; pregastric esterase; *Rhizopus* spp.
ANTAGONISTS:	*Aspergillus niger*; *Candida cylindraceae*; *Mucor miehei*; pancreatic lipase; pregastric esterase; *Rhizopus* spp.

LEGISLATION:

USA:
GRAS

CANADA:
The enzyme from specified sources may be used in certain products using GMP

UK and EUROPE:
The enzyme from specified sources may be used in certain products using GMP

AUSTRALIA/NZ:
Permitted to be added to any food as long as the source is listed in the regulations

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Owusu-Ansah, Y.J. (1991) Enzymes. In: Smith, J. (ed.) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow, pp. 120–150.

ANY OTHER RELEVANT INFORMATION:

Aspergillus niger: high in esterase
Candida cylindraceae: active on higher fats and oils
Mucor miehei: high in true lipase activity
Pancreatic lipase: preferential action on triacylglycerols
Pregastric esterase: high esterase:lipase ratios
Rhizopus spp.: very varied specificities

NAME:	Lysozyme hydrochloride
CATEGORY:	Enzymes
FOOD USE:	Cheese
SYNONYMS:	Muramidase/INS No. 1105/*N*-acetylmuramide glycanhydrolase/EC 3.2.1.17/CAS 9066059-5
PROPERTIES AND APPEARANCE:	A polypeptide obtained from hen's egg whites consisting of 129 amino acids and having a molecular mass of about 14 kDa and an isoelectric point of 10.7; possesses enzymatic activity in its ability to hydrolyse the β(1 → 4) linkages between *N*-acetylmuramic acid and *N*-acetylglucosamine in the outer membranes of bacterial species, in particular Gram-positive organisms; usually obtained in the hydrochloride form for food use; must conform to the General Specifications for Enzyme Preparations used in Food Processing Not less than 950 µg/mg, as lysozyme hydrochloride, calculated on the anhydrous basis White odourless powder. Soluble in water; insoluble in organic solvents and in concentrated saline solutions
FUNCTION IN FOODS:	Preservative (mainly to prevent the late blowing of cheese caused by *Clostridium tyrobutyricum*)
LEGISLATION:	**USA:** GRAS **CANADA:** The enzyme from specified sources may be used in certain products using GMP **UK and EUROPE:** The enzyme from specified sources may be used in certain products using GMP **AUSTRALIA/NZ:** Permitted to be added to any food as long as the source is listed in the regulations
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NAME:	Malt carbohydrase
CATEGORY:	Enzymes
FOOD USE:	Beer/Bakery products/Alcoholic beverages/Syrups
SYNONYMS:	Malt/1,4-α-D-glucan glucanohydrolase (EC 3.2.1.1)/1,4-α-D-glucan maltohydrolase (EC 3.2.1.2)
PROPERTIES AND APPEARANCE:	Malt is the product of controlled germination of barley Active principles: α-amylase (glycogenase, diastase); β-amylase (glycogenase, diastase) α-Amylase: hydrolysis of 1,4-α-glucosidic linkages in polysaccharides, (starch, glycogen) yielding dextrins and oligosaccharides and monosaccharides β-Amylase: hydrolysis of 1,4-α-glucosidic linkages in polysaccharides (starch, glycogen) yielding successively maltose units from the non-reducing ends of the chains
FUNCTION IN FOODS:	Used in brewing, baking, manufacture of alcoholic beverages and manufacture of syrups
LEGISLATION:	**USA:** GRAS **CANADA:** The enzyme from specified sources may be used in certain products using GMP **UK and EUROPE:** The enzyme from specified sources may be used in certain products using GMP **AUSTRALIA/NZ:** Permitted to be added to any food as long as the source is listed in the regulations
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NAME:	Metallo-neutral proteases
CATEGORY:	Enzymes
FOOD USE:	Fermented beverages/Flour/Hydrolysed proteins/Meat
SYNONYMS:	EC 3.4.24.4
pH OPTIMUM:	*Aspergillus oryzae* 7; *Bacillus thermoproteolyticus* 8; *Bacillus* spp. 7
TEMPERATURE OPTIMUM °C:	*Aspergillus oryzae* 50; *Bacillus thermoproteolyticus* 65; *Bacillus* spp. 50
SIDE ACTIVITIES:	*Aspergillus oryzae*: other proteases *Bacillus thermoproteolyticus*: other proteases *Bacillus* spp.: other proteases
FUNCTION IN FOODS:	Hydrolysis of proteins
TECHNOLOGY OF USE IN FOODS:	Preferential cleavage of bonds with hydrophobic residues
SYNERGISTS:	*Aspergillus oryzae*; *Bacillus thermoproteolyticus*; *Bacillus* spp.
ANTAGONISTS:	*Aspergillus oryzae*: reducing agents, chelating agents, halogens *Bacillus thermoproteolyticus*: reducing agents, chelating agents, halogens *Bacillus* spp.: reducing agents, chelating agents, halogens
LEGISLATION:	**USA:** GRAS **CANADA:** The enzyme from specified sources may be used in certain products using GMP **UK and EUROPE:** The enzyme from specified sources may be used in certain products using GMP **AUSTRALIA/NZ:** Permitted to be added to any food as long as the source is listed in the regulations
REFERENCES:	http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010. www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010.

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www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010.
O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.
Owusu-Ansah, Y.J. (1991) Enzymes. In: Smith, J. (ed.) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow, pp. 120–150.

NAME:	Microbial rennet
CATEGORY:	Enzymes
FOOD USE:	Cheese
SYNONYMS:	Microbial chymosin/EC 3.4.23.4
pH OPTIMUM:	4.8–6
TEMPERATURE OPTIMUM °C:	30–40
FUNCTION IN FOODS:	Specific for one bond of κ-casein
TECHNOLOGY OF USE IN FOODS:	Cheese: coagulation of casein as powder or solution at 0.01–0.15%
LEGISLATION:	**USA:** GRAS **CANADA:** The enzyme from specified sources may be used in certain products using GMP **UK and EUROPE:** The enzyme from specified sources may be used in certain products using GMP **AUSTRALIA/NZ:** Permitted to be added to any food as long as the source is listed in the regulations
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NAME:	Naringinase (*Penicillium* spp.)
CATEGORY:	Enzymes
FOOD USE:	Fruit and vegetable juices
SYNONYMS:	β-L-l-rhamnosidase/EC 3.2.1.40
pH OPTIMUM:	3–5
TEMPERATURE OPTIMUM °C:	40
SIDE ACTIVITIES:	β-glucosidase (EC 3.1.1.21)
FUNCTION IN FOODS:	Debittering of citrus juice as powder
TECHNOLOGY OF USE IN FOODS:	Fruit and vegetable juices: debittering of citrus juice as powder
LEGISLATION:	**USA:** GRAS **CANADA:** The enzyme from specified sources may be used in certain products using GMP **UK and EUROPE:** The enzyme from specified sources may be used in certain products using GMP **AUSTRALIA/NZ:** Permitted to be added to any food as long as the source is listed in the regulations
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NAME:	Papain (papaya species)
CATEGORY:	Enzymes
FOOD USE:	Meat and other proteinaceous foods/Meat and fish/Eggs and egg products
SYNONYMS:	EC 3.4.22.2/CAS 9001-73-4/EINECS 232-627-2/Vegetable pepsin/Papayotin
PROPERTIES AND APPEARANCE:	White to grey powder, slightly hygroscopic
pH OPTIMUM:	5–7
TEMPERATURE OPTIMUM °C:	65
SIDE ACTIVITIES:	Lysozyme, glucanase, glucosidase, cellulase
FUNCTION IN FOODS:	Direct food additive, enzyme, processing aid, texturiser; meat tenderiser, tissue softening agent. Chillproofing, antihazing agent for beer. Preferential cleavage of arginine, lysine
TECHNOLOGY OF USE IN FOODS:	Meat and other proteinaceous foods. Meat and fish: tenderisation of meat as liquid, produces fish hydrolysates as liquid at 2% of protein, enhances fish stick-water effluent treatment as liquid at 0.2%. Removal of oil from tissues as liquid Eggs and egg products: improves drying properties as liquid/powder
SYNERGISTS:	Reducing compounds
ANTAGONISTS:	Oxidising agents
LEGISLATION:	**USA:** GRAS **CANADA:** The enzyme from specified sources may be used in certain products using GMP **UK and EUROPE:** The enzyme from specified sources may be used in certain products using GMP **AUSTRALIA/NZ:** Permitted to be added to any food as long as the source is listed in the regulations
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Owusu-Ansah, Y.J. (1991) Enzymes. In: Smith, J. (ed.) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow, pp. 120–150.

ANY OTHER RELEVANT INFORMATION:

Proteolytic enzyme derived from latex of the green fruit and leaves of *Carica papaya*
Molecular mass 21 kDa

NAME:	Pectinase
CATEGORY:	Enzymes
FOOD USE:	Alcoholic beverages/Non-alcoholic beverages/Coffee, cocoa/Fruits and vegetables/Fats and oils
SYNONYMS:	poly(l,4-α-D-galacturonide) glycano-hydrolase EC 3.2.1.15/CAS 9032-75-1/EINECS 232-885-6
pH OPTIMUM:	*Aspergillus* spp. 2.5–6; *Rhizopus* spp. 2.5–6
TEMPERATURE OPTIMUM °C:	*Aspergillus* spp. 40–60; *Rhizopus* spp. 30–50
SIDE ACTIVITIES:	*Aspergillus* spp.: pectinesterase, pectin lyase, etc. *Rhizopus* spp.: pectinesterase, pectin lyase, etc.
FUNCTION IN FOODS:	Enzyme for wine, cider, fruit juice, natural flavour/colour extracts, citrus fruit skins for jams, vegetable stock for soup manufacture
TECHNOLOGY OF USE IN FOODS:	Alcoholic beverages: in clarification of wine, decreases pressing time and increases extraction yield as liquid complex at 0.01– 0.02% Non-alcoholic beverages: in coffee, removal of gelatinous coating during drying, as liquid or powder at 20–50 ppm; in cocoa, hydrolysis of pulp from beans during fermentation as liquid or powder Fruits and vegetables: in juices, improves extraction, 0.003–0.03%; aids clarification, 0.01–0.02% mostly liquid; in vegetables, production of hydrolysates as liquid at 11–20 ppm Fats and oils: in extractions, degrades pectin substances to release oil as liquid/powder at 0.5–3% DS
SYNERGISTS:	*Aspergillus* spp.; *Rhizopus* spp.
ANTAGONISTS:	*Aspergillus* spp.; *Rhizopus* spp.
LEGISLATION:	**USA:** GRAS **CANADA:** The enzyme from specified sources may be used in certain products using GMP **UK and EUROPE:** The enzyme from specified sources may be used in certain products using GMP **AUSTRALIA/NZ:** Permitted to be added to any food as long as the source is listed in the regulations

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Owusu-Ansah, Y.J. (1991) Enzymes. In: Smith, J. (ed.) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow, pp. 120–150.

ANY OTHER RELEVANT INFORMATION:

Wide variety of component activities

NAME:	Penicillin amidase
CATEGORY:	Enzymes
SYNONYMS:	Penicillin amidohydrolase/EC 3.5.1.11
pH OPTIMUM:	*Bacillus* spp. 7–8; *Basidiomycetes* spp. 4–6
TEMPERATURE OPTIMUM °C:	*Bacillus* spp. 37; *Basidiomycetes* spp. 50
SIDE ACTIVITIES:	*Bacillus* spp.: usually very pure *Basidiomycetes* spp.: usually very pure
REFERENCE:	Owusu-Ansah, Y.J. (1991) Enzymes. In: Smith, J. (ed.) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow, pp. 120–150.

NAME:	Pepsin (porcine mucosa)
CATEGORY:	Enzymes
FOOD USE:	Cheese
SYNONYMS:	EC 3.4.23.1/CAS 9001-75-6/EINECS 232-629-3/Pepsinum
PROPERTIES AND APPEARANCE:	White or yellowish-white powder or lustrous transparent or translucent scales, odourless
pH OPTIMUM:	1.8–2.2
TEMPERATURE OPTIMUM °C:	40–60
SIDE ACTIVITIES:	Usually very pure
FUNCTION IN FOODS:	Preferential cleavage of phenylalanine, leucine
TECHNOLOGY OF USE IN FOODS:	Cheese: coagulation of casein as powder or solution at 0.01–0.15%
SYNERGISTS:	Reducing agents
ANTAGONISTS:	Oxidising agents; aliphatic alcohols
LEGISLATION:	**USA:** GRAS **CANADA:** The enzyme from specified sources may be used in certain products using GMP **UK and EUROPE:** The enzyme from specified sources may be used in certain products using GMP **AUSTRALIA/NZ:** Permitted to be added to any food as long as the source is listed in the regulations
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www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010.
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Owusu-Ansah, Y.J. (1991) Enzymes. In: Smith, J. (ed.) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow, pp. 120–150.

ANY OTHER RELEVANT INFORMATION:

A digestive enzyme of gastric juice which hydrolyses certain linkages of proteins to produce peptones
Molecular mass 36 kDa

NAME:	Peroxidase (horseradish)
CATEGORY:	Enzymes
FOOD USE:	Dairy products
SYNONYMS:	Hydrogen peroxide oxidoreductase/EC 1.11.1.7
pH OPTIMUM:	5–7
TEMPERATURE OPTIMUM °C:	45
SIDE ACTIVITIES:	Catalase
FUNCTION IN FOODS:	Elimination of hydrogen peroxide from treated milk
TECHNOLOGY OF USE IN FOODS:	Elimination of hydrogen peroxide from treated milk
LEGISLATION:	**USA:** GRAS **CANADA:** The enzyme from specified sources may be used in certain products using GMP **UK and EUROPE:** The enzyme from specified sources may be used in certain products using GMP **AUSTRALIA/NZ:** Permitted to be added to any food as long as the source is listed in the regulations
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Owusu-Ansah, Y.J. (1991) Enzymes. In: Smith, J. (ed.) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow, pp. 120–150.

ANY OTHER RELEVANT INFORMATION: A specific haem protein enzyme

NAME:	Protease
CATEGORY:	Enzymes
FOOD USE:	Meat products/Fish products/Beverages/Soups, broths/Dairy products/Bakery products
SYNONYMS:	INS No. 1101(i)/ 1. Aminopeptidases (EC 3.4.11) 2. Serine endopeptidases (EC 3.4.21) 3. Aspartic endopeptidases (EC 3.4.23)/Secondary enzyme activity α-Amylase (EC 3.2.1.1)
PROPERTIES AND APPEARANCE:	Protease from *Aspergillus oryzae*, var.: produced by the controlled fermentation of non-toxicogenic and non-pathogenic strains of *A. oryzae* and isolated from the growth medium Active principles: endopeptidases and exopeptidases Reactions catalysed: (1) Hydrolysis of proteins at the N-terminal, liberating amino acids (2) Hydrolysis of proteins containing serine peptide bonds (3) Hydrolysis of proteins containing aspartic acid bonds Off-white to tan amorphous powders dispersed in food-grade diluents or carriers; may contain stabilisers and preservatives; soluble in water and practically insoluble in ethanol and ether
FUNCTION IN FOODS:	Used in the preparation of and/or in meat and fish products, beverages, soup and broths, dairy and bakery products
LEGISLATION:	**USA:** GRAS **CANADA:** The enzyme from specified sources may be used in certain products using GMP **UK and EUROPE:** The enzyme from specified sources may be used in certain products using GMP **AUSTRALIA/NZ:** Permitted to be added to any food as long as the source is listed in the regulations
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Owusu-Ansah, Y.J. (1991) Enzymes. In: Smith, J. (ed.) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow, pp. 120–150.

NAME:	Pullulanase
CATEGORY:	Enzymes
FOOD USE:	Sugar manufacture
SYNONYMS:	EC 3.2.1.4/CAS 9075-68-7/EINECS 232-983-9
PROPERTIES AND APPEARANCE:	White powder
pH OPTIMUM:	*Bacillus* spp. 4.5; *Klebsiella aerogenes* 5
TEMPERATURE OPTIMUM °C:	*Bacillus* spp. 60; *Klebsiella aerogenes* 50
SIDE ACTIVITIES:	*Bacillus* spp.: protease, amylase *Klebsiella aerogenes*: protease, amylase
FUNCTION IN FOODS:	Food enzyme in production of maltose. Hydrolysis of 1,6-α-D-glucosidic link in pullulan, amylopectin, glycogen and limit dextrans
TECHNOLOGY OF USE IN FOODS:	Food enzyme in production of maltose. Hydrolysis of 1,6-α-D-glucosidic link in pullulan, amylopectin, glycogen and limit dextrans
LEGISLATION:	**USA:** GRAS **CANADA:** The enzyme from specified sources may be used in certain products using GMP **UK and EUROPE:** The enzyme from specified sources may be used in certain products using GMP **AUSTRALIA/NZ:** Permitted to be added to any food as long as the source is listed in the regulations
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NAME:	Rennet (bovine abomasum)
CATEGORY:	Enzymes
FOOD USE:	Cheese
SYNONYMS:	Chymosin/EC 3.4.23.4/CAS 9001-98-3/Bovine rennet/Rennin
PROPERTIES AND APPEARANCE:	Yellowish-white powder, peculiar odour, slight salty taste
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	Slightly soluble
pH OPTIMUM:	4.8–6
TEMPERATURE OPTIMUM °C:	30–40
SIDE ACTIVITIES:	May contain pepsin
FUNCTION IN FOODS:	Specific for one bond of κ-casein
TECHNOLOGY OF USE IN FOODS:	Cheese: coagulation of casein as powder or solution at 0.01–0.15%
LEGISLATION:	**USA:** GRAS **CANADA:** The enzyme from specified sources may be used in certain products using GMP **UK and EUROPE:** The enzyme from specified sources may be used in certain products using GMP **AUSTRALIA/NZ:** Permitted to be added to any food as long as the source is listed in the regulations
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NAME:	Subtilisin
CATEGORY:	Enzymes
FOOD USE:	Baked goods/Alcoholic beverages (beer)
SYNONYMS:	EC 3.4.21.14
pH OPTIMUM:	*Bacillus amyloliquifaciens* 9–11; *Bacillus licheniformis* 9–11; *Bacillus subtilis* 9–10; *Aspergillus oryzae* 8–10
TEMPERATURE OPTIMUM °C:	*Bacillus amyloliquifaciens* 60–70; *Bacillus licheniformis* 60–70; *Bacillus subtilis* 55; *Aspergillus oryzae* 60–70
SIDE ACTIVITIES:	*Bacillus amyloliquifaciens*: amylase, glucanase, other protease *Bacillus licheniformis*: amylase, glucanase, other protease *Bacillus subtilis*: amylase, glucanase, other protease *Aspergillus oryzae*: amylase, glucanase, other protease
FUNCTION IN FOODS:	Baked goods: modification of gluten in baking of biscuits as powder at up to 0.25% of flour; to reduce mixing time of dough as tablets at 75 HU per 100 g flour Alcoholic beverages (beer): to provide nitrogen for yeast growth and aid in filtration and chillproofing as liquid or powder at 0.3% DS
TECHNOLOGY OF USE IN FOODS:	Baked goods: modification of gluten in baking of biscuits as powder at up to 0.25% of flour; to reduce mixing time of dough as tablets at 75 HU per 100 g flour Alcoholic beverages (beer): to provide nitrogen for yeast growth and aid in filtration and chillproofing as liquid or powder at 0.3% DS
ANTAGONISTS:	*Bacillus amyloliquifaciens* organophosphorus compounds; *Bacillus licheniformis* organophosphorus compounds; *Bacillus subtilis* organophosphorus compounds; *Aspergillus oryzae* organophosphorus compounds

NAME:	Tannase
CATEGORY:	Enzymes
FOOD USE:	Non-alcoholic beverages
SYNONYMS:	Tannic acid acylhydrolase/EC 3.1.1.20
pH OPTIMUM:	*Aspergillus niger* 4.5; *Aspergillus oryzae* 3–5
TEMPERATURE OPTIMUM °C:	*Aspergillus niger* 55; *Aspergillus oryzae* 45
SIDE ACTIVITIES:	*Aspergillus niger*: amylase, glucoamylase *Aspergillus oryzae*: amylase, glucoamylase, protease, cellulase
FUNCTION IN FOODS:	Removal of polyphenolics as liquid or powder 0.03%
TECHNOLOGY OF USE IN FOODS:	Removal of polyphenolics as liquid or powder 0.03%
LEGISLATION:	**USA:** Not approved **CANADA:** Not approved **EUROPE:** Not approved
REFERENCES:	Ash, M. and Ash, I. (1995) *Food Additives*. Gower Publishing, Brookfield, VT. Owusu-Ansah, Y.J. (1991) Enzymes. In: Smith, J. (ed.) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow, pp. 120–150.

NAME:	Trypsin (pancreatic)
CATEGORY:	Enzymes
FOOD USE:	Baked goods/Alcoholic beverages (beer)
SYNONYMS:	EC 3.4.21.4/CAS 9002-07-7/EINECS 232-650-8
pH OPTIMUM:	8–9
TEMPERATURE OPTIMUM °C:	45
SIDE ACTIVITIES:	Amylase, lipase, esterase
FUNCTION IN FOODS:	Preferential cleavage of arginine, lysine
TECHNOLOGY OF USE IN FOODS:	Baked goods: modification of gluten in baking of biscuits as powder at up to 0.25% of flour; to reduce mixing time of dough as tablets at 75 HU per 100 g flour Alcoholic beverages (beer): to provide nitrogen for yeast growth and aid in filtration and chillproofing as liquid or powder at 0.3% DS
ANTAGONISTS:	Compounds in cereals, beans, potato, egg
LEGISLATION:	**USA:** GRAS **CANADA:** The enzyme from specified sources may be used in certain products using GMP **UK and EUROPE:** The enzyme from specified sources may be used in certain products using GMP **AUSTRALIA/NZ:** Permitted to be added to any food as long as the source is listed in the regulations
REFERENCES:	http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010. www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010. www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010. www.foodstandards.gov.au/_srcfiles/Standard_1_3_3_Processing_Aids_v113.pdf. Accessed 4 May 2010.

www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010.
Ash, M. and Ash, I. (1995) *Food Additives*. Gower Publishing, Brookfield, VT.
O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.
Owusu-Ansah, Y.J. (1991) Enzymes. In: Smith, J. (ed.) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow, pp. 120–150.

ANY OTHER RELEVANT INFORMATION: Bovine more thermotolerant

NAME:	Xylanase
CATEGORY:	Enzymes
FOOD USE:	Fruit juice
SYNONYMS:	1,3-β-D-xylanhydrolase/EC 3.2.1.32
pH OPTIMUM:	*Aspergillus niger* 3–5; *Aspergillus oryzae* 4; *Bacillus* spp. 7–9
TEMPERATURE OPTIMUM °C:	*Aspergillus niger* 45–55; *Aspergillus oryzae* 45; *Bacillus* spp. 55–65
SIDE ACTIVITIES:	*Aspergillus niger*: amylase, glucoamylase, glucosidase, cellulase *Aspergillus oryzae*: amylase, glucanase, glucoamylase, cellulase *Bacillus* spp.: amylase, glucanase, protease
FUNCTION IN FOODS:	Endo-hydrolysis of 1,3-β-D-xylose units of xylans
TECHNOLOGY OF USE IN FOODS:	Endo-hydrolysis of 1,3-β-D-xylose units of xylans
SYNERGISTS:	*Aspergillus niger*; *Aspergillus oryzae*; *Bacillus* spp.
ANTAGONISTS:	*Aspergillus niger*; *Aspergillus oryzae*; *Bacillus* spp.
REFERENCE:	Owusu-Ansah, Y.J. (1991) Enzymes. In: Smith, J. (ed.) *Food Additive User's Handbook*. Blackie Academic & Professional, Glasgow, pp. 120–150.

Part 6

Flavour Enhancers

Lily Hong-Shum

Food Additives Data Book, Second Edition. Edited by Jim Smith and Lily Hong-Shum.

NAME:	Acetic acid
CATEGORY:	Flavour enhancer
FOOD USE:	Baked goods/Catsup/Cheese/Chewing gum/Condiments/Dairy products/Fats/Fats (rendered)/Gravies/Mayonnaise/Meat products/Oils/Pickles/Relishes/Salad dressings/Sauces
SYNONYMS:	Acetic acid (aqueous solution)/Acetic acid, glacial/Acide acetique (French)/Acido acetico (Italian)/Azijnzuur (Dutch)/Essigsaeure (German)/Octowy kwas (Polish)/CAS 64-19-7/EINECS/ELINCS 200-580-7/Ethanoic acid/Ethylic acid/Methanecarboxylic acid/Pyroligneus acid/Vinegar acid/Ry-So/Sour Dough Base/Vanease/BFP white sour/FEMA No. 2006/E260/UN2789(DOT)/UN2790(DOT)/INS260
FORMULA:	CH_3COOH
MOLECULAR MASS IN Daltons:	60.05
PROPERTIES AND APPEARANCE:	Clear colourless liquid; pungent vinegar-like odour. Sharply acid taste. Miscible with water, alcohol, glycerol, ether, carbon tetrachloride; practically insoluble in carbon disulphide; soluble in most organic solvents
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	117–118
MELTING RANGE IN °C:	16.7
FLASH POINT IN °C:	43
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.049
FUNCTION IN FOODS:	Acidifier; boiler water additive; colour diluent; curing/pickling agent; flavour enhancer; flavouring agent; pH control agent; solvent/vehicle, preservative
SYNERGISTS:	Acts synergistically with lactic and sorbic acid and is more effective against yeast and bacteria than against moulds
ANTAGONISTS:	Incompatible with: chromic acid, nitric acid, 2-amino-ethanol, NH_4NO_3, ClF_3, chlorosulphonic acid, (O_3 + diallyl methyl carbinol), ethylenediamine, ethylene imine, (HNO_3 + acetone), oleum, $HClO_4$, permanganates, $P(OCN)_3$, KOH, NaOH, *n*-xylene, carbonates and many oxides and phosphates

FOOD SAFETY ISSUES:

Human poison by unspecified route. Moderately toxic by various routes; severe eye and skin irritant; caustic – can cause severe burns, lacrimation and conjunctivitis

Human systemic effects by ingestion: changes in oesophagus, ulceration or bleeding from the small and large intestines. Human systemic irritant effects and mucous membrane irritant

Experimental reprotoxicity effects; mutagenic data

Common air contaminant. Combustible liquid; moderate fire and explosive hazard when exposed to heat or flame; can react vigorously with oxidising materials

To fight fire use CO_2, dry chemical, alcohol foam, foam and mist. When heated to decomposition will emit irritating fumes. Potentially explosive with 5-azido-tetrazole, hydrogen peroxide, potassium permanganate, sodium peroxide, phosphorus trichloride. Potentially violent reactions with acetaldehyde and acetic anhydride. Ignites on contact with potassium-*tert*-butoxide

LEGISLATION:

USA:

FDA 21 CFR 182.1005

Approved for use in foods as flavour enhancer, flavouring agent/adjuvant, curing/pickling agent, pH control agent, solvent/vehicle at GRAS quantities

GRAS: limitations of

- 0.26% in baked goods
- 0.8% in cheese and dairy products
- 0.5% in chewing gum
- 9.0% in condiments and relishes
- 0.5% in fats and oils
- 0.3% in gravies and sauces
- 0.6% in meat products
- 0.15% in all other food categories

when used in accordance with good manufacturing practices

USDA 9 CFR 318.7 Sufficient for purpose

21 CFR 182.70, 172.814, 184.1005, 73.85, 178.1010

CANADA:

18-10-79

Permitted for use in cream cheese spread, canned asparagus, and gelatin as pH-adjusting agents, acid-reacting materials, and water-correcting agents at GMP levels

Permitted for use as class 1 preservatives in preserved fish, meat, meat by-products, poultry, and pickles at food manufacturing practice levels

Approved for use in unstandardised foods at GMP levels

AUSTRALIA/PACIFIC RIM:

Japan: approved as acetic acid glacial; used as acidity regulator and food acid

UK and EUROPE:
EEC Regulations (E260)
Used as antibacterial preservative;
acidity stabiliser; diluent for colours;
flavouring agent
No limits on ADI
UK: approved for use
Europe: listed

REFERENCES:

www.medicinescomplete.com/mc/merck/current. Merck Index Online. Accessed 5–6 September 2009.
Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York.
Lewis, R.J. Sr (1989) *Food Additives Handbook*. Van Nostrand Reinhold, New York.
Shmuel, Y. (ed.) (2004) *Dictionary of Food Compounds with CD-ROM: Additives, Flavors and Ingredients*. Chapman & Hall/CRC, USA.
Smoley, C.K. (1993) *Everything Added to Food in the United States*. U.S. Food and Drug Administration, CRC Press, Boca Raton, FL.

ANY OTHER RELEVANT INFORMATION:

Manufacturer/Distributor: AB R Lundberg, AMC Chems; Asiamerica Int'l; BASF; Fluka; Frutarom Ltd; Ruger; Sigma; Vopak USA; Zeta Pharm.
Marketed under trade name 2X White Sour; Ry-Fla-Vor

NAME:	Algae, brown
CATEGORY:	Flavour enhancer
FOOD USE:	Flavouring/Seasonings/Spices
SYNONYMS:	Brown algae/*Analipus japonicus*/*Eisenia bicyclis*/*Kjellmaniella gyrate*/*Hizikia fusiforme*/*Laminaria angustata*/*L. japonica*/*L. longicruris*/*L. claustonia*/*L. digitata*/*Macrocystis pyrifera*/CAS 977026928
FUNCTION IN FOODS:	Flavour enhancer; flavour adjuvant; flavouring agent; spices; seasonings
ALTERNATIVES:	Red algae
FOOD SAFETY ISSUES:	Heated to decomposition will emit acrid smoke and irritating fumes
LEGISLATION:	**USA:** FDA 21 CFR 184.1120: approved for use in foods as flavour enhancer, flavouring adjuvant for spices and seasonings at GRAS quantities. GRAS use at level not in excess of the amount reasonably required to accomplish the intended effect FDA 21 CFR 172.365
REFERENCES:	Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York. Lewis, R.J. Sr (1989) *Food Additives Handbook*. Van Nostrand Reinhold. New York.
ANY OTHER RELEVANT INFORMATION:	Manufacturer/Distributor: Degussa AG/Health & Nutrition

NAME:	Algae, red
CATEGORY:	Flavour enhancer
FOOD USE:	Flavourings/Seasonings/Spices
SYNONYMS:	Red algae/*Porphyra crispata*/*P. deutata*/*P. perforata*/*P. suborbiculata*/*P. tenera*/*Rhodymenia palmata*/*Gloiopeltis furcata*/CAS 977090042
FUNCTION IN FOODS:	Flavour enhancer; flavour adjuvant; spices and seasonings
ALTERNATIVES:	Brown algae
FOOD SAFETY ISSUES:	Heated to decomposition will emit acrid smoke and irritating fumes
LEGISLATION:	**USA:** FDA 21 CFR 184.1121: approved for use in foods as flavour enhancer, flavouring adjuvant for spices and seasonings at GRAS quantities. GRAS use at level not in excess of the amount reasonably required to accomplish the intended effect
REFERENCES:	Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York. Lewis, R.J. Sr (1989) *Food Additives Handbook*. Van Nostrand Reinhold, New York.
ANY OTHER RELEVANT INFORMATION:	Manufacturer/Distributor: Degussa AG/Health & Nutrition

NAME:	Ammonium chloride
CATEGORY:	Flavour enhancer
SYNONYMS:	Ammonium muriate/Sal ammonia/Sal ammoniac/Salmiac/CAS 12125-02-09/EINECS/SLINCS 235-186-4/INS510
FORMULA:	NH_4Cl
MOLECULAR MASS IN Daltons:	53.50
PROPERTIES AND APPEARANCE:	Colourless to white crystal or powder, cooling saline taste. Soluble 28.3% in water and glycerol, soluble in methanol, ethanol, somewhat hygroscopic. Tendency to cake strongly endothermic. Sublimes without melting. Freely soluble in water, glycerin, more so in boiling water; HCl and NaCl decrease its solubility in water; slightly soluble in alcohol. Almost insoluble in acetone, ether, ethyl acetate. pH of aqueous solution (25°C): 1% (5.5), 3% (5.1), 10% (5.0)
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	@ 0°C 22.9 @ 15°C 26.0 @ 25°C 28.3 @ 80°C 39.6
MELTING RANGE IN °C:	337.8
FLASH POINT IN °C:	520
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.5274
FUNCTION IN FOODS:	Yeast food; dough conditioner; flavour enhancer; leavening agent; processing aid; flour treatment agent
ANTAGONISTS:	Incompatible with alkalis and their carbonates, lead and silver salts. Explosive reaction with potassium chlorate or bromine trifluoride, violent reaction with bromine pentafluride NH_4, NO_3, IF_7
FOOD SAFETY ISSUES:	Poisonous by subcutaneous, intravenous and intramuscular routes, severe eye irritant, mutation data, Toxic Substance Control Act listed. When heated to decomposition will emit very toxic fumes of NO_x, Cl^- and NH_3. Potential symptoms of overexposure to fumes are irritation of eyes, skin and respiratory system; cough; dyspnoea; pulmonary sensitisation

LEGISLATION:

USA:
FDA 21 CFR178.1010, 184.1139. GRAS

CANADA:
Canadian Provisional Domestic Substance listed

UK and EUROPE:
Europe: listed
UK: approved

AUSTRALIA/PACIFIC RIM:
Japan: approved for use

REFERENCES:

www.medicinescomplete.com/mc/merck/current. Merck Index Online. Accessed 5–6 September 2009.
Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York.

ANY OTHER RELEVANT INFORMATION:

Manufacturer/Distributor: AMRESCO, Aldrich, Arkema, Ashland, BASF, China Nat'l, Degussa AG/Health & Nutrition, EM Chemicals, Fluka, henywell Spec. Chems., Integra, Sal Chem, Sigma, Lianing, Voigt Global Distrib., Xiamen Topusing, Zaclon

Store at room temperature, hygroscopic

NAME:	Ammonium glutamate
CATEGORY:	Flavour enhancer
FOOD USE:	Meat/Poultry
SYNONYMS:	CAS 7558-63-6/Monoammonium glutamate/Ammoniumglutaminat (German)/MAG/Monoammonium L-glutamate
FORMULA:	$C_5H_9NO_4H_3N$
MOLECULAR MASS IN Daltons:	164.19
ALTERNATIVE FORMS:	Monoammonium glutamate/Monosodium glutamate/Monopotassium glutamate
PROPERTIES AND APPEARANCE:	White crystalline powder; odourless. Soluble in water; insoluble in common organic solvents
FUNCTION IN FOODS:	Flavour enhancer; salt substitute; multipurpose food ingredient
ALTERNATIVES:	Monosodium glutamate; monoammonium glutamate; monopotassium glutamate; disodium guanylate; disodium inosinate; L-glutamic acid
FOOD SAFETY ISSUES:	Moderately toxic by intraperitoneal route. When heated to decomposition, will emit toxic fumes including NO_x and NH_3
LEGISLATION:	**USA:** FDA 21 CFR 182.1500: GRAS when used in accordance with GMP USDA 9 CFR 318.7, 381.147: sufficient for purpose
REFERENCE:	Lewis, R.J. Sr (1989) *Food Additives Handbook*. Van Nostrand Reinhold, New York.
ANY OTHER RELEVANT INFORMATION:	Manufacturer/Distributor: Ajinomoto USA., Inc., 500 Frank W. Burr Blvd., Teaneck, NJ 07666, USA. Tel (201) 448-1212; Fax (201) 488-6282 (NJ Head Office); Sigma

NAME:	Ammonium glycyrrhizate
CATEGORY:	Flavour enhancer
FOOD USE:	Baked goods/Beverages (alcoholic)/Beverages (non-alcoholic)/Candy (hard)/Candy (soft)/Chewing gum/Herbs/Plant protein products/Seasonings/Vitamin or mineral dietary supplements/Pharmaceuticals
SYNONYMS:	CAS 053956040/EINECS/ELINCS 258-887-7/, pentahydrate/Monoammonium glycyrrhizinate/Ammonium glycyrrhizinate/Magnasweet®/MAG
FORMULA:	$C_{42}H_{62}O_{16}H_3N$
MOLECULAR MASS IN Daltons:	840.08
ALTERNATIVE FORMS:	Ammonium glycyrrhizinate, pentahydrate/Ammonium glycyrrhizinate/Monoammonium glycyrrhizinate
PROPERTIES AND APPEARANCE:	Obtained by extraction from ammoniated glycyrrhizin; derived from roots of *Glycyrrhiza glabra*, family Leguminosae White powder, sweet taste; insoluble in glacial acetic acid; soluble in ammonia. About 100 times as sweet as sucrose; hygroscopic
MELTING RANGE IN°C:	209 (dec.)
FUNCTION IN FOODS:	Flavour enhancer; flavouring agent; surface-active agent; foaming agent; aromatisation of food; sweetening agent for taste correction of food and drugs and production of confectioneries; sweetness potentiators; masking agents; reduce metallic aftertaste from high-intensity sweeteners
ALTERNATIVES:	For licorice taste: licorice/licorice root extract; licorice; thaumatin For high sweetness intensity: aspartame; ethyl maltol; glycine; sucralose
TECHNOLOGY OF USE IN FOODS:	Some relative sweetness measured against 20 mg/100 mL of sucrose solution (70 times sweeter) or 10 mg/100 mL of sucrose solution (93 times sweeter). Slow onset of sweetness, but taste is long. Effectively masks bitter, harsh and astringent aftertastes common to pharmaceutical active ingredients. Enhances and magnifies natural and artifical flavours Pre-solubilised: shelf-stable solution of glycerin or propylene glycol ideal for use when rapid dispersion is desired or when powder is unsuitable for processing Powder forms: good dispersion and compression properties designed for dry mixes, aqueous systems and tableting soluble in aqueous, alcoholic and hydro-alcoholic type formulations can be incorporated into

	products containing propylene glycol and glycerin oil-based systems will require use of suitable emulsifiers; most favoured solubility pH 3.5–8.0. Dissolving of powdered form will require moderate agitation and elevated temperature of solvent to 140–160°C (liquid form could be used in absence of these conditions)
SYNERGISTS:	Shows synergism when mixed with sucrose. Works synergistically with other natural and artificial sweeteners to provide better overall sweetness and in proper combination can create systems that simulate sucrose. Works synergistically with primary sweeteners (i.e. sucrose, fructose, and high-intensity sweeteners)
ANTAGONISTS:	Elevated saccharin levels may intensify metallic aftertaste
FOOD SAFETY ISSUES:	When heated to decomposition will emit acrid smoke and irritating fumes. Toxic fumes of CO, CO_2, NO_x. Incompatible with strong oxidising agents. Harmful by ingestion; may be harmful by inhalation; skin absorption; may cause eye/skin irritation, changes in heart/bladder/adrenal weight, hepatitis, changes in blood count; over-exposure can cause sodium retention and potassium loss leading to hypertension, water retention and electrolyte imbalance; mutagen; reproductive effector; target organs; adrenal cortex; TSCA (Toxic Substance Control Act) listed
LEGISLATION:	**USA:** FDA 21 CFR 184.1408: approved for use in foods as flavour enhancer, flavouring agent, surface-active agent at GRAS quantities GRAS, with limitations of: 0.05% in baked goods, 0.1% in alcoholic beverages, 0.15% in non-alcoholic beverages, 1.1% in chewing gum, 16.0% in hard candy, 0.15% in herbs and seasonings, 0.15% in plant protein products, 3.1% in soft candy, 0.5% in vitamin or mineral dietary supplements, 0.1% in all other foods except sugar substitutes when used in accordance with food manufacturing practices Not permitted for use as a non-nutritive sweetener in sugar substitutes **CANADA:** DSL (Canadian Provisional Domestic Substance List) Listed
REFERENCES:	Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York. Krutosikova, A. and Uher, M. (1992) *Natural and Synthetic Sweet Substances*. Ellis Horwood, New York. Lewis, R.J. Sr (1989) *Food Additives Handbook*. Van Nostrand Reinhold, New York.
ANY OTHER RELEVANT INFORMATION:	Manufacturer/Distributors: MacAndrews & Forbes Company, Third Street and Jefferson Avenue, Camden, NJ 08104, USA. Tel (609) 964-8840. Telfax (609) 964-6029. Telex: 84-5337; Acros Org.; Adept Sol'ns.; Asiamerica Int'l.; Atomergic Chemetals; CarboMer; Fisher Scientific UK; Fluka; Frutarom; MP Biomedicals; Mafco Worldwide; NetQem; Sigma; Universal Preserv-A-Chem

NAME:	Aspartame
CATEGORY:	Flavour enhancer/Non-nutritive sweeteners
FOOD USE:	Artificial sweeteners/Flavour enhancer for foods, beverages, chewing gum, and pharmaceuticals
SYNONYMS:	CAS22839-47-0, EINECS/ELINCS 245-261-3/INS951/3-Amino-*N*-(α-carboxphenethyl) succinamic acid *N*-methyl ester/APM/Aspartylphenylalanine methyl ester/*N*-l-α-Aspartyl-l-phenylalanine l-methyl ester/ methyl aspartyphenylalanate/1-methyl *N*-L-α-aspartyl-L-phenylalanine/Equal (Nutrasweet Co.)/Nutrasweet (Nutrasweet Co.)/Sanecta (Holland Sweetener)
FORMULA:	$C_{14}H_{18}N_2O_5$
MOLECULAR MASS IN Daltons:	294.34
PROPERTIES AND APPEARANCE:	White crystalline powder or colourless needles, odourless, sweet tasting, prolonged sweet aftertaste, slightly soluble in water, alcohol. Consists of L-aspartic acid and the methyl ester of L-phenylalanine. 160 times sweeter than sucrose
MELTING RANGE IN °C:	246–248
FUNCTION IN FOODS:	Intense sweeteners (160–250 times sweeter than sucrose), flavour enhancer, especially in citrus drinks
FOOD SAFETY ISSUES:	By ingestion, can cause allergic dermatitis. Can have possible link to neural problems, headaches, experimental reproductive effects. Should not be used by individuals with phenylketonuria (PKU). TSCA (Toxic Substances Control Act) listed. When heated to decomposition will emit toxic fumes of NO_x, CO and CO_2.
LEGISLATION:	**USA:** FDA 21 CFR 172.804 **AUSTRALIA/PACIFIC RIM:** Japan: approved for use **CANADA:** Approved for use Canadian Provisional Domestic Substance List
REFERENCES:	www.medicinescomplete.com/mc/merck/current. Merck Index Online. Accessed 5–6 September 2009. Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York.

ANY OTHER RELEVANT INFORMATION:	Manufacturers/Distributors: AB R Lundberg, Ajinomoto, Aldrich, Ashland, CarboMer, Celestar, Danisco Sweeteners, Fluka, Functional Foods, NutraSweet, Sigma, Spectrum Quality Prods., Sweeteners Plus, Tiger Chem, Unicersal Preserv-A-Chem. Vopak USA, Westco, Xinchem Store in well-closed containers Trade names: Equal?, HSC Aspartame Fine Powder, HSC Aspartame Pearl 700, HSC Aspartame Powder 200, NutraSweet

NAME:	Calcium chloride
CATEGORY:	Flavour enhancer
SYNONYMS:	Calcium chloride anhydrous/CAS 10043-52-4 (anhydrous)/10035-04-08 (dihydrate)/7774-34-7 (hexahydrate)/ EINECS/ELINCS 233-140-8/INS509/E509
FORMULA:	$CaCl_2$ (anhydrous) $CaCl_2 \cdot 2H_2O$ (dihydrate)
MOLECULAR MASS:	110.99 (anhydrous) 147.01 (dihydrate)
PROPERTIES AND APPEARANCE:	Greyish-white crystals, granules, lumps or flakes. Odourless. Freely soluble in water (with liberation of much heat) and alcohol. pH 4.5–9.2 (5%)
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	>1600
MELTING RANGE IN °C:	772 (anhydrous) 176 (dihydrate)
FLASH POINT IN °C:	Boiling point >1600°C
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	2.16 (anhydrous) 1.83 (dihydrate)
FUNCTION IN FOODS:	Sequestrant; firming agent; anticaking agent; antimicrobial; curing agent; flavour enhancer; humectant; nutrient supplement; pH control agent; pickling agent; processing aid; stabiliser; surfactant; texturiser; thickener in foods; solvent in preparation of hops for beer brewing
ANTAGONISTS:	Reacts violently with BrF_3 (B_2O_3 + CaO), reaction with zinc to release explosive hydrogen gas. Exothermic reaction with water
FOOD SAFETY ISSUES:	Poisonous by intravenous, intramuscular, intraperitoneal and subcutaneous routes. Moderately toxic by ingestion causing stomach and heart disturbances. Severe eye irritant. Human systemic effects: tumorigen, mutagen, questionable carcinogen. When heated to decomposition will emit toxic fumes of Cl^-. Toxic Substance Control Act listed

LEGISLATION:

USA:
FDA 21CFR133.102, 133.108, 133.111, 133.113, 133.118, 133.127, 133.136, 133.138, 133.141, 145.145, 150.141, 150.161, 172.560, 178.1010, 184.1193, GRAS,
USDA 9 CFR 318.7, 381.147. For use at 3% maximum

CANADA:
Canadian Provisional Domestic Substance List

UK and EUROPE:
Europe: listed (ADI not specified)
UK: approved

AUSTRALIA/PACIFIC RIM:
Japan: approved for use (1% max.)

OTHERS:
WHO limitation: 350–800 mg/kg in canned fruits/vegetable; 200 mg/kg in preserves, processed cheese

REFERENCES:

www.medicinescomplete.com/mc/merck/current. Merck Index Online. Accessed 5–6 September 2009.
Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York.

ANY OTHER RELEVANT INFORMATION:

Manufacturer/Distributor: AB R Lundberg, AMRESCO, Aldrich, Ashland, Fluka, J.T. Baker, Lohmann, MPSI, Oriental Chem. Ind., P.B. & S, Penta Mfg., Sigma, Stanchem, Universal Preserv-A-Vhem, VMR Int'l. Varsal Instruments, Vopak USA, Vulcan Chems, Wako Chem. USA

NAME:	Disodium guanylate
CATEGORY:	Flavour enhancer
FOOD USE:	Flavour enhancer in foods/Flavouring agent in pharmaceuticals/Canned foods/Poultry/Sauces/Snack items/Soups
SYNONYMS:	Disodium GMP/Disodium guanylate (FCC)/Disodium guanosine-5′-monophosphate/disodium 5′-guanylate/GMP/GMP disodium salt/GMP sodium salt/G-5′-P/Guanosine 5′-disodium phosphate/Guanosine monophosphate disodium salt/Guanosine 5′-monophosphate disodium salt/Guanylic acid sodium salt/Sodium GMP/Sodium guanosine-5′-monophosphate/Sodium guanylate/Sodium-5′-guanylate/CAS 5550-12-9 (anhydrous)/FEMA 3668/INS627/E627/I + G/Luxor 1576, 1626, 1639, EB-400, GMP disodium salt
FORMULA:	$C_{10}H_{14}N_5O_8P \cdot 2Na$ or $Na_2C_{10}H_{12}N_5O_8P \cdot 2H_2O$
MOLECULAR MASS IN Daltons:	409.24
PROPERTIES AND APPEARANCE:	Colourless to white crystals. Characteristic taste. Soluble in cold water. Very soluble in hot water. Slightly soluble in alcohol. Insoluble in ether. Decomposes at about 190–250°C. Characteristic meaty taste. Practically insoluble in alcohol, acetone, ether
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	@ 25°C ~25 g/100 mL
FUNCTION IN FOODS:	Acts as a flavour intensifier like sodium inosinate and sodium glutamate. Said to be more effective than either
ALTERNATIVES:	Sodium inosinate; L-glutamic acid; monoammonium glutamate; monopotassium glutamate; monosodium glutamate; ammonium glutamate; potassium glutamate
FOOD SAFETY ISSUES:	Moderately toxic by intraperitoneal, subcutaneous and intravenous routes. Mildly toxic by ingestion. Mutagenic data. TSCA (Toxic Substance Control Act) listed. When heated to decomposition will emit toxic fumes of PO_x, NO_x and Na_2O

LEGISLATION:

USA:
FDA 21 CFR 145.131, 155.120, 155.130, 155.170, 155.200, 155.201, 170.60, 172.530 (used as flavour enhancer; use at level not in excess of the amount reasonably required to accomplish the intended effect. USDA 9CFR318.7, 381.147 (use at sufficient for purpose). FEMA GRAS

CANADA:
Canadian Provisional Domestic Substance listed

UK and EUROPE:
Europe: listed
UK: approved

AUSTRALIA/PACIFIC RIM:
Japan: approved for use

REFERENCES:

www.medicinescomplete.com/mc/merck/current. Merck Index Online. Accessed 5–6 September 2009.
Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York.
Lewis, R.J. Sr (1989) *Food Additives Handbook*. Van Nostrand Reinhold, New York.

ANY OTHER RELEVANT INFORMATION:

Manufacturer/Distributors: Ajinomoto USA., Inc., AMERSCO, Fluka, Kyowa Hakko Kogyo, Sigma
Moisture-sensitive, keep under argon

NAME:	Disodium inosinate
CATEGORY:	Flavour enhancer
FOOD USE:	Flavour enhancer in foods
SYNONYMS:	Disodium IMP/disodium 5′-inosinate/disodium inosine-5′-phosphate/IMP/IMP disodium salt/IMP sodium salt/inosine 5′-disodium phosphate/inosine-5′-monophosphate disodium/dodium inosinate/sodium 5′-inosinate/CAS4691-65-0/FEMA3669/INS631/E631
FORMULA:	$C_{10}H_{11}N_4O_8PNa_2$
MOLECULAR MASS IN Daltons:	392.17
PROPERTIES AND APPEARANCE:	Colourless to white crystals, characteristic taste. Soluble in water, slightly soluble in alcohol, insoluble in ether. A 5′-nucleotide derived from seaweed or dried fish
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** ~13 g/100 mL
FOOD SAFETY ISSUES:	Moderately toxic by several routes; experimental teratogen; mutagenic data; Toxic Substance Control Act listed. When heated to decomposition will emit toxic fumes of PO_x, NO_x and Na_2O
LEGISLATION:	**USA:** FDA 21 CFR155.120; 155.130; 155.170; 155.200; 155.201; 170.60; 172.535 (must contain ≤150 ppm soluble barium) USDA 9 CFR318.7; 381.147; FEMA GRAS **CANADA:** Canadian Provisional Domestic Substances listed **UK and EUROPE:** UK: approved for use **AUSTRALIA/PACIFIC RIM:** Japan: approved for use
REFERENCES:	www.medicinescomplete.com/mc/merck/current. Merck Index Online. Accessed 5–6 September 2009. Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York.
ANY OTHER RELEVANT INFORMATION:	Manufacture/Distributor: Ajinomoto, Penta Mfg, Sigma

NAME:	Disodium 5′-ribonucleotides
CATEGORY:	Flavour enhancer
FOOD USE:	Flavour enhancer in foods
SYNONYMS:	INS635/E635
PROPERTIES AND APPEARANCE:	Colourless or white crystal or white crystal powder. Odourless, characteristic taste. Soluble in water. Slightly soluble in ethanol. Practically insoluble in ether. Mixture of disodium 5′-inosinate and disodium 5′-guanylate
REFERENCE:	Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York.

NAME:	Esterase-lipase
CATEGORY:	Flavour enhancer
FOOD USE:	Cheese/Fats/Milk products/Oil
PROPERTIES AND APPEARANCE:	Derived from *Mucor miehei*
TECHNOLOGY OF USE IN FOODS:	Enzyme for hydrolysis of fat, used as flavour enhancer in cheeses, fats and oils
FOOD SAFETY ISSUES:	When heated to decomposition will emit acrid smoke and irritating fumes
LEGISLATION:	**USA:** FDA 21 CFR 173.140: use at a level not in excess of the amount reasonably required to accomplish the intended effect
REFERENCES:	Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York. Lewis, R.J. Sr (1989) *Food Additives Handbook*. Van Nostrand Reinhold, New York.

NAME:	Ethyl maltol
CATEGORY:	Flavour enhancer/Aliphatic ketone
FOOD USE:	Chocolate/Desserts/Wine
SYNONYMS:	CAS 4940-11-8/FEMA 3487/INS637/E637/3-Hydroxyl-2-ethyl-4-pyrone/2-Ethyl-3-hydroxy-4*H*-pyran-4-one/2-Ethyl pyromeconic acid/Veltol®/Veltol®-Plus
FORMULA:	$C_7H_8O_3$
MOLECULAR MASS IN Daltons:	140.14
PROPERTIES AND APPEARANCE:	White crystalline powder; caramel sweet odour; sweet fruity taste. Soluble in water, alcohol, propylene glycol, chloroform
MELTING RANGE IN °C:	88–90
FUNCTION IN FOODS:	Synthetic flavouring agent imparting sweet taste; flavour enhancer; processing aid; sweetness enhancement; increased creaminess; masked bitterness; reduced acid bite; antioxidant in foods; minimises undesirable flavours in saccharin-containing beverages
ALTERNATIVES:	Aspartame; glycine; sucralose; thaumatin; ammoniated glycyrrhizin products
TECHNOLOGY OF USE IN FOODS:	Veltol®-Plus. Soluble in alcohol; 1 g of product will dissolve in: 55 mL of water; 10 mL alcohol; 17 mL propylene glycol; 5 mL chloroform
SYNERGISTS:	Flavour/fragrance modifier/enhancer for food especially baked goods, beverages and synthetic berry and citrus flavourings. Will provide sweetness enhancement of aspartame, allowing reduced usage levels
FOOD SAFETY ISSUES:	Moderately toxic by ingestion, subcutaneous routes. Mutagenic data available. TSCA (Toxic Substances Control Act) listed. When heated to decomposition, will emit acrid smoke and fumes

LEGISLATION:

USA:
FDA 21 CFR 172.515: approved for use as flavouring agents in synthetic flavouring substances and adjuvants
Used at a level not in excess of the amount reasonably required to accomplish the intended effect
BATF 27 CFR 240.1051: limitation of 100 mL/L

UK and EUROPE:
Europe: listed
UK: approved for use
EEC Regulation (E637): approved for use as a flavouring agent to impart sweet taste and as flavour enhancer
ADI 0–2 mg/kg body weight

REFERENCES:

www.medicinescomplete.com/mc/merck/current. Merck Index Online. Accessed 5–6 September 2009.
Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York.
Lewis, R.J. Sr (1989) *Food Additives Handbook*. Van Nostrand Reinhold, New York.

ANY OTHER RELEVANT INFORMATION:

Manufacturer/Distributor: Pfizer Canada Inc., Food Science Group, P.O. Box 800, Point-Claire/Dorval, Quebec H9R 4V2. Tel (800) 363-7928/(514) 426-6888; Fax (800) 265-9503/(514) 426-6895; Pfizer Canada, Inc., 17300 Trans Canada Highway, Kirkland, Quebec H9J 2M5. Tel (800) 363-7928
Also: ADA Int'l; Ashland; Camida Ltd; Danisco Cultor; Forum Bioscience; Lluch Essence; Voigt Global Distrib.; Vopak USA

NAME:	L-Glutamic acid
CATEGORY:	Flavour enhancer/Amino acid
SYNONYMS:	CAS 56-86-0/EINECS/ELINCS 200-293-7/FEMA 3285/INS620/E620/α-Glutamic acid/L-2-aminoglutaric acid/2-Aminopentanedioic acid/α-Aminoglutaric acid/1-Aminopropane-1,3-dicarboxylic acid/Glusate/Glutacid/Glutamic acid/d-Glutam-iensuur/Glutaminic acid/L-Glutaminic acid/Glutaminol/Glutaton/L-2-aminopentanedioic acid; 1-Amino-propane-1,3-dicarboxylic acid/Glu/α-Glutamic acid
FORMULA:	$C_5H_9NO_4$
MOLECULAR MASS IN Daltons:	147.15
ALTERNATIVE FORMS:	Monosodium glutamate/Monopotassium glutamate/Monoammonium glutamate
PROPERTIES AND APPEARANCE:	An essential amino acid present in all complete proteins. White, free-flowing, rhombic crystal or crystal powder; virtually odourless; decomposes at 247–249°C; sublimes at 200°C. Slightly soluble in water; practically insoluble in methanol, ethanol, ether, acetone, cold glacial acetic acid and common neutral solvents
MELTING RANGE IN °C:	194 (DL); 224–225 (L)
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.4601 (DL); 1.538 (L)
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 25°C** 8.64 g/L **@ 50°C** 21.86 g/L **@ 75°C** 55.32 g/L **@ 100°C** 140.00 g/L
FUNCTION IN FOODS:	Flavour enhancer; nutrient; dietary supplement; salt substitute
ALTERNATIVES:	Ammonium glutamate; disodium inosinate; disodium guanylate; monoammonium glutamate; monopotassium glutamate; monosodium glutamate; potassium glutamate
FOOD SAFETY ISSUES:	Human systemic effects by ingestion and intravenous route (headache, vomiting or nausea). When heated to decomposition, will emit toxic fumes of NO_x

LEGISLATION:

USA:
FDA 21 CFR 172.320: 12.4% maximum: approved for use as dietary and nutritional additive at level of 12.4%
FDA 21 CFR 182.1045: GRAS when used in accordance with GMP
Approved for use as GRAS food substance and salt substitute

CANADA:
DSL (Canadian Provisional Domestic Substance List)

UK and EUROPE:
Europe: listed
UK: approved for use
EEC Regulation (E620): approved for use as dietary supplement, flavour enhancer, salt substitute at ADI of 0–120 mg/kg body weight

AUSTRALIA/PACIFIC RIM:
Japan: approved for use as dietary supplement (amino acid) and flavourings

REFERENCES:

www.medicinescomplete.com/mc/merck/current. Merck Index Online. Accessed 5–6 September 2009.
Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York.
Lewis, R.J. Sr (1989) *Food Additives Handbook*. Van Nostrand Reinhold, New York.
Shmuel, Y. (ed.) (2004) *Dictionary of Food Compounds with CD-ROM: Additives, Flavors and Ingredients*. Chapman & Hall/CRC, USA.

ANY OTHER RELEVANT INFORMATION:

Manufacturer/Distributor: Ajinomoto USA., Inc., 9 West 57th Street, New York, NY 10019, USA. Telex 232220 (AJI UR); Tel (212) 688-8360
Others: Ashland; China Nat'l Chem; Degussa AG/Health & Nutrition; Sigma; Universal Preserv-A-Chem; Vopak USA; Wego Chem. & Min.
Store at room temperature

NAME:	Glycine
CATEGORY:	Flavour enhancer
FOOD USE:	Beverages/Rendered fats/Beverage base
SYNONYMS:	CAS 56-40-6/EINECS/ELINCS 200-272-2/FEMA 3287/INS640/E640/Hampshire glycine/Aminoacetic acid/Glycocoll/Glycolixir/Aminoethanoic acid/Gyn-Hydralin/Glycosthene/Gly
FORMULA:	$H_2N\text{-}CH_2\text{-}COOH$
MOLECULAR MASS IN Daltons:	75.08
ALTERNATIVE FORMS:	Sodium glycinate
PROPERTIES AND APPEARANCE:	Simplest amino acid, and the principal amino acid in sugar cane. Monoclinic prism from alcohol. White crystals or crystal powder; odourless, sweet taste. Soluble in water; insoluble in alcohol, ether. Decomposes at 233°C, and completely sintered at 290°C
MELTING RANGE IN °C:	232–236 (decomposition)
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.1607
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 25°C** 25.0 g/100 mL **@ 50°C** 39.1 g/100 mL **@ 75°C** 54.4 g/100 mL **@ 100°C** 67.2 g/100 mL
FUNCTION IN FOODS:	Buffering agent; flavour enhancer; sweetener; stabiliser; nutrient; dietary supplement; reduces bitter taste of saccharin; retards rancidity in animal and vegetable fats; chicken feed additive; flavour modifier
ALTERNATIVES:	Aspartame; ethyl maltol; sucralose; thaumatin; ammoniated glycyrrhizin
FOOD SAFETY ISSUES:	Moderately toxic by intravenous route; mildly toxic by ingestion. Mutagenic data available; TSCA (Toxic Substances Control Act) listed. When heated to decomposition, will emit toxic fumes of NO_x

LEGISLATION:

USA:
FDA 21 CFR 170.50: no longer GRAS
for use in human food
21 CFR 582.5049: GRAS for animal feed
21 CFR 172.320: limitation of 3.5% by weight
21 CFR 172.812: approved for use as a masking agent for bitter aftertaste of saccharin in beverages and stabiliser in mono- and diglycerides
Limitations of 0.2% (of finished beverage) and 0.02% (of mono- and diglyceride)
USDA 9 CFR 318.7: 0.01% in rendered animal fat

CANADA:
Approved for use as sequestering agent for mono- and diglycerides (0.02%)
DSL (Canadian Provisional Domestic Substance List)

AUSTRALIA/PACIFIC RIM:
Japan: approved for use as dietary supplement (amino acid) and flavourings

REFERENCES:

www.medicinescomplete.com/mc/merck/current. Merck Index Online. Accessed 5–6 September 2009.
Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York.
Lewis, R.J. Sr (1989) *Food Additives Handbook*. Van Nostrand Reinhold, New York.

ANY OTHER RELEVANT INFORMATION:

Manufacturer/Distributor: AB R Lundberg; Ajinomoto; Dastech Int'l; EM Chemicals; Galland – Schlesinger Ind.; Hawkins Chem; Jarchem Ind.; Mutchler; Rochem Int'l; Sigma; Vopak USA
Store at room temperature

NAME:	Lactic acid
CATEGORY:	Flavour enhancer
FOOD USE:	Cheese spreads/Egg (dry powder)/Olives/Poultry/Salad dressing mix/Wine/Confectionery/Cultured dairy products/Frozen desserts/Jams, jellies, preserves/Seasoning, sauces/Seafood/Soft drinks
SYNONYMS:	CAS 50-21-5/CAS 598-82-3 (DL)/CAS 79-33-4 (L)/CAS 10326-41-7 (D)/EINECS/ELINCS 200-018-0/209-954-4 (DL)/201-296-2 (L)/EINECS 233-713-2 (D)/INS270/E270/FEMA 2611/UN1760/Purac/ 2-Hydroxypropionic acid/Acetonic acid/Ethylidenelactic acid/1-Hydroxyethane 1-carboxylic acid/ 2-hydroxyethane-carboxylic acid/2-Hydroxypropanoic acid/α-Hydroxypropionic acid/Kyselina milecna (Czech)/DL-lactic acid/Milchsaure (German)/Milk acid/Ordinary lactic acid/Racemic lactic acid/Propanoic acid, 2-Hydroxyl-/Propionic acid, 2-hydroxy
FORMULA:	$CH_3CHOHCOOH$
MOLECULAR MASS IN Daltons:	90.09
ALTERNATIVE FORMS:	Lactic acid, monosodium salt/Calcium lactate/Sodium lactate/Potassium lactate
PROPERTIES AND APPEARANCE:	Yellow to colourless crystals or syrupy 50% liquid. Odourless, acid taste. Volatile with superheated steam; slightly soluble in ether; insoluble in chloroform, petroleum ether, carbon disulphide. Miscible in water, alcohol + ether, glycerol, furfural. Product of the metabolism of glucose and glycogen. Refractive index 1.4251; anionic
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	122 @ 15 mmHg
MELTING RANGE IN °C:	16.8–18
BOILING RANGE IN °C:	122 (15 mmHg)
FLASH POINT IN °C:	> 110
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.209–1.249

FUNCTION IN FOODS: Acidulant in beverages; antimicrobial agent; buffer; chelating agent; curing agent; flavour enhancer; flavouring adjuvant; flavouring agent; pH control agent; pickling agent; preservative; raising agent; solvent; texture modifier; vehicle (for cheese, confectionery, cultured dairy products, olives, poultry, wine)

ALTERNATIVES: Citric acid; L-tartaric acid; malic acid; sodium citrate; succinic acid; tannic acid

TECHNOLOGY OF USE IN FOODS: Due to its mild acidic taste, it will not be effective in masking mild aromatic flavours. When added to packing brine for green olives and onions, will ensure clarity of brine and improve flavour

SYNERGISTS: Lactic acid in conjunction with sodium lactate will provide an excellent buffer system which is beneficial in manufacturing of confections as it provides acid taste without risk of sucrose inversion. Improves antimicrobial properties of other organic acids (i.e. benzoic, propionic, etc.)

ANTAGONISTS: Incompatible with oxidising agents, iodides, HNO_3, albumin

FOOD SAFETY ISSUES: Moderately toxic by ingestion and rectal routes. Mutagenic data available. Severe skin and eye irritant. An FDA over-the-counter drug. Mixture with nitric acid + hydrofluoric acid may react vigorously and is a storage hazard. When heated to decomposition, will emit acrid smoke and irritating fumes

LEGISLATION:

USA:
FDA 21 CFR 131.144, 131, 150.141, 150.161, 172.814; FDA 21 CFR 184.1061: approved for use in foods as antimicrobial, curing/pickling agent, flavouring agent/adjuvant, pH control agent, solvent/vehicle at GRAS quantities
GRAS: when used at a level not in excess of the amount reasonably required to accomplish the intended effect
USDA 9 CFR 318.7, 381.147: sufficient for purpose BATF 27 CFR 240.1051
GRAS: when used in accordance with GMP
Not for use in infant foods

UK and EUROPE:
Europe: listed
UK: approved for use
EEC Regulations (E270): approved for use as preservative, antioxidant synergist, acidulant, flavouring in malting process
No ADI limits

CANADA
Approved for use as pH-adjusting or water-correcting agents

AUSTRALIA/PACIFIC RIM:
Japan: approved for use as acidity regulator, food acid, raising agent

REFERENCES:

www.medicinescomplete.com/mc/merck/current. Merck Index Online. Accessed 5–6 September 2009.
Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York.
Lewis, R.J. Sr (1989) *Food Additives Handbook*. Van Nostrand Reinhold, New York.

ANY OTHER RELEVANT INFORMATION:

Manufacturer/Distributor: ADM Food Additives Division, 4666 Faries Parkway, Decatur, IL 62526, USA. Tel (217) 424-5387; Fax: (217) 424-2473
Storage: hygroscopic

NAME:	Licorice (*Glycyrrhiza glabra*)	
CATEGORY:	Flavour enhancer	
FOOD USE:	Baked goods/Alcoholic beverages/Non-alcoholic beverages/Chewing gum/Hard candy/Herbs/Seasonings/Plant protein products/Soft candy/Vitamin and mineral supplements	
SYNONYMS:	Glycyrrhiza/Liquorice/Licorice root/Glycyrrhiza glabra/CAS 97700-4-31-1/CAS 68916-91-6	
PROPERTIES AND APPEARANCE:	Dried rhizome and roots of *Glycyrrhiza glabra*; strong lingering sweet taste; counteracts excessive saltiness	
FUNCTION IN FOODS:	Natural flavouring agent; flavour enhancer; surface-active agent	
ALTERNATIVES:	Ammoniated glycyrrhizin; licorice root extract; licorice extract; thaumatin	
LEGISLATION:	**USA:** FDA 21 CFR 184.1408: approved for use in foods as flavour enhancer, flavouring agent, surface-active agent at GRAS quantities Limitation for use at levels of 0.05–16% Limitations of 0.05% (baked goods), 0.1% (alcoholic beverages), 0.15% (non-alcoholic) beverages), 1.1% (chewing gum), 16% (hard candy), 0.15% (vitamin/mineral supplements), 0.1% (other foods) Not permitted as non-nutritive sweetener in sugar substitutes	**AUSTRALIA/PACIFIC RIM:** Japan: approved for use as natural flavouring
REFERENCES:	Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York. Lewis, R.J. Sr (1989) *Food Additives Handbook*. Van Nostrand Reinhold, New York.	

NAME:	Licorice (*Glycyrrhiza glabra*) extract	
CATEGORY:	Flavour enhancer	
FOOD USE:	Baked goods/Alcoholic beverages/Non-alcoholic beverages/Chewing gum/Hard candy/Herbs/Seasonings/Plant protein products/Soft candy/Vitamin and mineral supplements	
SYNONYMS:	*Glycyrrhiza glabra* extract/CAS 84775-66-6/CAS 97676-23-8/EINECS/ELINCS 238-895-2/FEMA 2628/Glycyrrhiza extract/Glycyrrhiza glabra; Glycyrrhiza glabra extract/Glycyrrhiza glabra root extract/Licorice extract/Licorice root extract/Liquorice extract	
PROPERTIES AND APPEARANCE:	Extract of root of licorice, *Glycyrrhiza glabra*	
FUNCTION IN FOODS:	Flavour enhancer for food, beverage; natural flavouring agent; surface-active agent	
ALTERNATIVES:	Licorice root extract; thaumatin; ammoniated glycyrrhizin	
LEGISLATION:	**USA:** FDA 21 CFR 184.1408: substance affirmed as GRAS for use as flavour enhancer, flavouring agent, surface-active agent at 0.05–16%	**AUSTRALIA/PACIFIC RIM:** Japan: approved for use
REFERENCES:	Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York. Lewis, R.J. Sr (1989) *Food Additives Handbook*. Van Nostrand Reinhold, New York.	

NAME:	Licorice root extract
CATEGORY:	Flavour enhancer
FOOD USE:	Bacon/Baked goods/Beverages (alcoholic)/Beverages (non-alcoholic)/Candy (hard)/Candy (soft)/Chewing gum/Cocktail mixes/Herbs/Ice-cream/Imitation whipped products/Plant protein products/Seasonings/Soft drinks/Syrups/Vitamin or mineral dietary supplements
SYNONYMS:	CAS 8008-94-4/Glycyrrhiza/Glycyrrhizae (Latin)/Glycyrrhiza extract/Glycyrrhizina/Kanzo (Japanese)/ Licorice root/Licorice/Licorice extract
ALTERNATIVE FORMS:	*Glycyrrhiza glabra* extract/Licorice/Licorice root/Licorice extract
FUNCTION IN FOODS:	Flavour enhancer; flavouring agent; surface-active agent in foods, beverages, chewing gum, herbs, seasonings, dietary supplements
ALTERNATIVES:	Licorice extract; thaumatin; ammoniated glycyrrhizin
FOOD SAFETY ISSUES:	Moderately toxic by intraperitoneal and subcutaneous routes; mildly toxic by ingestion. Mutagenic data available. When heated to decomposition, it emits acrid smoke and irritating fumes
LEGISLATION:	**USA:** FDA 21 CFR 184.1408: approved for use in foods as flavour enhancer, flavouring agent, surface-active agent at GRAS quantities GRAS: with limitation of (as glycyrrhizin) 0.05% in baked goods; 0.1% in alcoholic beverages; 0.15% in non-alcoholic beverages; 1.1% in chewing gum; 16.0% in hard candy; 0.15% in herbs and seasonings; 0.15% in plant protein products; 3.1% in soft candy; 0.5% in vitamin or mineral dietary supplements; 0.1% in all other foods except sugar substitutes when used in accordance with GMP Not permitted to be used as a non-nutritive sweetener in sugar substitutes
REFERENCES:	Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York. Lewis, R.J. Sr (1989) *Food Additives Handbook*. Van Nostrand Reinhold, New York.
ANY OTHER RELEVANT INFORMATION:	Manufacture/Distributor: Chart; Frutarom; Ruger

NAME:	Magnesium sulphate anhydrous
CATEGORY:	Flavour enhancer
FOOD USE:	Various
SYNONYMS:	CAS 10034-88-9/EINECS/ELINCS 231-298-2/INS518/E518/Magnesium sulfate (1:1)/Sulfuric acid magnesium salt (1:1)/Epsom salts/Bitter salts/Mg 5 – Sulfat/Magnesium sulfate
FORMULA:	$MgSO_4$
MOLECULAR MASS IN Daltons:	120.37
PROPERTIES AND APPEARANCE:	Colourless crystals; opaque needles or granular crystalline powder; odourless with cooling, bitter, salt taste. Slowly soluble in glycerin; slightly soluble in alcohol. Non-combustible; decomposes at 1124°C
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	2.65
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 71 g/100 mL **@ 40°C** 91 g/100 mL
FUNCTION IN FOODS:	Dietary supplement; fermentation aid; flavour enhancer; nutrient; processing aid; tofu coagulant (Japan); yeast nutrient
ALTERNATIVES:	Sodium lactate; ammonium chloride; calcium chloride; potassium chloride
FOOD SAFETY ISSUES:	Moderately toxic by ingestion, intraperitoneal, and subcutaneous routes; an experimental teratogen. Parenteral use or use in presence of renal insufficiency may lead to magnesium intoxication. Potentially explosive reaction when heated with ethoxyethynyl alcohols (e.g. 1-ethoxy-3-methyl-1-butyn-3-ol). When heated to decomposition, will emit toxic fumes of SO_x

LEGISLATION:

USA:
FDA 21 CFR 182.5443: approved for use in foods as dietary supplement at GRAS quantities
FDA 21 CFR 184.1443: approved for use in foods as flavour enhancer, nutrient supplement, processing aid at GRAS quantities
GRAS: when used at a level not in excess of the amount reasonably required to accomplish the intended effect

CANADA:
Approved for use in the following: as pH-adjusting or water-correcting agent; as starch-modifying agent at 0.4%; to restore functional properties in egg albumen

UK and EUROPE:
Europe: approved for use
UK: approved for use
EEC Regulations (E518): approved for use as dietary supplement, firming agent, and for use in beer making

AUSTRALIA/PACIFIC RIM:
Japan: approved for use as coagulant for tofu, fermentation aid, yeast nutrient

REFERENCES:

www.medicinescomplete.com/mc/merck/current. Merck Index Online. Accessed 5–6 September 2009.
Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York.
Lewis, R.J. Sr (1989) *Food Additives Handbook*. Van Nostrand Reinhold, New York.

ANY OTHER RELEVANT INFORMATION:

Manufacturer/Distributors: Aldrich; Alfa Chem; Fluka, Sigma; Thomas Scientific; VMR Int'l; Vopak USA; Xiamen Topusing
Storage: hygroscopic

NAME:	Magnesium sulphate heptahydrate
CATEGORY:	Flavour enhancer
FOOD USE:	Beer-making
SYNONYMS:	CAS 10034-99-8/EINECSELINCS 231-298-8/INS518/E518/Bitter salts/Espom salts/Sulfuric acid/ Magnesium salt (1:1) heptahydrate
FORMULA:	$MgSO_4 \cdot 7H_2O$
MOLECULAR MASS IN Daltons:	246.48
ALTERNATIVE FORMS:	Magnesium sulphate
PROPERTIES AND APPEARANCE:	Efflorescent colourless orthorhombic crystal or powder; bitter, saline, cooling taste; slightly soluble in alcohol; pH 6–7; loses water of crystallisation above 150°C
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.670
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 71 g/100 mL
FUNCTION IN FOODS:	Firming agent; flavour enhancer; nutrient/dietary supplement; processing aid in food and beer-making, moderately toxic by several routes; parenteral use or use in presence of renal insufficiency may lead to magnesium intoxication; target organs are nerves and GI system
TECHNOLOGY OF USE IN FOODS:	Keep in well-closed container
LEGISLATION:	**USA:** FDA 21 CFR 184.1443: affirmed as GRAS for use as flavour enhancer, nutrient supplement and processing aid **UK and EUROPE:** Europe: listed UK: approved for use EEC Regulation (E518): approved for use as dietary supplement, firming agent and in beer-making

	CANADA: DSL (Canadian Provisional Domestic Substance List)	**AUSTRALIA/PACIFIC RIM:** Japan: approved for use as coagulant for tofu, fermentation aid, and yeast nutrient
REFERENCES:	Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York. Lewis, R.J. Sr (1989) *Food Additives Handbook*. Van Nostrand Reinhold, New York.	
ANY OTHER RELEVANT INFORMATION:	Manufacturer & Distributor: Aldrich; Bioth China; EMD Chems; Fluka; Sigma; Spectrum Quality Prods.; Xiamen Topusing Store at room temperature in a well-closed container	

NAME:	Malic acid/*N*-Hydroxysuccinic acid
CATEGORY:	Flavour enhancer
FOOD USE:	Beverages (dry mix)/Candy (hard)/Candy (soft)/Chewing gum/Fats (chicken)/Fillings/Fruit juices/Fruits (processed)/Gelatins/Jams/Jellies/Lard/Non-alcoholic beverages/Puddings/Shortening/Soft drinks/Wine/ Fruit-flavour-based mints/Pharmaceuticals
SYNONYMS:	CAS 6915-15-7/CAS 97-67-6 (L)/CAS 617-48-1 (DL)/636-61-3(D+)/EINECS/ELINCS 202-601-5; 203-022-08(DL)/FEMA 2655/INS296/E296/Apple acid/1-Hydroxy-1,2-ethanedicarboxylic acid/*N*-hydroxysuccinic acid/Kyselina jablecna/Hydroxybutanedioic acid/Pomalus acid/Butanedioic acid/hydroxyl-; Deoxytetraric acid/hydroxysuccinic acid/succinic acid/hydroxyl-; malic acid
FORMULA:	$COOHCH_2CH(OH)COOH$
MOLECULAR MASS IN Daltons:	134.10
ALTERNATIVE FORMS:	D(+) form/L(−) form (apple acid)
PROPERTIES AND APPEARANCE:	White or colourless crystals, powder or granules; strong acid taste. Exhibits isomeric forms (DL, L and D) Very soluble in water and alcohol; slightly soluble in ether; practically insoluble in benzene (L form). DL, L, and D isomeric forms, combustible
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	150 (DL)/140 (D or L) – decomposition
MELTING RANGE IN °C:	131–132 (DL); 128 (DL); 101 (D); 100 (D or L)
BOILING POINT °C:	140 (decompose)
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.595 (D or L); 1.601 (DL)
PURITY %:	Not less than 99.0 and not more than 100.5 of $C_4H_6O_5$

SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:

in water:	**@ 20°C**	55.8						
	@ 50°C	0.1 (pH 2.78)	1.0 (pH 2.39)	3.0 (pH 2.04)	5.0 (pH 1.92)	10.0 (pH 1.78)	20.0 (pH 1.61)	50.0 (pH 0.96)
	@ 100°C	68.9						
in ethanol solution:	**@ 25°C**	39.16						

FUNCTION IN FOODS: Flavour adjuvant; flavour enhancer; flavouring agent; food acidulant; pH control agent; synergist for antioxidant; creates a well-balanced sensation between mint and fruit flavour

ALTERNATIVES: In beverages: citric acid, tartaric acid. In canned fruits and vegetables: lactic acid. Fumaric acid; tannic acid; succinic acid

TECHNOLOGY OF USE IN FOODS: Increases product yield in cheese production. 1 gram is soluble in 1.4 mL of ethanol. Store at low humidity, low temperature, and airtight container to avoid caking

Tart taste builds gradually and lasts longer than other food acids; the bitter aftertaste of some sugar substitutes is suppressed by malic acid

Calcium salt form of this acid has a better solubility than other food acids, which allows it to be used with hard water

In fruit drinks: enhances the flavour of fruits and extends the flavour sensation without masking the natural note; addition of malic acid in soft drinks will lower the pH, creating an unfavourable environment for microorganisms and thus may be considered a preservative; level of acid required varies inversely with the degree of carbonation of soft drink; used to correct the natural deficiencies of fruit when added directly to fruit/juice or during fermentation of wine

In bakery products: used to enhance fruit flavour in fruit fillings and aid in colour retention; when malic acid is used, the amount of acid and pectin added for gel formation in fillings is decreased; the slightly higher pH of malic acid helps prevent meltdown of icing or frostings when it is applied to warm baked products; malic acid in combination with lactic, acetic and propionic acid will give a sourdough flavour in sourdough bakery products.

In gelatin desserts: allows for use of a lower level of gelatin to set the protein gel system

In puddings: the slightly higher pH prevents weeping of free water from starch gels formed when cooking

In hard candy: the lower melting point of this acid makes it easy to disperse in the syrup melt, thus requiring minimum folding and kneading

In canned fruits and vegetables: addition of this acid causes the pH to decrease thus reducing the processing time and temperature needed to eliminate the threat of microbial contamination, and greatly improves quality and nutritive value

SYNERGISTS:

Works synergistically with aspartame to reduce the amount of sugar substitute in diet products without affecting sweetness, while extending the sweetness potency
Works in combination with ascorbic acid to stabilise beverages and prevent discoloration
Can be used to increase the effectiveness of benzoates and sorbates as preservatives in fruit drinks

FOOD SAFETY ISSUES:

Poisonous by intraperitoneal route. Moderately toxic by ingestion; a skin and severe eye irritant. When heated to decomposition, will emit acrid smoke and irritating fumes. Dust and aqueous solutions may irritate skin, eyes, mucous membrane; TSCA (Toxic Substance Control Act) listed

LEGISLATION:

USA:
FDA 21 CFR 146.113, 150.141, 150.161, 169.115, 169.140, 169.150, 131.144, 184.1069: approved for use in foods as flavour enhancer, flavouring agent and adjuvant, pH control agent at GRAS quantities
GRAS: with limitation of 3.4% in non-alcoholic beverages; 3.0% in chewing gum; 0.8% in gelatins, puddings and fillings; 6.9% in hard candy; 2.6% in jams and jellies; 3.5% in processed fruits and fruit juices; 3.0% in soft candy; 0.7% in all other foods when used in accordance with GMP USDA 9 CFR 318.7: limitation of 0.01% on basis of total weight in combination with antioxidants in lard and shortening
BATF 27 CFR 240.1051
Not for use in baby foods

UK and EUROPE:
Europe: listed
UK: approved for use
ECC Regulations (E296): malic acid in DL or L forms is approved for use as acid and flavouring

CANADA:
Approved for use in the following: as pH-adjusting or water-correcting agent for fruits, fruit jam/jelly, and cheeses

AUSTRALIA/PACIFIC RIM:
Japan: approved for use

REFERENCES:

www.medicinescomplete.com/mc/merck/current. Merck Index Online. Accessed 5–6 September 2009.
Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York.
Lewis, R.J. Sr (1989) *Food Additives Handbook*. Van Nostrand Reinhold, New York.

ANY OTHER RELEVANT INFORMATION:	Manufacturers/Distributors: Haarmann & Reimer Corp., Food Ingredients Division, 1884 Miles Avenue (P. O. Box 932), Elkhart, IN 46514 (46515); Tel (800) 348-7414/(219) 264-8716; Fax: (219) 262-6747 Browning Chemical Corporation, 707 Westchester Avenue, White Plains, NY 10604-3104; Tel (914) 686-0300; Fax (914) 686-0310; Telex 23 5039 AB R Lundberg; AMC Chems; Aldrich; Ashland; Fluka; Degussa AG/Health & Nutrition; Takeda Vitamins & Food USA; Tate & Lyle N. Am.; Vopak USA Marketed under trade name of Purac®; LM25 Hi Pure

NAME:	Monosodium glutamate
CATEGORY:	Flavour enhancer
FOOD USE:	Meat/Poultry/Sauces/Soups
SYNONYMS:	CAS 142-47-2/EINECS/ELINCS 205-538-1/INS621/E621/Sodium hydrogen L-glutamate/Accent/Chinese seasoning/Glutacyl/Glutamic acid, monosodium salt/Glutammato monosodico (Italian)/Glutavene/ Monosodioglutammato (Italian)/Natriomglutaminat (German)/Monosodium-L-glutamate (FCC)/ α-Monosodium glutamate/MSG/RL-50/Sodium glutamate/Sodium L-glutamate/L(+) sodium glutamate/vetsin/ Zest/Glutamic acid monosodium salt monohydrate/L-glutamate monohydrate/Sodium glutamate monohydrate/ Monosodium L-glutamate monohydrate/Asahi Aji/Glutamic acid; sodium salt/Sodium hydrogen glutamate
FORMULA:	$C_5H_8NNaO_4 \cdot H_2O$ or $HOOCCH(NH_2)\text{-}CH_2CH_2COONaH_2O$
MOLECULAR MASS IN Daltons:	180.13/169.13 (anhydrous)/187.13 (monohydrate)
ALTERNATIVE FORMS:	Monoammonium glutamate/Potassium glutamate/Monopotassium glutamate/Ammonium glutamate
PROPERTIES AND APPEARANCE:	Monosodium salt of L-form of glutamic acid. White or almost-white crystals or powder; free-flowing cystals or crystalline powder; forms rhombic prisms when crystallised from water. Below –8°C will recrystallise as a pentahydrate, which after filtration and exposure to air will lose water of crystallisation and become the monohydrate. Slight peptone-like odour; meat-like taste. Slightly sweet or slightly salty taste. Very soluble in water; slightly soluble in alcohol
PURITY %:	Not less than 99.0 of $C_5H_8NNaO_4$ H_2O
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 25°C** 74.2 g/100 mL **@ 60°C** 101.4 g/100 mL
FUNCTION IN FOODS:	Flavour enhancer; dietary supplement (Japan)
ALTERNATIVES:	Disodium inosinate; disodium guanylate; monoammonium glutamate; monopotassium glutamate; L-glutamic acid; ammonium glutamate; potassium glutamate
TECHNOLOGY OF USE IN FOODS:	pH of a 5% solution is 6.7–7.2; 5% maximum weight loss on drying; sodium content 12.3%. Bulk density is 0.67–0.84 g/cm^3 (11.0–13.8 g/cubic inch); 2.88 calories/g. Generally added in concentrations ranging from 0.1 to 0.8% based on the weight of the food

Works in harmony with salty and sour tastes, but contributes little or nothing to many sweet foods. Once the correct amount is used, additional use contributes little (if any) to the food flavour; in fact it can result in a decline in palatibility

FOOD SAFETY ISSUES:

Moderately toxic by intravenous route; mildly toxic by ingestion and other routes. Human systemic effects by ingestion and intravenous routes include somnolence, hallucinations and distorted perception, headache, dyspnoea, nausea or vomiting. Experimental teratogen and reprotoxicity effects; causes 'Chinese restaurant syndrome'. Non-mutagenic TSCA (Toxic Substances Control Act) listed. When heated to decomposition, will emit fumes of NO_x and Na_2O

LEGISLATION:

USA:
FDA 21 CFR 145.131, 155.120, 155.130, 155.170, 155.200, 158.170, 161.190, 169.115, 169.140, 169.150, 172.320, 182.1: GRAS when used at levels not in excess of the amount reasonably required to accomplish the intended effect
USDA 9 CFR 318.7: sufficient for purpose
USDA 9 CFR 381.147: sufficient for purpose

CANADA:
Approved for use to accentuate flavour in vegetable, meat and fish products in levels of up to 0.8%.
DSL (Canadian Provisional Domestic Substances List)

UK and EUROPE:
Europe: listed
EEC Regulation (E621): approved for use as flavour enhancer, ingredient where reduction of sodium intake is desired
Limited ADI 0–120 mg/kg body weight
UK: approved for use, with the exception of baby food

AUSTRALIA/PACIFIC RIM:
Japan: approved for use as dietary supplement (amino acid) and flavourings

OTHER COUNTRIES:
FAO and World Health Organization:
ADI 0–120 mg/kg body weight

REFERENCES:

www.medicinescomplete.com/mc/merck/current. Merck Index Online. Accessed 5–6 September 2009.
Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York.
Lewis, R.J. Sr (1989) *Food Additives Handbook*. Van Nostrand Reinhold, New York.

ANY OTHER RELEVANT INFORMATION:

Manufacturer/Distributor: Ajinomoto USA., Inc., 9 West 57th Street, New York, NY 10019, USA. Telex 232220 (AJI UR); Tel (212) 688-8360

NAME:	Potassium chloride
CATEGORY:	Flavour enhancer
FOOD USE:	Jelly (artificially sweetened)/Meat (raw cuts)/Poultry (raw cuts)/Preserves (artifically sweetened)/ Beer malting/Infant formula
SYNONYMS:	CAS 7447-40-7/EINECS/ELINCS 231-211-8/INS508/E508/Tripotassium trichloride/Chlorid draselny (Czech)/Chloropotassuril/Dipotassium dichloride/Emplets potassium chloride/Enseal/Kalitabs/Kaochlor/ Kaon-cl/Kay ciel/K-lor – Con/Klotrix/k-prendedome/Pfiklor/Potassium monochloride/Potavescent/Rekawan/ Slow-k/Capshure KCL-140-50/Capshure KCL-165-70/Durkote Potassium Chloride/hydrogen vegetable oil/ Frimulsion 6G/Merecol LK/Morton Flour Lite Salt Mixt/Morton Lite Salt Mixt/Morton Lite Salt TFCMixt/ Kaskay/Kayback/K-Contin/K-Norm/K-Tab/Leo – K/Micro – K/Nu – K/Peter – Kal/Repone K/Span – K/ Chlorvescent/Camcopot/Diffu-K/Kaleorid/Kalium – Duriles/Potassium muriate
FORMULA:	KCl
MOLECULAR MASS IN Daltons:	74.55
ALTERNATIVE FORMS:	Ammonium chloride
PROPERTIES AND APPEARANCE:	Colourless to white cubic crystals or powder; odourless with salty taste. Saline taste at low concentrations. Soluble in water, glycerin; slightly soluble in alcohol; insoluble in absolute alcohol, ether, acetone. Hydrochloric acid, sodium or magnesium chlorides diminish its solubility in water; pH 7
MELTING RANGE IN °C:	773 (sublimes @ 1500)
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.987
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 1 g dissolves in 2.8 mL of water **@ 100°C** 1 g dissolves in 1.8 mL of boiling water
in glycerol:	1 g dissolves in 14 mL of glycerol
in alcohol:	1 g dissolves in 250 mL of alcohol
FUNCTION IN FOODS:	Direct food additive; dietary supplement; flavour enhancer; flavouring agent; gelling agent; nutrient; pH control agent; salt substitute; tissue-softening agent; yeast food; stabiliser; thickener; tissue softener

ALTERNATIVES: Ammonium chloride; calcium chloride; sodium lactate; magnesium sulphate

FOOD SAFETY ISSUES: Human poison by ingestion. Poison experimentally by ingestion, intravenous and intraperitoneal routes; moderately toxic by subcutaneous route. Human systemic effects by ingestion include nausea, blood clotting changes, cardiac arrhythmias. Also an eye irritant. Mutagenic data available. TSCA (Toxic Substances Control Act) listed. Explosive reaction with BrF_3; sulphuric acid + potassium permanganate. When heated to decomposition, will emit toxic fumes of K_2O and Cl^-

LEGISLATION:

USA:
FDA 21 CFR 150.141, 150.161, 166.110: approved for use in margarine
21 CFR 182.5622: approved for use in foods as dietary supplement at GRAS quantities
Preparations containing >100 mg potassium/tablet or >20 mg potassium/mL regulated as drugs
21 CFR 184.1622: approved for use in foods as flavour enhancer, flavouring agent, nutrient supplement, pH control agent, stabiliser, thickener at GRAS quantities
GRAS when used in accordance with GMP
Preparations containing ≥100 mg of potassium per tablet are drugs covered by 21 CFR 201.306, USDA 9 CFR 318.7
USDA 9 CFR 381.147: limitation of not more than 3% of a 2.0 molar solution
A solution of the approved inorganic chlorides injected into or applied to raw meat cuts shall not result in a gain of more than 3% above the weight of the untreated product

UK and EUROPE:
Europe: listed
UK: approved for use
EEC Regulations (E508): approved for use as gellant, salt substitute, dietary supplement in malting process for beer making

CANADA:
Approved for use as the following: pH-adjusting or water-correcting agent in brewing at GMP levels; yeast food for brewing and unstandardised bakery products at GMP levels; emulsifying, gelling, stabilising or thickening agent for unstandardised foods at GMP levels.
DSL (Canadian Provisional Domestic Substance List)

AUSTRALIA/PACIFIC RIM:
Japan: approved for use

REFERENCES:

www.medicinescomplete.com/mc/merck/current. Merck Index Online. Accessed 5–6 September 2009.
Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York.
Lewis, R.J. Sr (1989) *Food Additives Handbook*. Van Nostrand Reinhold, New York.
Shmuel, Y. (ed.) (2004) *Dictionary of Food Compounds with CD-ROM: Additives, Flavors and Ingredients*. Chapman & Hall/CRC, USA.

ANY OTHER RELEVANT INFORMATION:

Manufacturer/Distributor: Aldrich; Alfa Chem; Ashland; Asiamerica Int'l; Fluka; Magnesia GMBH; Sigma; Univar Ltd; Vopak USA

Storage: hygroscopic, store at room temperature

NAME:	Potassium glutamate		
CATEGORY:	Flavour enhancer		
FOOD USE:	Meat		
SYNONYMS:	CAS 19473-49-5 (monohydrate)/EINECS/ELINCS 363-737-7 (monohydrate)/INS622/E622/Monopotassium salt/Monopotassium L-glutamate (FCC)/MPG/Potassium glutamate/Monopotassium glutaminate/Potassium hydrogen L-glutamate/L-glutamic acid/Potassium L-glutamate		
FORMULA:	$KOOCCH_2CH_2CH(NH_2)COOH \cdot H_2O$ (monohydrate)		
MOLECULAR MASS IN Daltons:	185.24 (anhydrous); 203.24 (monohydrate)		
ALTERNATIVE FORMS:	Monosodium glutamate/Monoammonium glutamate/Monopotassium glutamate/Ammonium glutamate		
PROPERTIES AND APPEARANCE:	White, free-flowing, hygroscopic crystalline powder; practically odourless. Freely soluble in water; slightly soluble in alcohol		
FUNCTION IN FOODS:	Flavour enhancer; salt substitute; nutrient; dietary supplement; replenisher		
ALTERNATIVES:	Monosodium glutamate; monopotassium glutamate; monoammonium glutamate; ammonium glutamate; disodium inosinate; disodium guanylate; L-glutamic acid		
FOOD SAFETY ISSUES:	Mildly toxic by ingestion and possibly other routes. Human systemic effects by ingestion: headache. TSCA (Toxic Substances Control Act) listed. When heated to decomposition, will emit toxic fumes of K_2O and NO_x		
LEGISLATION:	**USA:** FDA 21 CFR 182.1516: GRAS when used at a level not in excess of the amount reasonably required to accomplish the intended effect	**UK and EUROPE:** Europe: listed UK: approved for use EEC Regulations (E622): approved for use as flavour enhancer, salt substitute	**AUSTRALIA/PACIFIC RIM:** Japan: approved for use as flavouring

REFERENCES:

Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York.
Lewis, R.J. Sr (1989) *Food Additives Handbook*. Van Nostrand Reinhold, New York.

ANY OTHER RELEVANT INFORMATION:

Manufacturer/Distributor: Ajinomoto USA., Inc., 500 Frank W. Burr Blvd., Teaneck, NJ 07666, USA. Tel (201) 448-1212; Fax (201) 488-6282 (NJ Head Office); Degussa; Fluka; Napp Tech; RTD Hallstar; Sigma; Spectum Quality Prods; Voigt Global Distributors
Storage: hygroscopic

NAME:	Potassium lactate
CATEGORY:	Flavour enhancer
FOOD USE:	Confectionery/Jams/Jellies/Marmalades/Margarine
SYNONYMS:	CAS 996-31-6/EINECS/ELINCS 213-631-3; 288-752-8/INS326/E326/Potassium-L-2-hydroxypropionate/ Propanoic acid/2-Hydroxy-monopotassium salt/Arlac P/Purasal®P/USP 60
FORMULA:	$CH_3CHOHCOOK$
MOLECULAR MASS IN Daltons:	128.17
ALTERNATIVE FORMS:	Potassium-L-2-hydroxypropionate/2-Hydroxy-monopotassium salt/Propanoic acid
PROPERTIES AND APPEARANCE:	White solid, odourless, hygroscopic. Potassium salt of lactic acid
FUNCTION IN FOODS:	Direct food additive; flavour enhancer; flavouring agent; flavouring adjuvant; humectant; pH control agent; antioxidant synergist; antimicrobial (meat and poultry products); adjuvant
FOOD SAFETY ISSUES:	When heated to decomposition, will emit acrid smoke and irritating fumes; eye irritant; TSCA (Toxic Substances Control Act) listed
LEGISLATION:	**USA:** FDA 21 CFR 184.1639: affirmed as GRAS for use as flavour enhancers, flavouring agent/ adjuvant, humectant, pH control agent Not authorised for infant foods and infant formulas **CANADA:** DSL (Canadian Provisional Domestic Substance List) **UK and EUROPE:** Europe: listed UK: approved for use EEC Regulation (E326): approved for use in synergism with antioxidants and as buffer with no specified limits for ADI
REFERENCES:	Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York. Lewis, R.J. Sr (1989) *Food Additives Handbook*. Van Nostrand Reinhold, New York.

ANY OTHER RELEVANT INFORMATION:

Manufacturers/Distributors: AB R Lundberg; Degussa AG/Health & Nutrition; FBC Ind.; Ferro Pfanstiehl Europe; GFS; Generichem; Integra; Lohmann; PURAC Am; Premium Ingred.; Reliable Biopharmeceutical; Universal Preserv-A-Chem; Vopack USA; Eilke Int'l

Storage: hydroscopic substance, store in dry area

Trade names: Arlac P; Galaflow PL60

NAME:	Sodium alginate/Algin
CATEGORY:	Flavour enhancer/Hydrophilic polysaccharide
FOOD USE:	Candy (hard)/Condiments/Confections/Edible films/Frostings/Fruit juices/Fruits (processed)/Gelatins/Puddings/Relishes/Sauces/Toppings/Ice-cream (as stabiliser)/Boiler water additive
SYNONYMS:	Alginate, sodium salt/Alginic acid, monosodium salt/Alginic acid, sodium salt/Algin (polysaccharide)/CAS 9005-38-3/FEMA 2014, 2015/INS 401/E401/Algin/Alginate KMF/Algin (polysaccharide)/Algipon L-1168/Amnucol/Antimigrant C45/Cecalgine TBV/Cohasal-1H/Dariloid Q/Dariloid QH/Duckalgin/Halltex/K′-algiline/Kelco gel LV/Kelco HV/Kelcosol/Kelgin F/Kelgin HV/Kelgin LV/Kelgin MV/Kelgin QL/Kelgin XL/Kelgum/Kelset/Kimitsu/Kimitsu Algin 1–2/Kimitsu 1–3/Kelvis/Kelsize/Keltex/Keltone/Keltone LV/Keltone HV/Lamitex/Manucol/Manucol DM/Manucol LB/Manucol DMF/Manucol DH/Manugel GHB/Manugel GMB/Manugel DJX/Manugel DMB/W-300 FG/Manutex/Meypralgin R/LV/Minus/Mosanon/Nouralgine/OG1/Pectalgine/Proctin BUS/Prime F-25/Prime F-40/Prime F-400/Prime F-600/Protacell 8/Protanal 686/Protanal HF120M/Protanal HFC60/Protanal KC 119/Protanal KP/Protanal KPM/Protanal LF 5/60/Protanal LF 20/Protanal LF 20/40/Protanal LF 60/Protanal LF 120M/Protanal LF 200/Protanal LFS 40/Protanal SF 40/Protanal SF 60/Protanal SF 120/Protanal SF 120M/Protanal SP 5H/Protanal VK 687/Protanal VK 749/Protanal VK 805 IMP/Protanal VK 990/Protanal VK 998/Protanal VPM/Protanal VSM/Protatek/Snow algin H/Solberg FD 100 Range/Sodium alginate HV NF/FCC/Sodium alginate LV/Sodium alginate LVC/Sodium alginate MV NF/FCC/Sodium polymannuronate/Stipine/Tagat/Tragaya
FORMULA:	$(C_6H_7O_6Na)n$
MOLECULAR MASS IN Daltons:	198.11
PROPERTIES AND APPEARANCE:	Sodium salt of alginic acid. Colourless to slightly yellow filamentous or granular solid or powder; odourless and tasteless. In water, it forms a viscous colloidal solution. Insoluble in ether, alcohol/hydroalcoholic solutions where alcohol content is >30% w/w, chloroform, and in aqueous solution when pH is below 3. Decomposes on heating above 150°C
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.59 kg/L
FUNCTION IN FOODS:	Boiler water additive; emulsifier; firming agent; flavour enhancer; formulation aid; processing aid; stabiliser; surface-active agent; texturiser; thickener

TECHNOLOGY OF USE IN FOODS: Long-term viscosity is poor when pH is above 10. Use in ice-cream manufacturing to stabilise colloid, ensure creamy texture and prevent the growth of ice crystals. Also used as suspending agent in soft drinks

ANTAGONISTS: Incompatible with divalent cations (except magnesium) or other heavy metal ions, cationic quaternary amines, or chemicals which cause alkaline degradation or acid precipitation. Can be avoided by use of sequestrants or careful pH control

FOOD SAFETY ISSUES: Poison by intravenous and intraperitoneal routes. Causes blood haemorrhage in mice; TSCA (Toxic Substances Control Act) listed. When heated to decomposition, will emit toxic fumes of Na_2O

LEGISLATION:

USA:
FDA 21 CFR 133.133, 133.134, 33.162, 133.178, 133.179, 1150.141, 150.161, 173.310, 21 CFR 184.1724: approved for use in foods as texturiser, formulation aid, stabiliser, thickener, firming agent, flavour enhancer, flavour adjuvant, emulsifier, processing aid, surface-active agent at GRAS quantities
GRAS: with limitation of
1.0% in condiments and relishes except pimento ribbon for stuffed olives
6.0% in confections and frostings
4.0% in gelatins, puddings
10.0% in hard candy
2.0% in processed fruits and fruit juices
1.0% in all other foods when used in accordance with GMP

UK and EUROPE:
Europe: listed
UK: approved for use
EEC Regulations (E401): approved for use as stabiliser, suspending agent, thickener, calcium source, gellant, copper firming agent in brewing
ADI limited to 0–50 mg/kg body weight

CANADA:
Permitted for use in the following:
as emulsifying, gelling, stabilising, or thickening agent in brewing and salad dressings at GMP levels in infant formula at 0.03% as consumed in combination with carrageenan or guar gum, but total should not exceed 0.03%
DSL (Canadian Provisional Domestic Substance List)

AUSTRALIA/PACIFIC RIM:
Japan: approved for use as thickener, stabiliser, gelling agent

REFERENCES:

www.medicinescomplete.com/mc/merck/current. Merck Index Online. Accessed 5–6 September 2009.
Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York.
Lewis, R.J. Sr (1989) *Food Additives Handbook*. Van Nostrand Reinhold, New York.

ANY OTHER RELEVANT INFORMATION:

Manufacture/Distributor: Kelco Division of Merck & Co. Inc., 8355 Aero Drive, San Diego, CA 92123, USA. Tel (800) 535-2656; Fax (619) 467-6520; Telex 695228

AB R Lundberg; Ashland; Degussa AG/Health & Nutrition; Fluka; Frutarom; Ruger; Sigma; Univar Ltd; Vopak USA

Trade names: KIMICA Algin I-3

NAME:	Sodium lactate
CATEGORY:	Flavour enhancer
FOOD USE:	Biscuits/Fruits/Meat products/Hog carcasses/Trip/Vegetable/Nuts/Sponge cake/Swiss roll/Water (canned)/Water (bottled)
SYNONYMS:	Arlac S/Patlac NAL/CAS 72-17-3/Per-glycerin/INS325/E325/EINECS/ELINCS 200-772-0/Lacolin/2-hydroxypropanoic acid monosodium salt/Lactic acid sodium salt/Sodium-L-2-hydroxypropionate/Purasal S/SP 60/Lactic acid, monosodium salt
FORMULA:	$CH_3CHOHCOONa$
MOLECULAR MASS IN Daltons:	112.07
ALTERNATIVE FORMS:	Potassium lactate/Calcium lactate
PROPERTIES AND APPEARANCE:	Sodium salt of lactic acid. Colourless or yellowish syrupy liquid; odourless; slight salt taste. Very hygroscopic; miscible in water and alcohol. Combustible; decomposes at 140°C. Anionic
MELTING RANGE IN °C:	17
FUNCTION IN FOODS:	Cooked-out juice retention aid; corrosion preventative; denuding agent; emulsifier; flavour enhancer; flavouring agent/adjuvant; food additive; glycerol substitute; hog scald agent; humectant; lye peeling agent; pH control agent; washing agent; antioxidant synergist; bulking agent in foods; antimicrobial (meat and poultry); preservative; adjuvant
ALTERNATIVES:	Potassium lactate; calcium lactate
FOOD SAFETY ISSUES:	Moderately toxic by intraperitoneal route; eye irritant. TSCA (Toxic Substances Control Act) listed. When heated to decomposition, will emit toxic fumes of Na_2O
LEGISLATION:	**USA:** FDA 21 CFR 184.1768: affirmed as GRAS for use as emulsifier, flavour enhancer, flavouring agent or adjuvant, humectant, and pH control **CANADA:** Approved for use as pH-adjusting or water-correcting agent for margarine and unstandardised foods in accordance with GMP DSL (Canadian Provisional Domestic Substance List)

Not permitted for infant food and infant formulas
USDA 9 CFR 318.7: in meat products, where allowed, limitation of 5% of phosphate in pickle at 10% pump level; 0.5% of phosphate in product (only clear solution may be injected into product)

AUSTRALIA/PACIFIC RIM:
Japan: approved for use as acidity regulator, food acid, flavouring

UK and EUROPE:
Europe: listed
ECC Regulation (E325): approved for use as humectants, glycerol substituted, body agent, and in synergism with antioxidants
No specified ADI limit
UK: approved for use

REFERENCES:

www.medicinescomplete.com/mc/merck/current. Merck Index Online. Accessed 5–6 September 2009.
Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York.
Lewis, R.J. Sr (1989) *Food Additives Handbook*. Van Nostrand Reinhold, New York.

ANY OTHER RELEVANT INFORMATION:

Manufacturer/Distributor: ADM Food Additives Division, 4666 Faries Parkway, Decatur, IL 62526, USA. Tel (217) 424-5387; Fax (217) 424-2473.

Others: AB R Lundberg; Asiamerica Int'l; EMD Chems; J.T. Baker; Spectrum Quality Prods.; Thomas Scientific; VMR Int'l; Voigt Global Distrib.; Vopak USA; Wilke Int'l

Trade names: Arlac S; Purasal® S/SP60

NAME:	Succinic acid
CATEGORY:	Flavour enhancer/Decarboxylic acid
FOOD USE:	Beverages/Condiments/Meat products/Relishes/Sausages (hot)
SYNONYMS:	CAS 110-15-6/EINECS/ELINCS 203-740-4/INS363/E363/FEMA 3044/Asuccin/Amber/Amber acid/ Bernsteinsaure (German)/Butanedioic acid/1,2-Ethanedicarboxylic acid/Ethylenesuccinic acid/ 1,4-Butanedioic acid/Wormwood/Wormwood acid
FORMULA:	$HOOCCH_2CH_2COOH$
MOLECULAR MASS IN Daltons:	118.10
ALTERNATIVE FORMS:	Potassium succinate/Potassium salt trihydrate
PROPERTIES AND APPEARANCE:	Colourles or white crystals, monoclinic prisms; odourless with sour acid taste. Soluble in water (77 g/L); very soluble in alcohol, ether, acetone, glycerin; practically insoluble in benzene, carbon disulphide, carbon tetrachloride, petroleum ether. Decomposes at 235°C. Combustible
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760mmHg):	235
MELTING RANGE IN °C:	185–187
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.564

SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:

1 g dissolves in:	13 mL cold water	18.5 mL alcohol	36 mL acetone	113 mL ether	1 mL boiling water	6.3 mL methanol	20 mL glycerol

FUNCTION IN FOODS:	Flavour enhancer; miscellaneous and general-purpose food chemical; neutralising agent; pH control agent; sequestrant; buffer
ALTERNATIVES:	Malic acid; tannic acid; L-tartaric acid; lactic acid
TECHNOLOGY OF USE IN FOODS:	The pH of a 0.1M aqueous solution is 2.7

FOOD SAFETY ISSUES:

Moderately toxic by subcutaneous route; a severe eye irritant. Primary irritant; mutagen; TSCA (Toxic Substances Control Act) listed. When heated to decomposition, will emit acrid smoke and irritating fumes

LEGISLATION:

USA:

FDA 21 CFR 131.144

FDA 21 CFR 184.1091: approved for use in foods as flavour enhancer, pH control agent at GRAS quantities

GRAS: with limitation of 0.084% in condiments and relishes; 0.0061% in meat products when used in accordance with GMP

UK and EUROPE:

Europe: listed

UK: approved for use

EEC Regulations (E363): approved for use as acidulant, buffer, neutraliser

AUSTRALIA/PACIFIC RIM:

Japan: approved for use as acidity regulator, food acid, flavouring

REFERENCES:

www.medicinescomplete.com/mc/merck/current. Merck Index Online. Accessed 5–6 September 2009.

Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York.

Lewis, R.J. Sr (1989) *Food Additives Handbook*. Van Nostrand Reinhold, New York.

Shmuel, Y. (ed.) (2004) *Dictionary of Food Compounds with CD-ROM: Additives, Flavors and Ingredients*. Chapman & Hall/CRC, USA.

ANY OTHER RELEVANT INFORMATION:

Manufacturer/Distributor: Aldrich; Boith China; Degussa AG/Health & Nutrition; Fluka; KIC Chem; Sigma; Takeda Vitamin & Food USA; VWR Int'l; Voigt Global Distrib

Storage at room temperature. Widely distributed in higher plants and produced by microorganisms. Present in cheese and fresh meat

NAME:	Sucralose
CATEGORY:	Flavour enhancer
FOOD USE:	Beverages/Processed foods
SYNONYMS:	CAS 56038-13-2/INS955/1,6-Dichloro-1,6-dideoxy-β-D-fructofuranosyl-4-chloro-4-deoxy-α-D-galactopyranoside/4,1′,6′-Trichlorogalactosucrose/4′,1′,6′-Trichloro-4,1′,6′-trideoxy-galacto-sucrose/TGS
FORMULA:	$C_{12}H_{19}C_{13}O_8$
MOLECULAR MASS IN Daltons:	397.64
PROPERTIES AND APPEARANCE:	Chlorinated sucrose derivative with enhanced sweetness (600 times sweeter than sucrose). White crystalline powder; odourless; sweet taste. Soluble in water, methanol, alcohol; slightly soluble in ethyl acetate. A non-caloric sweetener with good taste
MELTING RANGE IN °C:	130
FUNCTION IN FOODS:	Non-nutritive sweetener; flavour enhancer in processed foods, beverages
ALTERNATIVES:	Aspartame; ethyl maltol; glycine; thaumatin; ammoniated glycyrrhizin
FOOD SAFETY ISSUE:	LD_{50} (unreported in mouse) > 16 g/kg
LEGISLATION:	**CANADA:** Approved for use as sweetener and flavour enhancer in the following at the levels specified: tabletop sweetener (GMP); breakfast cereal, 0.1%; beverages (concentrates and mixes) and desserts, 0.025%; chewing gum, breath freshener and table syrups, 0.15%; salad dressing, condiments and puddings, 0.04%; fruit spreads, 0.045%; confectionery and alcoholic beverages, 0.07%; baking mixes and bakery products, 0.065% as consumed; processed fruit and vegetable products, 0.015% **USA:** FDA 21 CFR 172.831 **AUSTRALIA/PACIFIC RIM:** Also permitted for use (1991) in Australia, Russia, Romania and Mexico

REFERENCES:

www.medicinescomplete.com/mc/merck/current. Merck Index Online. Accessed 5–6 September 2009.
Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York.
Lewis, R.J. Sr (1989) *Food Additives Handbook*. Van Nostrand Reinhold, New York.
Shmuel, Y. (ed.) (2004) *Dictionary of Food Compounds with CD-ROM: Additives, Flavors and Ingredients*. Chapman & Hall/CRC, USA.

ANY OTHER RELEVANT INFORMATION:

Manufacturer/Distributor: Redpath Specialty Products, 95 Queen's Quay East, Toronto, Ontario, Canada M5E 1A3. Tel (800) 267-1517
Others: CarboMer; Sigma
Trade name: Splenda®

NAME:	Tannic acid
CATEGORY:	Flavour enhancer
FOOD USE:	Apple juice/Baked goods/Beer/Candy (hard)/Candy (soft)/Cough drops/Fats (rendered)/Fillings/Frozen dairy desserts and mixes/Gelatins/Meat products/Non-alcoholic beverages/Puddings/Wine
SYNONYMS:	CAS 1401-55-4; 72401-53-7/EINECS/ELINCS 276-638-0/EINECS/ELINCS 215-753/FEMA 3042/INS 181/ Tannin/D'acid tannique (French)/Gallotannic acid/Gallotannin/Glycerite
FORMULA:	$C_{76}H_{52}O_{46}$
MOLECULAR MASS IN Daltons:	1701.28
PROPERTIES AND APPEARANCE:	Occurs in the bark and fruit of many plants (e.g. oak species, sumac). Yellowish-white or light-brown amorphous, bulky powder or flakes or spongy masses; faint characteristic odour with astringent taste. Gradually darkens on exposure to air and light. Decomposes at 210–215°C. Very soluble in water, alcohol, acetone; almost insoluble in benzene, chloroform, ether, petroleum ether, carbon disulphide, carbon tetrachloride
MELTING RANGE IN °C:	200
FLASH POINT IN °C:	199 (open cup); autoignition temperature: 527
FUNCTION IN FOODS:	Boiler water additive (food contact); clarifying agent (for beer and wine); fat rendering aid; flavouring agent; flavouring enhancer; pH control agent; colorant; emulsifier; stabiliser; thickener; processing aid
ALTERNATIVES:	Malic acid; succinic acid; L-tartaric acid; lactic acid
TECHNOLOGY OF USE IN FOODS:	Keep in tightly closed container and protected from light. 1 g of additive will dissolve in 0.35 mL of water, 1 mL of warm glycerol. Use in clarification of beer or wine
ANTAGONISTS:	Incompatible with salts of heavy metals, alkaloids, gelatin, albumin, starch, oxidising substances (e.g. permanganates, chlorates), spirit nitrous ether, lime water. Will produce insoluble precipitates. Produces bluish-black colour precipitate with ferric salts
FOOD SAFETY ISSUES:	Poison by ingestion, intramuscular, intravenous and subcutaneous routes; moderately toxic by parenteral route. An experimental carcinogen and tumorigen; also experimental reproductive effects. Mutagenic data available. TCSA (Toxic Substances Control Act) listed. Combustible when exposed to heat or flame; to fight fire, use water. When heated to decomposition, will emit acrid smoke and irritating fumes

LEGISLATION:

USA:

FDA 21 CFR 173.310: approved for use as boiler water additive

FDA 21 CFR 184.1097: approved for use in foods as flavouring agent, flavouring adjuvant, flavour enhancer, processing aid, pH control agent at GRAS quantities

GRAS: with limitation of
- 0.01% in baked goods
- 0.015% in alcoholic beverages
- 0.005% in non-alcoholic beverages and for gelatins, puddings, and fillings
- 0.04% in frozen dairy desserts and mixes
- 0.04% in soft candy
- 0.013% in hard candy and cough drops
- 0.001% in meat products

when used in accordance with GMP

USDA 9 CFR 318.7: sufficient for purpose

BATF 27 CFR 240.1051: limitation of 3.0 g/L calculated as gallic acid equivalents (GAE) in apple juice or wine; limitation of 0.8 g/L in white wine and 0.3 g/L in rosé wine

CANADA:

Approved for use as the following: fining agent in cider, honey wine, wine (200 ppm); to reduce adhesion in chewing gum at GMP levels

UK AND EUROPE:

UK: not permitted for use in food

REFERENCES:

www.medicinescomplete.com/mc/merck/current. Merck Index Online. Accessed 5–6 September 2009.

Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York.

Lewis, R.J. Sr (1989) *Food Additives Handbook*. Van Nostrand Reinhold, New York.

Shmuel, Y. (ed.) (2004) *Dictionary of Food Compounds with CD-ROM: Additives, Flavors and Ingredients*. Chapman & Hall/CRC, USA.

ANY OTHER RELEVANT INFORMATION:

Manufacturer/Distributor: Ashland; CarboMer; Degussa AG/Health & Nutrition; Ruger; Sigma; VMR Int'l; Voige Global Distributor; Vopak USA; Xin Chem

Storage: keep well closed, protect from light

NAME:	L-Tartaric acid
CATEGORY:	Flavour enhancer
FOOD USE:	Baking powder/Effervescent beverages (grape and lime flavoured)/Jellies (grape flavoured)/Poultry/Wine/Baked goods/Gelatin desserts/Pharmaceuticals (i.e. effervescent salts)/Cream of Tartar
SYNONYMS:	CAS 87-69-4/EINECS 201-766-0/FEMA 3044/INS334/E334/2,3-Dihydrosuccinic acid/2,3-Dihydroxybutanedioic acid/L-(+)-tartaric acid/L-2,3-Dihydroxybutanedioic acid/α,β-Dihydroxysuccinic acid/Weinsteinsaure (German)/Dextrotartaric acid/Dihydroxysuccinic acid/Dihydroxybutanedioic acid/Succinic acid, 2,3-dihydroxy-/3 Hydroxymalic acid/Malic acid, 3-hydroxy-1 Tartaric acid (INCI)/Thearic acid
FORMULA:	COOH-CHOH-CHOH-COOH
MOLECULAR MASS IN Daltons:	150.10
PROPERTIES AND APPEARANCE:	Colourless to translucent crystals or white powder; odourless with a strong acid taste; effervescent; stable to air and light. Soluble in water, alcohol, glycerin; partly soluble in ether; insoluble in chloroform. Occurs in juice of grapes and few other fruits and plants (i.e. leaves of *Bauhinia reticulata*). Residues of wine industry, not as widely distributed as citric or malic acid. When heated to melting point has odour of burnt sugar
MELTING RANGE IN °C:	168–170
DENSITY AT 20°C (AND OTHER: TEMPERATURES) IN g/L	1.0045 (1%, 15/4°C)
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 139 g/100 mL **@ 50°C** 195 g/100 mL **@ 100°C** 343 g/100 mL
in ethanol solution (100%)	**@ 18°C** 20.4 g/100 g
FLASH POINT IN °C:	210 (open cup)
FUNCTION IN FOODS:	Direct food additive; acidulant; firming agent; flavour enhancer; flavouring agent; humectant; pH control agent; sequestrant; dough conditioner; to correct acid deficiency in wine making during poor harvest years; antioxidant synergist; used in leavening systems (i.e. baking powder); stabiliser; chelating agent; used in soft drink, confectionery products and gelatin desserts as an acidulant

ALTERNATIVES:

Malic acid (as acidulant in carbonated beverages); citric acid; phosphoric acid; fumaric acid; succinic acid; tannic acid; lactic acid

TECHNOLOGY OF USE IN FOODS:

1 g of additive will dissolve in the following: 0.75 mL water at room temperature; 0.5 mL boiling water; 1.7 mL methanol; 3 mL ethanol; 10.5 mL propanol; 250 mL ether. Used to enhance the natural and synthetic fruit flavoured drinks and candies

FOOD SAFETY ISSUES:

Strong organic acid. Reacts with silver to produce unstable silver tartrate. Moderately toxic by intravenous route; mildly toxic by ingestion. Strong solutions are mildly irritating to humans. May cause convulsions, somnolence, haemorrhage. When heated to decomposition, will emit acrid smoke and irritating fumes. TSCA (Toxic Substances Control Act) listed

LEGISLATION:

USA:

FDA 21 CFR 150.161, 150.141, 131.144, 184.1099: approved for use in foods as firming agent, flavour enhancer, flavouring agent/adjuvant, processing aid, pH control agent at GRAS quantities

GRAS when used in accordance with GMP

USDA 9 CFR 318.7

USDA 9 CFR 381.147: sufficient for purpose

BATF 27 CFR 240.1051: use as prescribed in 27 CFR 240.364, 240.512

BATF 27 CFR 240.364, 240.512

UK and EUROPE:

Europe: listed

UK: approved for use (in wine)

EEC Regulations (E334): approved for use at ADI of 0–30 mg/kg body weight

CANADA:

Approved for use in the following: as Class IV preservative for fats and oils and unstandardised foods at GMP level; as pH-adjusting or water-correcting agent at GMP levels

AUSTRALIA/PACIFIC RIM:

Japan: approved for use

REFERENCES:

www.medicinescomplete.com/mc/merck/current. Merck Index Online. Accessed 5–6 September 2009.

Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York.

Lewis, R.J. Sr (1989) *Food Additives Handbook*. Van Nostrand Reinhold, New York.

Shmuel, Y. (ed.) (2004) *Dictionary of Food Compounds with CD-ROM: Additives, Flavors and Ingredients*. Chapman & Hall/CRC, USA.

ANY OTHER RELEVANT INFORMATION:	Manufacturer/Distributor: Browning Chemical Corporation, 707 Westchester Avenue, White Plains, NY 10604-3104, USA. Tel (914) 686-0300; Fax (914) 686-0310; Telex 23 5039 AB R Lundberg; AMC Chems; AMRESCO; Ashland; Asiamerica Int'l; Changzhou Changmao Biochem; EM Chem; Fluka; Takeda Vitamins & Food USA; Thomas Scientific; Vopak USA

NAME:	Thaumatin
CATEGORY:	Flavour enhancer/Protein
FOOD USE:	Chewing gum/Dairy products/Animal feeds/Pet foods
SYNONYMS:	CAS 53850-34-3/FEMA 3732/INS957/E957/Katemfe/Talin
MOLECULAR MASS IN Daltons:	21 000–22 000
PROPERTIES AND APPEARANCE:	Sweet-tasting basic protein extracted from the fruit of the tropical plant *Thaumatococcus danielli*. 750–1600 times sweeter than sucrose on weight basis; 30 000–100 000 times sweeter than sucrose on a molar basis. Licorice aftertaste; strongly cationic. Relatively stable in solution and on heating. Non-carcinogenic; favourable gestatory properties. Talin is extremely soluble in water; soluble in ethanol, propanol-2, glycerol and propylene glycol; insoluble in acetone, ether and toluene
FUNCTION IN FOODS:	Flavour enhancement of sweetness and certain flavour compounds (i.e. peppermint, ginger, cinnamon and coffee). Reduces fiery, peppery, or bitter elements associated with certain flavour compounds (i.e. peppermint, ginger, cinnamon and coffee). Non-nutritive sweetener. Savoury flavour; taste modification; masking of bitter and unpleasant taste of metallic ions (i.e. sodium, iron and potassium). Flavour enhancer for coffee and peppermint flavour
ALTERNATIVES:	For the licorice aftertaste and flavour enhancement associated with thaumatin: licorice root; licorice root extract; ammoniated glycyrrhizin For the sweetness potency and flavour enhancement associated with thaumatin: sucralose; aspartame; ethyl maltol; glycine
TECHNOLOGY OF USE IN FOODS:	Protein loses sweetness on heating, on splitting of disulphide bridges and also at pH <2.5; 0.9 g of thaumatin produces sweetness equivalent to 1.5 kg of sugar. Hence the importance of the tertiary structure for the sweetness Temperature affects the sweetness of thaumatin, but will depend on the concentration, presence of oxygen, salts or polyelectrolytes, and pH. Irreversible thermal denaturation occurs at 75°C and pH 5; 55°C and pH 3.0; 65°C and pH 7.2 Talin can be used in chewing gum, 50–150 mg/kg; in soft drinks, 10–15 mg can substitute 20–30% of sucrose. Can also be used in gelatin-based confectionery and tobacco flavour, coffee and tea. Also successfully masks the unpleasant taste of drugs in medicinal applications. Talin is stable at pH 2–10; thermal stability is affected mainly

by pH, presence of oxygen, and other soluble matter, especially polysaccharides. Talin can be pasteurised or UHT-sterilised in non-alcoholic beverages at pH 2.8–3.5

Thaumatin is also combined with saccharin and L-glucose, with xylitol and others. Thaumatin admixed with glycyrrhizin and amino acids is marketed in Japan as San Sweet T-1 and T-100. It will remain stable indefinitely when freeze-dried or spray-dried, if stored under ambient conditions. It will also remain stable at 120°C in canning operations and under pasteurisation and UHT conditions. Thaumatin will impart licorice-like taste at higher levels; therefore, its use as the only source of sweetness is limited to applications where the required sweetness is less than the equivalent of 10% sucrose. Potential low-calorie sweetener

SYNERGISTS:

Synergistic with saccharin, acesulfame-K. Talin, when used with either sucrose or acesulfame-K or stevioside, showed some degree of synergism. Thaumatin also synergises with monosodium glutamate and 5′-nucleotides to increase the flavour enhancement

FOOD SAFETY ISSUES:

No adverse effects in short-term tests. Not allergenic, mutagenic or teratogenic

LEGISLATION:

USA:
Permitted in USA for use as flavour enhancer in chewing gum

CANADA:
Approved for use as follows: as sweetener and flavour enhancer in chewing gum and breath freshener products at 500 ppm; as bitterness masking agent in salt substitutes at 400 ppm; as flavour enhancer and unstandardised flavour preparations at 100 ppm

UK and EUROPE:
UK: approved for use
Permitted in EU at 50–400 ppm in chewing gum, vitamin preparations and some other sugar-free products

AUSTRALIA/PACIFIC RIM:
Japan: approved for use and considered as a natural food

OTHER COUNTRIES:
World Health Organization: ADI not specified

REFERENCES:

www.medicinescomplete.com/mc/merck/current. Merck Index Online. Accessed 5–6 September 2009.
Anonymous (1996) Thaumatin: the sweetest substance known to man has a wide range of food applications. *Food Technology* **50**, 74–75.
Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York.
Lewis, R.J. Sr (1989) *Food Additives Handbook*. Van Nostrand Reinhold, New York.
Krutosikova, A. and Uher, M. (1992) *Natural and Synthetic Sweet Substances*. Ellis Horwood, New York.

ANY OTHER RELEVANT INFORMATION:

Manufacturer/Distributor: Kaden Biochems; Research Organix
Trade name: Talin®

Part 7

Flour Additives

Gordon R. Carson

This Part is based upon the First Edition contribution of Catriona Crawford

Food Additives Data Book, Second Edition. Edited by Jim Smith and Lily Hong-Shum.

NAME:	Acetone peroxide
CATEGORY:	Flour additive
FOOD USE:	Flour/Whole wheat flour/Bread
SYNONYMS:	Triacetone triperoxide (TATP)/Peroxyacetone/CAS 17088-37-8
FORMULA:	$C_9H_{18}O_6$ (trimer)
MOLECULAR MASS IN Daltons:	222.24
PROPERTIES AND APPEARANCE:	White crystalline solid
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	160.0 (explosive)
MELTING POINT IN °C:	91.0
DENSITY AT 25°C (AND OTHER TEMPERATURES) IN g/cm^3:	1.22
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	Insoluble in water
FUNCTION IN FOODS:	Bleaching, maturing or dough conditioning agent
ALTERNATIVES:	Chlorine; Benzoyl peroxide; Lipoxidase
TECHNOLOGY OF USE IN FOODS:	Used as a maturing and bleaching agent to improve the baking performance of bread flour. Can be used alone but typically used in conjunction with benzoyl peroxide. Usage level typically 200–400 ppm
FOOD SAFETY ISSUES:	Because of its highly explosive nature and handling safety issues, not widely in food use

LEGISLATION:

USA:
Permitted in flour, bread and rolls (GMP)
21 CFR 178.802

CANADA:
Good manufacturing practice (GMP)
CRC Division 16, Table II A.1

UK and EUROPE:
Not permitted

AUSTRALIA/NZ
Not permitted

REFERENCES:

Kent, N.L. and Evers, A.D. (1994) *Kent's Technology of Cereals*: *An Introduction for Students of Food Science and Agriculture*, 4th edn. Woodhead Publishing, Cambridge, p. 172.

Lide, D.R. (ed.) (2007/2008) *Handbook of Chemistry and Physics*, 88th edn. CRC Press, Boca Raton, FL.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

NAME:	Alpha-amylase
CATEGORY:	Flour Additive/Enzyme
FOOD USE:	Flour/Whole wheat flour/Bread/Breakfast cereals/Products of the brewing industry
SYNONYMS:	CAS 9000-92-4/E1100
FUNCTION IN FOODS:	Fungal and cereal-sourced alpha-amylase acts as a bread improver; it increases loaf volume and oven spring, and improves bread crumb texture. It also enhances the gassing power of breadmaking flour, and is used in the brewing industry in conjunction with other enzymes to hydrolyse starch. Bacterial-sourced alpha-amylase, with its high heat tolerance, is used as an anti-staling aid to enhance the shelf-life of bakery products
TECHNOLOGY OF USE IN FOODS:	The optimum level of addition of fungal and cereal alpha-amylase to breadmaking flour will be based on the level of damage starch induced by milling of the flour. In top patent or all-purpose family type hard wheat flours which are low in starch damage (60–80 Farrand units) commercial amylase preparations (Dohtone-2, Dohtone-3) are generally added at a rate of 1–2 g per 50 kg of flour. Bread or high gluten type hard wheat flours generally employ a higher addition rate of 2–4 g per 50 kg of flour. The functional activity of fungal amylase preparations are usually measured in fungal amylase units (FAU) as opposed to Sandstedt, Kneen and Blish (SKB) units used for barley malt preperations
SYNERGISTS:	Malted barley flour (as a cereal source), hemicellulase
FOOD SAFETY ISSUES:	No safety concerns in food. Because it is an enzyme, possible occupational allergic reactions to prolonged dust exposure in the bakery and flour mills may occur
LEGISLATION:	**USA:** Fungal preparations is permitted in flour and bread Good manufacturing procedure (GMP), 21 CFR Chapter 4, Part 137.105 **CANADA:** Fungal preparations is permitted in flour, bread, 'unstandardised bakery products', various foods. Bacterial preparations are only permitted at the bakery. GMP. CRC Division 16 Table V, A.1 **UK and EUROPE:** UK: Fungal preparations are permitted for general food use including bread and flour Europe: Fungal preparations are permitted *quantum satis* in bread in most EU countries Council Regulation (EU) No. 1332/2008, No. 1493/1999, No. 258/1997 **AUSTRALIA/NZ** Fungal preparations are permitted in bread

REFERENCES:

Chamberlain, N., Collings, T.H. and McDermott, E.E. (1981) Alpha-amylase and bread properties. *Journal of Food Technology* **16**, 127–152.

Hui, Y.H. (2006) Functional additives. In: Corke, H., De Leyn, I., Nip, W.K. and Cross, N. (eds) *Bakery Products Science and Technology*. Blackwell Publishing Ltd., Oxford, chapter 12.

Miller, B.S., Johnson, J.A. and Palmer, D.L. (1953) A comparison of cereal, fungal and bacterial alpha-amylases as supplements for breadmaking. *Food Technology, Chicago* **7**, 38–42.

Palacios, H.R., Schwarz, P.B. and D'Applolonia B.L. (2004) Effect of α-amylases from different sources of the retrogradation and recrystallization of concentrated wheat gels: relationship to bread staling. *Journal of Agricultural and Food Chemistry* **52**, 5978–5986.

Pritchard, P.E. (1992) Studies on the bread-improving mechanism of fungal alpha-amylase. *Journal of Biological Education* **26**, 12–18.

ANY OTHER RELEVANT INFORMATION:

Fungal alpha-amylase for baking is produced from selected strains of *Aspergillus oryzae* var.; *Aspergillus niger* var.

Bacterial alpha-amylase for baking is produced from selected strains of *Bacillus subtilis* var.; *Rhizopus oryzae* var.

NAME:	Ammonium chloride
CATEGORY:	Flour additive
FOOD USE:	Flour/Whole wheat flour
SYNONYMS:	Ammonium muriate/Salmiac/CAS 12125-02-9/E510
FORMULA:	NH_4Cl
MOLECULAR MASS IN Daltons:	53.49
PROPERTIES AND APPEARANCE:	White granular powder
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	520.0
MELTING POINT IN °C:	338.0
DENSITY AT 25°C (AND OTHER TEMPERATURES) IN g/cm^3:	1.5274 (100 kPa)
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 0°C** 22.9 **@ 25°C** 28.3 **@ 80°C** 39.8
FUNCTION IN FOODS:	Yeast food; acidifier; water conditioner
ALTERNATIVES:	Various salts
TECHNOLOGY OF USE IN FOODS:	Used as an acidifier yeast food for flour, whole wheat flour. Typical usage level on flour 500–2000 ppm. May be used in bread up to 2500 ppm on flour portion
FOOD SAFETY ISSUES:	None

LEGISLATION:

USA:
Generally regarded as safe (GRAS), GMP
21 CFR 184.1138

CANADA:
Permitted in flour not exceeding 2000 ppm. Permitted in bread not exceeding 2500 ppm on flour portion
CRC Division B.13.001 (ix), 13.021 (m)

UK and EUROPE:
Not permitted

AUSTRALIA/NZ
Not permitted

REFERENCES:

Fennema, O.R. (ed.) (1996) *Food Chemistry*, 3rd edn. Marcel Dekker, New York, chapter 12.
Lide, D.R. (ed.) (2007/2008) *Handbook of Chemistry and Physics*, 88th edn. CRC Press, Boca Raton, FL.
O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

NAME:	Ammonium persulphate
CATEGORY:	Flour additive
FOOD USE:	Flour/Whole wheat flour/Bread/Unstandardised bakery foods/Brewers yeast
SYNONYMS:	Ammonium peroxydisulfate/CAS 7727-54-0/E923
FORMULA:	$(NH_4)_2S_2O_8$
MOLECULAR MASS IN Daltons:	228.2
PROPERTIES AND APPEARANCE:	White granular powder
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	Not applicable
MELTING POINT IN °C:	120.0
DENSITY AT 25°C (AND OTHER TEMPERATURES) IN g/cm^3:	1.98 (100 kPa)
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 25°C** 83.5
FUNCTION IN FOODS:	Bleaching, maturing and dough conditioning agent
ALTERNATIVES:	Ammonium sulphate; Benzoyl peroxide (bleaching); Potassium persulphate
TECHNOLOGY OF USE IN FOODS:	Oxidising or improving agent used in flour and whole wheat flour at 100–250 ppm. Bread use is up to a level of 100 ppm of flour. Used on unstandardised bakery foods (GMP)
FOOD SAFETY ISSUES:	None known

LEGISLATION:

USA:
Not permitted

UK and EUROPE:
Not permitted

CANADA:
Permitted on flour not to exceed 250 ppm
Permitted in bread not to exceed 100 ppm of flour
Unstandardised bakery foods GMP
CRC Division 16, table II A.2

AUSTRALIA/NZ
Not permitted

REFERENCES:

Anon. (2002) Skin contact reactions to food and spices. In: Brostoff, J. and Challacombe, S.J. (eds) *Food Allergy and Intolerance*, 2nd edn. Elsevier Science, London, chapter 45. Available at http://trove.nla.gov.au/work/9639260.

Lide, D.R. (ed.) (2007/2008) *Handbook of Chemistry and Physics*, 88th edn. CRC Press, Boca Raton, FL.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

NAME:	Ammonium phosphate, monobasic
CATEGORY:	Flour additive/Bakery additive
FOOD USE:	Self-raising flour/Bakery products
SYNONYMS:	Ammonium biphosphate/Ammonium dihydrogen phosphate/Diammonium phosphate/CAS 7783-20-2/E342
FORMULA:	H_6NO_4P
MOLECULAR MASS IN Daltons:	115.03
PROPERTIES AND APPEARANCE:	White crystalline powder
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	Not applicable
MELTING POINT IN °C:	190
DENSITY AT 25°C (AND OTHER TEMPERATURES) IN g/cm^3:	1.80
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	@ 20°C 40
FUNCTION IN FOODS:	Leavening and pH adjustment agent in bread, cakes, cookies and biscuits. Used in cheese starter cultures. Fermentation aid in yeast cultures
ALTERNATIVES:	Calcium phosphate (monobasic)
TECHNOLOGY OF USE IN FOODS:	May be added to flour to supply leavening action for self-raising pastry type flours. Typically used in conjunction with sodium bicarbonate. Used as a pH adjustment and leavening agent in cakes, pastries, muffin type products
FOOD SAFETY ISSUES:	None

LEGISLATION:

USA:
Permitted as direct food substance affirmed as GRAS
21 CFR 184.1141a

CANADA:
Permitted on bread up to 2500 ppm unless accompanied by other ammonium salts
CRC Division B.13.021 (m)

UK and EUROPE:
Not permitted on flour

AUSTRALIA/NZ
Not permitted on flour
Permitted in processed cereal, meals and finished flour products at GMP
Food Standards, Schedule 1, section 6.3, 6.4

REFERENCES:

Burdock, G.A. (1997) *Encyclopedia of Food and Color Additives,* Vol. 1 (A–E). CRC Press, Boca Raton, FL.

Lide, D.R. (ed.) (2007/2008) *Handbook of Chemistry and Physics*, 88th edn. CRC Press, Boca Raton, FL.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

Timm, R.G. (1988) Baking powder: factors affecting its performance. In: Bush, P.B., Clarke, I.R., Kort, M.J. and Smith, M.F. (eds) *Functionality of Ingredients in the Baking Industry*. Natal Technikon Printers, Durban.

NAME:	Ascorbic acid
CATEGORY:	Flour additive
FOOD USE:	Flour/Whole wheat flour/Bread/Unstandardised bakery foods
SYNONYMS:	L-Ascorbic acid/Vitamin C/CAS 50-81-7/E300
FORMULA:	$C_6H_8O_6$
MOLECULAR MASS IN Daltons:	176.12
PROPERTIES AND APPEARANCE:	White or light yellow granular powder
BOILING POINT IN °C AT VARIOUS PRESSURES (including 760 mmHg):	Not applicable
MELTING POINT IN °C:	190–192 (decomposes)
DENSITY AT 25°C (AND OTHER TEMPERATURES) IN g/cm^3:	1.65
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 25°C** 33 **@ 45°C** 40 **@ 100°C** 80
FUNCTION IN FOODS:	Maturing and dough conditioning agent typically added to improve flour and bread. Also used as a antioxidant in beverages
TECHNOLOGY OF USE IN FOODS:	Maturing and dough conditioning agent typically added to flour at 20–200 ppm. Also added to bread and unstandardised bakery foods generally between 40 and 200 ppm. Lower protein bread flours have a typical addition rate of 20–40 ppm, whereas high protein flour, bread and frozen dough addition rates usually between 80 and 180 ppm
FOOD SAFETY ISSUES:	None

LEGISLATION:

USA:
Permitted in flour and bread to a maximum of 200 ppm
21 CFR Chapter 4, Part 137.105

CANADA:
Permitted in flour and bread up to a maximum of 200 ppm
CRC Division 16, table II A.2A

UK and EUROPE:
UK: Permitted in all flour and bread except wholemeal to a maximum of 200 ppm
Council Regulations (EU) No. 141/1998, Schedule 3

AUSTRALIA/NZ
Not permitted on flour
Permitted in processed cereal, meals and finished flour products at GMP
Food Standards, Schedule 1, section 6.3, 6.4

REFERENCES:

Belitz, H.D., Grosch, W. and Schieberle, P. (2004) Wheat flour. In: *Food Chemistry*, 3rd revised edn. Springer-Verlag, Berlin, chapter 15.

Burdock, G.A. (1997) *Encyclopedia of Food and Color Additives*, Vol. 1 (A–E). CRC Press, Boca Raton, FL.

Hui, Y.U. (2006) Functional additives. In: Corke, H., De Leyn, I., Nip, W.K. and Cross, N. (eds) *Bakery Products Science and Technology*. Blackwell Publishing Ltd., Oxford, chapter 12.

Lide, D.R. (ed.) (2007/2008) *Handbook of Chemistry and Physics*, 88th edn. CRC Press, Boca Raton, FL.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

Williams, T. and Pullen, G. (2007) Functional ingredients. In: Cauvain, S.P. and Young, L.S. (eds) *Technology of Breadmaking*, 2nd edn. Springer Science, New York, pp. 51–92.

NAME:	Azodicarbonamide
CATEGORY:	Flour additive
FOOD USE:	Flour/Whole wheat flour/Bread/Unstandardised bakery foods
SYNONYMS:	Azobisformamide/Azodicarboxamide/Diazenedicarboxamide/CAS 123-77-3/E927a
FORMULA:	$C_2H_4O_2N_4$
MOLECULAR MASS IN Daltons:	116.079
PROPERTIES AND APPEARANCE:	Orange/red crystals
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	Not applicable
MELTING POINT IN °C:	212.0 decomposes (flammable)
DENSITY AT 25°C (AND OTHER TEMPERATURES) IN g/cm^3:	1.65
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	Soluble in hot water, insoluble in cold
FUNCTION IN FOODS:	Flour maturing or bread dough conditioning agent
ALTERNATIVES:	Ascorbic acid
TECHNOLOGY OF USE IN FOODS:	Generally used in low levels, 5–15 ppm up to a maximum of 45 ppm
FOOD SAFETY ISSUES:	Can cause sensitisation by dust inhalation. May be linked to the formation of semicarbonamide in bakery products at high usage levels
LEGISLATION:	**USA:** Permitted up to a maximum of 45 ppm on flour and bread 21 CFR Chapter 4, Part 137.105 **CANADA:** Permitted up to a maximum of 45 ppm on flour and bread CRC Division B.13.001 (e) (xi) **UK and EUROPE:** Not permitted **AUSTRALIA/NZ** Not permitted

REFERENCES:

Becalski, A., Lau, B.P., Lewis D. and Seaman, S.W. (2004) Semicarbazide formation in azodicarbonamide treated flour: a model study. *Journal of Agricultural and Food Chemistry* **52**, 5730–5734.

Belitz, H.D., Grosch, W. and Schieberle, P. (2004) Wheat flour. In: *Food Chemistry*, 3rd revised edn. Springer-Verlag, Berlin, chapter 15.

Hui, Y.U. (2006) Functional additives. In: Corke, H., De Leyn, I., Nip, W.K. and Cross, N. (eds) *Bakery Products Science and Technology*. Blackwell Publishing Ltd., Oxford, chapter 12.

Lide, D.R. (ed.) (2007/2008) *Handbook of Chemistry and Physics*, 88th edn. CRC Press, Boca Raton, FL.

Noonan, G.O., Begley, T.H. and Diachenko, G.W. (2008) Semicarbazide formation in flour and bread. *Journal of Agricultural and Food Chemistry* **56**, 2064–2067.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

NAME:	Benzoyl peroxide
CATEGORY:	Flour additive
FOOD USE:	Flour/Whole wheat flour/Vegetable oils
SYNONYMS:	Dibenzoyl peroxide/Acetoxyl/Benzoyl superoxide/CAS 94-36-0
FORMULA:	$(C_6H_5CO)_2O_2$
MOLECULAR MASS IN Daltons:	242.23
PROPERTIES AND APPEARANCE:	Colourless, rhombic crystalline solid
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	Not applicable (explosive)
MELTING POINT IN °C:	103–106 (may decompose when heated)
DENSITY AT 25°C (AND OTHER TEMPERATURES) IN g/cm^3:	1.334
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	Mildly soluble
FUNCTION IN FOODS:	Oxidative agent for bleaching flour and vegetable oils
ALTERNATIVES:	Lipoxidase; Enzymatic active soy flour
TECHNOLOGY OF USE IN FOODS:	Added to flour as a bleaching agent typically in the range 50–100 ppm. Does not affect the rheological characteristics of bread dough unlike chlorine treatment
FOOD SAFETY ISSUES:	Strong irritant to eyes and mucous membranes. Over-exposure may cause sensitisation dermatitis
LEGISLATION:	**USA:** Permitted in flour (GMP) 21 CFR Chapter 4, Part 137.105 **CANADA:** Permitted in flour not exceeding 150 ppm CRC Division B.13.001 (e) (vi) **UK and EUROPE:** Not permitted **AUSTRALIA/NZ** Not permitted

REFERENCES:

Burdock, G.A. (1997) *Encyclopedia of Food and Color Additives*, Vol. 1 (A–E). CRC Press, Boca Raton, FL.

Cauvain, S.P. (2009) Modifications of wheat flour. In: Cauvain, S.P. and Young, L.S. (eds) *The ICC Handbook of Cereals, Flour, Dough and Product Testing*. DEStech Publications, Lancaster, PA, chapter 5.

Kent, N.L. and Evers, A.D. (1994) *Kent's Technology of Cereals*: *An Introduction for Students of Food Science and Agriculture*, 4th edn. Woodhead Publishing, Cambridge, p. 172.

Lide, D.R. (ed.) (2007/2008) *Handbook of Chemistry and Physics*, 88th edn. CRC Press, Boca Raton, FL.

NIOSH Pocket Guide to Chemical Hazards (2007). DHHS/NIOSH **26**, pp. 97–140.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

NAME:	Calcium carbonate
CATEGORY:	Flour additive
FOOD USE:	Flour/Whole wheat flour/Bread
SYNONYMS:	Carbonic acid calcium salt (1:1)/Chalk (B.P.)/CAS 471-34-18/E170
FORMULA:	$CaCO_3$
MOLECULAR MASS IN Daltons:	100.09
PROPERTIES AND APPEARANCE:	White microcrystalline or amorphous powder
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	Not applicable
MELTING POINT IN °C:	825.0 (decomposes)
DENSITY AT 25°C (AND OTHER TEMPERATURES) IN g/cm^3:	2.711
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	Quantitatively soluble in weak acid
FUNCTION IN FOODS:	Calcium fortification
ALTERNATIVES:	Calcium sulphate
TECHNOLOGY OF USE IN FOODS:	Used to provide calcium supplementation of wheat flours and bakery goods. Generally added to provide 140 mg of calcium per 100 g of flour but this rate depends on jurisdiction May be part of the carrier of benzoyl peroxide and other chemicals in the preparation of bleaching and maturing agents Also used as yeast food for bread up to 2500 ppm of flour
FOOD SAFETY ISSUES:	None

LEGISLATION:

USA:
Permitted in flour at 960 mg per pound (454.3 g) of flour
21 CFR 137.165

CANADA:
Permitted such that 140 mg calcium is provided per 100 g of flour
CRC Division B.13.001 (f)

UK and EUROPE:
UK: mandatory enrichment on all wheat flour 235–390 mg/100 g flour
Not required on self-raising flour, wholemeal flour, wheat malt flour
Bread and Flour Regulations 1998 (SI 1998/141), Council Directive 95/2/EC

AUSTRALIA/NZ
Not permitted on flour
Permitted in processed cereal, meals and finished flour products at GMP
Food Standards, Schedule 1, section 6.3, 6.4

REFERENCES:

Burdock, G.A. (1997) *Encyclopedia of Food and Color Additives*, Vol. 1 (A–E). CRC Press, Boca Raton, FL.
Lide, D.R. (ed.) (2007/2008) *Handbook of Chemistry and Physics*, 88th edn. CRC Press, Boca Raton, FL.
O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

NAME:	Calcium phosphate, monobasic
CATEGORY:	Flour additive
FOOD USE:	Baked goods/Baking powder/Dough conditioner/Powder beverages
SYNONYMS:	Calcium tetrahydrogen diorthophosphate/Acid calcium phosphate/Monocalcium phosphate/Monocalcium orthophosphate/CAS 7758-23-8/E341
FORMULA:	$CaH_4O_8P_2$
MOLECULAR MASS IN Daltons:	234.05
PROPERTIES AND APPEARANCE:	White crystals or granules. Also occurs as the monohydrate
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	203.0
MELTING POINT IN °C:	200.0 decomposes (loses H_2O at 100)
DENSITY AT 25°C (AND OTHER TEMPERATURES) IN g/cm^3:	2.22
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	@ 20°C 1.8
FUNCTION IN FOODS:	Fast-acting raising agent; ingredient of baking powder; acts as an acidulant in baking powders and wheat breads. Yeast nutrient in yeast-raised goods. Used as a buffer and acidulant in beverage powders
ALTERNATIVES:	Sodium acid pyrophosphate; Monopotassium tartrate; Sodium aluminium phosphate
TECHNOLOGY OF USE IN FOODS:	A very fast-acting raising agent with a neutralising value of 80 (monohydrate) and 83 (anhydrous). Used alone, it reacts with sodium bicarbonate very rapidly, releasing 60–70% of the available carbon dioxide in a 2-minute mixing of dough. The reaction is completed during baking. It is used at low concentration in combination with a slow-acting acid such as sodium acid pyrophosphate in double-acting baking powder. Coated anhydrous monocalcium phosphate gives a more delayed reaction Used at a level of 0.03% in direct-set cottage cheese to aid acidification of the milk and decrease processing time. Sometimes added to instant pudding and 'no-bake' cheesecake mixes to strengthen the gel. May be used in canned fruit to increase firmness

FOOD SAFETY ISSUES:

Maximum tolerable daily intake 70 mg/kg body weight, expressed as P for phosphates from all sources, including those naturally present in food and derived from additives

LEGISLATION:

USA:
Permitted in phosphate flours not less than 0.25% and not more than 0.75% finished flour weight
21 CFR 137.175

CANADA:
Not permitted in flour. Dibasic and tribasic forms permitted as part of carrier for benzoyl peroxide
CRC Division 16, table VIII C.5 C.6

UK and EUROPE:
Not permitted in flour. Permitted in dry powdered desserts up to 7 g/kg
Council Directive No. 98/72/EC (Annex IV), No. 95/2/EC

AUSTRALIA/NZ
Not permitted on flour
Permitted in processed cereal, meals and finished flour products at GMP
Food Standards, Schedule 1, section 6.3, 6.4

REFERENCES:

Conn, J.F. (1981) Chemical leavening systems in flour products. *Cereal Foods World* **26**, 119–123.

LaBaw, G.D. (1982) Chemical leavening agents and their use in bakery products. *Bakers Digest* **56**, 16–18, 20–21.

Lide, D.R. (ed.) (2007/2008) *Handbook of Chemistry and Physics*, 88th edn. CRC Press, Boca Raton, FL.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

Stauffer, C.E. (1994) Chemical leavening. In: Kulp, K. (ed.) *Cookie Chemistry and Technology*. American Institute of Baking, Kansas.

Timm, R.G. (1988) Baking powder: factors affecting its performance. In: Bush, P.B., Clarke, I.R., Kort, M.J. and Smith, M.F. (eds) *Functionality of Ingredients in the Baking Industry*. Natal Technikon Printers, Durban.

NAME:	Chlorine
CATEGORY:	Flour additive
FOOD USE:	Cake-making flour/Flour for noodles and batters
SYNONYMS:	CAS 7782-50-5/E925
FORMULA:	Cl_2
MOLECULAR MASS IN Daltons:	70.91
PROPERTIES AND APPEARANCE:	Greenish-yellow gas, clear yellow liquid when packed under pressure
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	35.05
MELTING POINT IN °C:	–101.5
DENSITY AT 25°C (AND OTHER TEMPERATURES) IN g/cm^3:	2.898
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	Soluble (0.062 moles/L)
FUNCTION IN FOODS:	Used to treat flours for high-ratio cakes and fruit cakes; it modifies the properties of the starch, increasing the batter viscosity thus preventing 'collapse' of the cake. Also acts as a flour bleaching agent and in small amounts is used to whiten flour for Asian noodle applications
ALTERNATIVES:	Chlorine dioxide; Lipoxidase (bleaching agent); Heat treated cake flour (modifying agent)
TECHNOLOGY OF USE IN FOODS:	Treatment with chlorine is normally carried out at the mill in the gaseous phase and a chlorine agitator. The optimum level of chlorination is usually 1500–2000 mg/kg or to a resultant flour pH of 4.5–4.9 for cake and pastry type flours
FOOD SAFETY ISSUES:	Extremely reactive, will cause severe burns to mucous membranes

LEGISLATION:

USA:
Permitted as a flour treatment agent (GMP)
21 CFR 137.105

CANADA:
Permitted as a flour treatment agent (GMP)
CRC Division 16, Table II C.4

UK and EUROPE:
Not permitted

AUSTRALIA/NZ
Not permitted

REFERENCES:

Burdock, G.A. (1997) *Encyclopedia of Food and Color Additives*, Vol. 1 (A–E). CRC Press, Boca Raton, FL.

Guy, R.C.E. and Pithawala, H.R. (1981) Rheological studies of high-ratio cake batters to investigate the mechanism of improvement of flours by chlorination or heat treatment. *Journal of Food Technology* **16**, 153–166.

Johnson, A.C., Hoseney, R.C. and Ghiasi, K. (1980) Chlorine treatment of cake flours, V: oxidation of starch. *Cereal Chemistry* **57**, 94–96.

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Telloke, G.W. (1985) Chlorination of cake flour and its effects on starch gelatinisation. *Starke* **37**, 17–22.

Wei, C.I., Ghanberi, H.A., Wheeler, W.B. and Kirk, J.R. (1984) Fate of chlorine during flour chlorination. *Journal of Food. Science* **49**, 1136–1138, 1153.

NAME:	Chlorine dioxide
CATEGORY:	Flour additive
FOOD USE:	Flour for breadmaking
SYNONYMS:	Chlorine peroxide/Dyox/CAS 10049-04-04/E926
FORMULA:	ClO_2
MOLECULAR MASS IN Daltons:	67.45
PROPERTIES AND APPEARANCE:	Yellow to reddish-yellow gas at room temperature
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	11.0
MELTING POINT IN °C:	–59.0
DENSITY AT 25°C (AND OTHER TEMPERATURES) IN g/cm^3:	2.757
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 25°C** 3.01 g/L (34.5 mmHg)
FUNCTION IN FOODS:	Flour improver; flour bleaching agent; fats and oils bleaching agent
ALTERNATIVES:	Ascorbic acid; L-cysteine hydrochloride (flour improvers) Benzoyl peroxide; chlorine (flour bleaching agents)
TECHNOLOGY OF USE IN FOODS:	Treatment with chlorine dioxide is normally carried out at the mill. The chlorine dioxide, in the form of dyox gas (max. 4% chlorine dioxide) must be generated on site (dyox generator). Use by the milling industry is not very prevalent today as most mills typically have switched to chlorine gas for ease of application Flour treated with chlorine dioxide is suitable for bulk fermentation (traditional) and frozen dough breadmaking
FOOD SAFETY ISSUES:	Chlorine dioxide is mutagenic and highly reactive

LEGISLATION:

USA:
Permitted as a flour treatment agent (GMP)
21 CFR 137.105

UK and EUROPE:
Not permitted

CANADA:
Permitted as a flour treatment agent (GMP)
CRC Division 16, Table II C.4

AUSTRALIA/NZ
Not permitted

REFERENCES:

Burdock, G.A. (1997) *Encyclopedia of Food and Color Additives*, Vol. 1 (A–E). CRC Press, Boca Raton, FL.

Daniels, D.G.H. and Whitehead, J.K. (1957) Laboratory preparation of chlorine dioxide. *Chemistry and Industry* September 7, 1214.

Lide, D.R. (ed.) (2007/2008) *Handbook of Chemistry and Physics*, 88th edn. CRC Press, Boca Raton, FL.

Moore, T., Sharman, I.M. and Ward, R.J. (1957) The destruction of vitamin E in flour by chlorine dioxide. *Journal of Science in Food and Agriculture* **8**, 97–104.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

Parker, H.K. and Fortmann, K.L. (1949) Methods for the laboratory-scale production of chlorine dioxide and the treatment of flour. *Cereal Chemistry* **26**, 479–490.

NAME:	L-Cysteine hydrochloride
CATEGORY:	Flour additive
FOOD USE:	Flour/Whole wheat flour/Bread/Biscuits/Unstandardised bakery goods
SYNONYMS:	L-Cysteine monohydrochloride/(*R*)-2-Amino-3-mercaptopropanioc acid/Cysteine HCl/CAS 7048-04-6/E920
FORMULA:	$C_3H_7NO_2S.HCl \cdot H_2O$
MOLECULAR MASS IN Daltons:	175.63
PROPERTIES AND APPEARANCE:	White crystalline powder or colourless crystals
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	293.9
MELTING POINT IN °C:	175.0 (decomposes)
DENSITY AT 25°C (AND OTHER TEMPERATURES) IN g/cm^3:	1.50
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 100
in ethanol (5%):	Freely soluble
FUNCTION IN FOODS:	Flour improver, acts as a reducing agent to facilitate mixing. Improves the machinability of bread and biscuit dough
ALTERNATIVES:	Sulphur dioxide; Sodium metabisulphite; Thioserine; Glutathione; Inactive yeast; Protease
TECHNOLOGY OF USE IN FOODS:	L-Cysteine hydrochloride is a reducing agent that breaks the disulphide bonds of the gluten structure enabling faster dough development in the mixer and making the finished dough much easier to roll out into thin sheets. Typically used at the levels between 20 and 90 ppm. When used in conjunction with oxidative agents such as ascorbic acid, is suitably employed in the activated, no-time dough, or short fermentation bread production processes, which typically utilise low-energy mixers by small bakers Some jurisdictions permit higher levels of 300 ppm for the production of semi-sweet biscuits to improve the structure and appearance of the finished product

FOOD SAFETY ISSUES:

May cause dermal and respiratory sensitisation to prolonged dust exposure

LEGISLATION:

USA:
Not permitted on milled flour. Permitted on dough up to a maximum of 90 ppm
21 CFR 184.1272

CANADA:
Permitted in flour and dough up to a maximum of 90 ppm
CRC Division 13 B.13.001 (e) (xiii)

UK and EUROPE:
UK: Permitted in biscuit flour except wholemeal or flour to which sulphur dioxide (E220) or sodium metabisulphate has been added to a maximum of 300 ppm
Other flour and bread except wholemeal to a maximum of 75 ppm
Bread and Flour Regulations 1998, No. 141, Schedule 3

AUSTRALIA/NZ
Not permitted

REFERENCES:

Burdock, G.A. (1997) *Encyclopedia of Food and Color Additives*, Vol. 1 (A–E). CRC Press, Boca Raton, FL.

Grandvoinnet, P. and Berger, M. (1979) Ascorbic acid and cysteine in bakery products. *Industries Alimentaires et Agricoles* **96**, 941–947.

Hui, Y.U. (2006) Functional additives. In: Corke, H., De Leyn, I., Nip, W.K. and Cross, N. (eds) *Bakery Products Science and Technology*. Blackwell Publishing Ltd., Oxford, chapter 12.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

Ranum, P. (1992) Flour treatment and additives. *AIB Research Department Technical Bulletin* **14** (5).

Williams, T. and Pullen, G. (2007) Functional ingredients. In: Cauvain, S.P. and Young, L.S. (eds) *Technology of Breadmaking*, 2nd edn. Springer Science, New York, pp. 51–92.

NAME:	Glucoamylase
CATEGORY:	Flour additive/Enzyme
FOOD USE:	Flour/Whole wheat flour/Bread/Distillers mash/Precooked cereals
SYNONYMS:	Gamma-amylase/CAS 9000-92-4
FUNCTION IN FOODS:	Used to modify starch in flour, baking, brewing and distilling
ALTERNATIVES:	Alpha-amylase; Beta-amylase
TECHNOLOGY OF USE IN FOODS:	Cleaves every glucosidic bond to produce solely glucose. Used to provide fast-acting gassing power to brew-type dough systems. Used to reduce the amount of sugar added to bread while still maintaining desirable loaf colour and sweetness
FOOD SAFETY ISSUES:	May cause skin and respiratory sensitisation with prolonged exposure to dust
LEGISLATION:	**USA:** Permitted in flour, bread and unstandardised bakery goods (GMP) 21 CFR 170.130 **CANADA:** Permitted in flour, bread and unstandardised bakery goods (GMP) CRC Division 16, Table V G.1 **UK and EUROPE:** Not permitted **AUSTRALIA/NZ** Not permitted
REFERENCES:	Heflich, L.W. (1996) A baker's perspective. In: Zobel, H.F. and Hebeda, R.E. (eds) *Baked Goods Freshness: Technology, Evaluation and Inhibition of Staling*. Marcel Dekker, New York, pp. 239–257. O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.
ANY OTHER RELEVANT INFORMATION:	Enzyme sourced from *Aspergillus niger* var.; *Aspergillus oryzae* var.; *Rhizopus oryzae* var.

NAME:	Glucose oxidase
CATEGORY:	Flour additive/Enzyme
FOOD USE:	Flour/Whole wheat flour/Bread/Soft drinks/Liquid eggs
SYNONYMS:	β-D-glucopyranose aerodehydrogenase/Corylophyline/Microcide/Mikrotsid/CAS 9001-37-0
FUNCTION IN FOODS:	An aerobic dehydrogenase which catalyses the oxidation of glucose to gluconic acid; the molecular oxygen is reduced to hydrogen peroxide
TECHNOLOGY OF USE IN FOODS:	Used at 50–100 ppm to strengthen the rheological properties of bread dough, improves loaf volume and crumb structure. In addition it also provides dough drying and reduced dough stickiness. Works synergistically with low levels of ascorbic acid. Stable in pH systems of 4.5–7.0. Most active at pH 5.5–6.0 at 35°C Also measured by glucose oxidase units (GOU) which is defined as the quantity of enzyme which will cause the uptake of 10 mm^3 oxygen per minute in Warburg manometer at 30°C
FOOD SAFETY ISSUES:	May cause skin and respiratory sensitisation with prolonged exposure to dust
LEGISLATION:	**USA:** Permitted on bread as an enzyme active preparation (GMP) 21 CFR 136.110 (c) (9) **CANADA:** Permitted in flour, bread and unstandardised bakery goods (GMP) CRC Division 16, Table V G.3 **UK and EUROPE:** Not permitted in flour, permitted in various bakery goods *quantum satis* Council Regulation (EC) No. 1332/2008 (Article 4) **AUSTRALIA/NZ** Not permitted
REFERENCES:	Courtin, C.M., Veraverbeke, W.S. and Delcour, J.A. (eds) (2003) Food application. In: *Recent Advances in Enzymes in Grain Processing,* Proceedings of the Third European Symposium on Enzymes in Grain Processing. Katholieke Universiteit Leuven, Leuven, Belgium. Hui, Y.U. (2006) Functional additives. In: Corke, H., De Leyn, I., Nip, W.K. and Cross, N. (eds) *Bakery Products Science and Technology.* Blackwell Publishing Ltd., Oxford, chapter 12. O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ. Si, J.Q. (1997) Synergistic effect of enzymes for breadmaking. *Cereal Foods World* **42**, 802–807.

Vemulapalli V. and Hoseney, R.C. (1998) Glucose oxidase effects on gluten and water solubles. *Cereal Chemistry* **75**, 859–862.
Vemulapalli V., Miller, K.A. and Hoseney, R.C. (1998) Glucose oxidase in breadmaking systems. *Cereal Chemistry* **75**, 439–442.

ANY OTHER RELEVANT INFORMATION: Obtained from *Aspergillus niger* var.

NAME:	Lipase
CATEGORY:	Flour additive/Enzyme
FOOD USE:	Flour/Whole wheat flour/Bread/Unstandardised bakery products
SYNONYMS:	Glycerol ester hydrolase/CAS 9029-60-1/EC 1.13.11.12
FUNCTION IN FOODS:	Hydrolyses ester bonds of acylglycerols yielding monoglycerols and diglycerols and free fatty acids
TECHNOLOGY OF USE IN FOODS:	Used in flour and bread to increase dough strength and stability. Mainly used to retard bread staling through the emulsification action of the resultant glycerols
FOOD SAFETY ISSUES:	May cause skin and respiratory sensitisation with prolonged exposure to dust
LEGISLATION:	**USA:** Permitted in bread as enzyme active preparations (GMP) 21 CFR 136.110 (9) **CANADA:** Permitted in flour, whole wheat flour, bread (GMP) CRC Division 16 Table V L.2 **UK and EUROPE:** Not permitted in flour, permitted in various bakery goods *quantum satis* Council Regulation (EC) No. 1332/2008 (Article 4) **AUSTRALIA/NZ** Not permitted
REFERENCES:	Hui, Y.U. (2006) Functional additives. In: Corke, H., De Leyn, I., Nip, W.K. and Cross, N. (eds) *Bakery Products Science and Technology*. Blackwell Publishing Ltd., Oxford, chapter 12. Si, J.Q. (1997) Synergistic effects of enzymes for breadmaking. *Cereal Foods World* **42**, 802–803. Si, J.Q. and Hassan, T.T. (1994) Effect of lipase on breadmaking in correlation with their effects on dough rheology and wheat lipids. *Proceedings of International Symposium AACC/ICC/CCOA*. AACC, St Paul, MN. Williams, T. and Pullen, G. (2007) Functional ingredients. In: Cauvain, S.P. and Young, L.S. (eds) *Technology of Breadmaking*, 2nd edn. Springer Science, New York, pp. 51–92.

NAME:	Lipoxidase
CATEGORY:	Flour additive/Enzyme
FOOD USE:	Flour/Whole wheat flour/Bread
SYNONYMS:	Carotene oxidase/Lipoxygenase/Lipoperoxidase/CAS 9029-60-1/EC 1.13.11.12
SYNERGISTS:	Enzymatic active soybean whey or meal/Benzoyl peroxide/Chlorine dioxide
FUNCTION IN FOODS:	Non-chemical form of bleaching wheat flour
TECHNOLOGY OF USE IN FOODS:	Used in flour and bread as a non-chemical form of bleaching the naturally occurring xanthophyll in wheat flour. The effect does not take place in dry flour but occurs during the mixing and fermentation process of baking after water is added. Though a desirable effect in white bread, naturally occurring lipoxidases can negatively affect colour of pasta products obtained from the milling of durum semolina Lipoxygenase addition can also increase mixing tolerance and improves dough handling and rheological properties thus improving loaf volume
FOOD SAFETY ISSUES:	May cause skin and respiratory sensitisation with prolonged exposure to dust
LEGISLATION:	**USA:** Permitted in bread as enzyme active preparations (GMP) 21 CFR 136.110 (9) **CANADA:** Permitted in flour, whole wheat flour, bread (GMP) CRC Division 16 Table V L.3 **UK and EUROPE:** Not permitted in flour, permitted in various bakery goods *quantum satis* Council Regulation (EC) No. 1332/2008 (Article 4) **AUSTRALIA/NZ** Not permitted
REFERENCES:	Hoseney, R.C., Roa, H., Faubion, J. and Sidhy, J.S. (1980) Mixograph studies. IV. The mechanism by which lipoxygenase increases mixing tolerance. *Cereal Chemistry* **57**, 163–166. Hui, Y.U. (2006) Functional additives. In: Corke, H., De Leyn, I., Nip, W.K. and Cross, N. (eds) *Bakery Products Science and Technology*. Blackwell Publishing Ltd., Oxford, chapter 12. Swiss Institute of Bioinformatics ExPASy Proteomics Server. Available at: http://expasy.org/enzyme/1.13.11.12.

NAME:	Pentosanase
CATEGORY:	Flour additive/Enzyme
FOOD USE:	Flour/Whole wheat flour/Bread/Distillers mash/Unstandardised bakery products
SYNONYMS:	Hemicellulase/CAS 9025-57-4/EC 3.2.1.8
SYNERGISTS:	Alpha-amylase
FUNCTION IN FOODS:	A class of enzymes which break down linear chains of polysaccharide β-1,4-xylan into xylose. This reduces the hemicellulose content of flour thus improving loaf volume and crumb structure
TECHNOLOGY OF USE IN FOODS:	The fungal-derived enzymes are active at temperatures up to 55–65°C and are inactive above 65°C. The bacterial-derived enzymes remain active to much higher temperatures. Usage levels will vary widely depending on the type of commercial preparation, manufacturer and specific activity and users should rely on manufacturers recommendations. Usage in dough improves machinability and water absorption
FOOD SAFETY ISSUES:	May cause skin and respiratory sensitisation with prolonged exposure to dust
LEGISLATION:	**USA:** Permitted in bread as enzyme active preparations (GMP) 21 CFR 136.110 (9) **CANADA:** Permitted in flour, whole wheat flour, bread (GMP) CRC Division 16 Table V P.4 **UK and EUROPE:** Not permitted in flour, permitted in various bakery goods *quantum satis* Council Regulation (EC) No. 1332/2008 (Article 4) **AUSTRALIA/NZ** Not permitted
REFERENCES:	Hui, Y.U. (2006) Functional additives. In: Corke, H., De Leyn, I., Nip, W.K. and Cross, N. (eds) *Bakery Products Science and Technology*. Blackwell Publishing Ltd., Oxford, chapter 12.

Kulp, K. (1993) Enzymes as dough improvers. In: Kamel, B.S. and Stauffer, C.E. (eds) *Advances in Baking Technology*. Blackie Academic & Professional, London, pp. 152–176.
Wang, M., van Vliet, T. and Hamer, R.J. (2003) Influence of pentosans on the structure formation of gluten. *Industrial Proteins* **11**, 9–11.
Williams, T. and Pullen, G. (2007) Functional ingredients. In: Cauvain, S.P. and Young, L.S. (eds) *Technology of Breadmaking*, 2nd edn. Springer Science, New York, pp. 51–92.

ANY OTHER RELEVANT INFORMATION: Obtained from *Asperigillus niger* var.; *Bacillus subtilis* var.; *Trichoderma reesei* var.

NAME:	Potassium bromate
CATEGORY:	Flour additive
FOOD USE:	Flour/Whole wheat flour/Bread/Unstandardised bakery goods
SYNONYMS:	CAS 7758-01-02/E924
FORMULA:	$KBrO_3$
MOLECULAR MASS IN Daltons:	167.00
PROPERTIES AND APPEARANCE:	White crystalline powder
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	370.0 (decomposes)
MELTING POINT IN °C:	350.0
DENSITY AT 25°C (AND OTHER TEMPERATURES) IN g/cm^3:	3.27
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 6.91 **@ 40°C** 13.3
in alcohol:	Slightly soluble
FUNCTION IN FOODS:	Strong oxidising agent of the gluten proteins in flour and yeast raised bread products
ALTERNATIVES:	Potassium iodate; Ascorbic acid; Glucose oxidase
TECHNOLOGY OF USE IN FOODS:	Used to accelerate the flour ageing process to improve bread volume and crumb structure. Promotes the formation of disulphide bonds through the oxidation of the gluten thiol groups thus strengthening the gluten network and enhancing gas retention of the dough during fermentation and baking. Typical usage levels are between 10 and 45 ppm
FOOD SAFETY ISSUES:	Use is now banned in most countries. Research in the early 1990s indicated that at high levels not all of the bromate form of the salt is converted to the inert bromide form. May be carcinogenic

LEGISLATION:

USA:
Permitted in flour to a maximum of 50 ppm: 21 CFR 137.155
Permitted in bread up to a maximum of 100 ppm (including flour portion): 21 CFR 136.110

CANADA:
Not permitted

UK and EUROPE:
Not permitted

AUSTRALIA/NZ
Not permitted

REFERENCES:

California Office of Environment Health Hazard Assessment 25249.5. Available at: http://oehha.ca.gov/prop65/law/P65law72003.html.

Gelroth, J., Sanders, L., Cogswell, T. and Zvaners, R. (2009) The use of potassium bromate by the commercial baking industry. *Cereal Foods World* **54**, 205–208.

Hui, Y.U. (2006) Functional additives. In: Corke, H., De Leyn, I., Nip, W.K. and Cross, N. (eds) *Bakery Products Science and Technology*. Blackwell Publishing Ltd., Oxford, chapter 12.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

Panozzo, J.F., Bekes, F., Wrigley, C.W. and Gupta, R.B. (1994) The effects of bromate (0–30 ppm) on the proteins and lipids of dough. *Cereal Chemistry* **71**, 195–199.

Ranum, P. (1992) Flour treatment and additives. *AIB Research Department Technical Bulletin* **14** (5).

ANY OTHER RELEVANT INFORMATION:

The US Food and Drug Administration has advised bakeries to keep use level in bread below 50 ppm on the flour basis. Potassium bromate was added to the list of Proposition 65 on 1 January 1990 in the state of California (formally titled 'The Safe Drinking Water and Toxic Enforcement Act of 1986') which requires products containing these substances to carry a label as follows: 'WARNING: This product contains chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.'

NAME:	Protease
CATEGORY:	Flour additive/Enzyme
FOOD USE:	Flour/Whole wheat flour/Bread/Brewing/Meat tenderising
SYNERGISTS:	L-Cysteine hydrochloride
FUNCTION IN FOODS:	Hydrolysis of peptide bonds between amino acids of the gluten polypeptide chains
TECHNOLOGY OF USE IN FOODS:	Used in bread and cracker dough to moderate dough rheological characteristics by improving dough machinability. Also may be used to facilitate dough mixing development. The fungal-derived enzymes are active at temperatures up to 55–65 °C and are inactive above 65 °C. The bacterial-derived enzymes remain active to much higher temperatures Usage levels will vary widely depending on the type of commercial preparation, manufacturer, specific activity, and the protein content of the flour and users should rely on manufacturers recommendations. Because proteases irreversibly weaken the gluten structure they should be used sparingly
FOOD SAFETY ISSUES:	May cause skin and respiratory sensitisation with prolonged exposure to dust
LEGISLATION:	**USA:** Permitted in bakery products (GMP) 21 CFR 136.110 (9) **CANADA:** Permitted in flour, whole wheat flour, bread (GMP) CRC Division 16 Table V P.6 **UK and EUROPE:** Not permitted in flour, permitted in various bakery goods *quantum satis* Council Regulation (EC) No. 1332/2008 (Article 4) **AUSTRALIA/NZ** Not permitted
REFERENCES:	Hui, Y.U. (2006) Functional additives. In: Corke, H., De Leyn, I., Nip, W.K. and Cross, N. (eds) *Bakery Products Science and Technology*. Blackwell Publishing Ltd., Oxford, chapter 12. Kruger, J.E. (1971) Effects of proteolytic enzymes on gluten as measured by a stretching test. *Cereal Chemistry* **48**, 121–131.

Kulp, K. (1993) Enzymes as dough improvers. In: Kamel, B.S. and Stauffer, C.E. (eds) *Advances in Baking Technology*. Blackie Academic & Professional, London, pp. 152–176.
Mathewson, P.R. (2000) Enzymatic activity during bread baking. *Cereal Foods World* **45**, 98–101.

ANY OTHER RELEVANT INFORMATION: Obtained from *Aspergillus oryzae* var.; *Aspergillus niger* var.; *Bacillus subtilis* var.

NAME:	Pullulanase
CATEGORY:	Flour additive/Enzyme
FOOD USE:	Sugar manufacturing
SYNONYMS:	Alpha-dextrin endo-1,6-α-glucosidase/Amylopectin 6-glucanohydrolase/Debranching enzyme/Limit dextrinase/Pullulan 6-glucanohydrolase/CAS 9075-68-7/EC 3.2.1.142
SYNERGISTS:	Glucanase
FUNCTION IN FOODS:	Hydrolysis of glucosidic linkages in pullulan (E1204), amylopectin and glycogen
TECHNOLOGY OF USE IN FOODS:	Formation of maltose, which is an important fermentation aid in confectionary manufacturing and brewing
FOOD SAFETY ISSUES:	May cause skin and respiratory sensitisation with prolonged exposure to dust
LEGISLATION:	**USA:** Permitted in bakery products (GMP) 21 CFR 136.110 (9) **CANADA:** Permitted in flour, whole wheat flour, bread (GMP) CRC Division 16 Table V P.4 **UK and EUROPE:** Not permitted **AUSTRALIA/NZ** Not permitted
REFERENCES:	Hui, Y.U. (2006) Functional additives. In: Corke, H., De Leyn, I., Nip, W.K. and Cross, N. (eds) *Bakery Products Science and Technology*. Blackwell Publishing Ltd., Oxford, chapter 12. Jackson, E.B. and Howling, D. (1999) Glucose syrups and starch hydrolysates. In: *Sugar Confectionary Manufacture*, 2nd edn. Aspen Publishers, Gaithersburg, MD, chapter 2.
ANY OTHER RELEVANT INFORMATION:	Obtained from *Bacillus acidopullulyticus* var.; *Bacillus licheniformis* var.; *Bacillus subtilis* var.

NAME:	Sodium acid pyrophosphate
CATEGORY:	Flour additive/Sequestrant
FOOD USE:	Baked goods/Meat products/Processed cheese/Potato products
SYNONYMS:	Disodium dihydrogen pyrophosphate/Diphosphoric acid/Disodium salt/CAS 7758-16-9
FORMULA:	$H_2Na_2O_7P_2$
MOLECULAR MASS IN Daltons:	221.94
PROPERTIES AND APPEARANCE:	White granular powder
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	Not applicable
MELTING POINT IN °C:	220 (decomposes)
DENSITY AT 25°C (AND OTHER TEMPERATURES) IN g/cm^3:	1.86
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 13 **@ 50°C** 35
FUNCTION IN FOODS:	Used chiefly in baking powders as an acidifier for baking soda. Used in canned meats and potatoes to prevent darkening
ALTERNATIVES:	Monocalcium orthophosphate; Sodium aluminium phosphate
TECHNOLOGY OF USE IN FOODS:	Acid raising agent of slow but variable reactivity especially in cold water and used in conjunction with baking soda. Used typically as leavening aid in soft wheat bakery products such as cakes, muffins, biscuits. High levels can impart a bitter aftertaste in the finished product
FOOD SAFETY ISSUES:	None

LEGISLATION:

USA:
Permitted in food, GRAS, GMP
21 CFR 182.6787

CANADA:
Not permitted in flour
Permitted in baking powder and unstandardised foods (GMP)

UK and EUROPE:
Not permitted

AUSTRALIA/NZ
Not permitted

REFERENCES:

Conn, J.F. (1981) Chemical leavening systems in flour products. *Cereal Foods World* **26**, 119–123.

Köksel, H. and Gökmen, V. (2008) Chemical reactions in the processing of soft wheat products. In: Sumnu, S.G. and Sahin, S. (eds) *Food Engineering Aspects of Baked Sweet Goods*. CRC Press, Boca Raton, FL, pp. 49–80.

LaBaw, G.D. (1982) Chemical leavening agents and their use in bakery products. *Bakers Digest* **56**, 16–18, 20–21.

Stauffer, C.E. (1994) Chemical leavening. In: Kulp, K. (ed.) *Cookie Chemistry and Technology*. American Institute of Baking, Kansas.

Timm, R.G. (1988) Baking powder: factors affecting its performance. In: Bush, P.B., Clarke, I.R., Kort, M.J. and Smith, M.F. (eds) *Functionality of Ingredients in the Baking Industry*. Natal Technikon Printers, Durban.

NAME:	Xylanase
CATEGORY:	Flour additive/Enzyme
FOOD USE:	Flour/Whole wheat flour/Bread/Distillers mash/Unstandardised bakery products
SYNONYMS:	Xylan endo-1,3-β-xylosidase/Endo-1,3-β-xylanase/Hemicellulase/Pentosanase/CAS 9025-57-4/EC 3.2.1.8
SYNERGISTS:	Alpha-amylase
FUNCTION IN FOODS:	A class of enzymes formerly called pentosanases, which break down linear chains of polysaccharide β-1,4-xylan into xylose. This reduces the hemicellulose content of flour thus improving loaf volume and crumb structure
TECHNOLOGY OF USE IN FOODS:	The fungal-derived enzymes are active at temperatures up to 55–65°C and are inactive above 65°C. The bacterial-derived enzymes remain active to much higher temperatures Usage levels will vary widely depending on the type of commercial preparation, manufacturer and specific activity and users should rely on manufacturers recommendations
FOOD SAFETY ISSUES:	May cause skin and respiratory sensitisation with prolonged exposure to dust
LEGISLATION:	**USA:** Permitted in bread as enzyme active preparations (GMP) 21 CFR 136.110 (9) **CANADA:** Permitted in flour, whole wheat flour, bread (GMP) CRC Division 16 Table V X.1 **UK and EUROPE:** Not permitted in flour, permitted in various bakery goods *quantum satis* Council Regulation (EC) No. 1332/2008 (Article 4) **AUSTRALIA/NZ** Not permitted
REFERENCES:	Courtin, C.M. and Delcour, J.A. (2002) Arabinoxylans and endoxylanses in wheat flour bread making. *Journal of Cereal Science* **35**, 225–243. Koyuncu, O., Bilgicli, N., Elgun, A. and Kara, M. (2008) Effect of pentosanase on dough and bread properties by different types of flours. *Journal of Food Quality* **31**, 156–172. Wang, M., van Vliet, T. and Hamer, R.J. (2005) Interaction of water unextractable solids and xylanase with gluten protein: effect of wheat cultivars. *Journal of Cereal Science* **41**, 251–258.
ANY OTHER RELEVANT INFORMATION:	Obtained from *Aspergillus oryzae* var.

Part 8

Gases

Jim Smith and Lily Hong-Shum

Food Additives Data Book, Second Edition. Edited by Jim Smith and Lily Hong-Shum.

NAME:	Argon							
CATEGORY:	Packaging gas							
FORMULA:	Ar							
MOLECULAR MASS IN Daltons:	39.948							
PROPERTIES AND APPEARANCE:	Colourless, odourless, tasteless, inert gas							
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	−185.7							
MELTING RANGE IN °C:	−189.2							
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.784							
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:								
in water:	**@ 0°C**	5.6	**@ 20°C**	3.36	**@ 50°C**	3.0	**@ 100°C**	Soluble
in vegetable oil:	**@ 20°C**	Soluble	**@ 50°C**	Soluble	**@ 100°C**	Soluble		
in sucrose solution:								
10%	Soluble							
40%	Soluble							
60%	Soluble							
in sodium chloride solution:								
5%	Soluble							
10%	Soluble							
15%	Soluble							

in ethanol solution:	
5%	Soluble
20%	Soluble
95%	Soluble
100%	Soluble
in propylene glycol:	**@ 20°C** Soluble **@ 50°C** Soluble **@ 100°C** Soluble

REFERENCE:

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

NAME:	Carbon dioxide
CATEGORY:	Gas/Packaging gas
FOOD USE:	Carbonated beverages/Fruit/Meat/Poultry/Wine
SYNONYMS:	Anhydride carbonique/Carbonic acid gas/Carbonic anhydride/CAS 124-38-9/Kohlendioxyd/Kohlensaure/EINECS/ELINCS 204-696-9/INS290/E 290/UN1013(DOT)/UN1015(DOT)/UN1041(DOT)/UN 1845 (DOT)/UN 1952 (DOT)/UN2187 (DOT)
FORMULA:	CO_2
MOLECULAR MASS IN Daltons:	44.01
PROPERTIES AND APPEARANCE:	Colourless, odourless, non-combustible gas. Faint acid taste. Solid form as dry ice. CO_2 dissolves 1:1 (v:v) in water
MELTING RANGE IN °C:	Sublimes at −78.5 (760 mmHg)
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	Gas at 0°C 1.976 g/L at 760 mmHg Liquid at 0°C 0.914 g/L at 3464 kPa (34.3 atm) Solid at −56.6°C 1.512 g/L at 760 mmHg
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water (760 mmHg):	**@ 0°C** 171 mL CO_2 per 100 mL water **@ 20°C** 88 mL CO_2 per 100 mL water **@ 60°C** 36 mL CO_2 per 100 mL water
FUNCTION IN FOODS:	Aerating agent; carbonation; cooling agent; leavening agent; modified atmosphere for microbial control; pH control agent; processing aid; propellant; gas; preservative; freezant. Supercritical or liquid CO_2 used in extraction of caffeine and hops aroma/rice fumigant
TECHNOLOGY OF USE IN FOODS:	Less soluble in alcohol and other neutral organic solvents. Absorbed by alkaline solutions with formation of carbonates. Ozone is not affected by heat until temperature reaches ~200°C
ANTAGONISTS:	Incompatible with acrylaldehyde, aziridine, metal acetylides, sodium peroxide

FOOD SAFETY ISSUES:

Non-combustible. Is an asphyxiant and has teratogenic and reprotoxicity effects (experimental). Contact of CO_2 snow with skin can cause burns. In CO_2 atmosphere, dusts of magnesium, zirconium, titanium and some magnesium–aluminium alloys will ignite and explode. In CO_2 atmosphere, dusts of aluminium, chromium and magnesium when heated will ignite and explode. Reacts vigorously with ($Al + Na_2O_2$); S_2O; $Mg(C_2H_5)_2$; Li; ($Mg + Na_2O_2$); K; KHC; Na; Na_2C_2; NaK; Ti. CO_2 fire extinguishers can produce highly incendiary sparks of 5–15 mJ at 10–20 kV by electrostatic discharge

Potential symptoms of over-exposure include headache, dizziness, restlessness, paraesthesia; dyspnoea, sweating, malaise, increased heart rate and cardiac output, elevated blood pressure, coma, asphyxia and/or convulsions. TSCA (Toxic Substances Control Act) listed

LEGISLATION:

USA:

FDA 21 CFR 184.1240. GRAS when used in accordance with GMP; additive affirmed as GRAS for use as leavening agent, processing aid, propellant, aerating agent, gas

FDA 21 CFR 193.45. Approved for modified atmosphere for pest control

USDA 9 CFR 318.7, 381.147. Sufficient for purpose

BATF 21 CFR 240.1051. CO_2 content of finished wine shall not be increased during the transfer operation

FDA 21 CFR 169.115, 169.140, 169.150, 169.120

UK and EUROPE:

E290

Approved for use as preservative; coolant; freezant (liquid form); packaging gas; aerator

UK: approved for use

EU: listed

CANADA:

Approved for use according to GMP as carbonation in carbonated (naming the fruit) juice; wine; malt liquors; beer; ale; cider; stout; porter; light beer; water (represented as mineral or spring water)

In unstandardised foods: approved for use as carbonation and pressure dispensing agent according to GMP

Also approved for use according to GMP as solvent for decaffeination of green coffee beans; spice extracts; natural extractives; flavour (naming the flavour); hop extract; pre-isomerised hop extract

DSL (Canadian Provisional Domestic Substance List)

AUSTRALIA/PACIFIC RIM:

Japan: approved for use as acidity regulator and food acid

REFERENCES:

www.medicinescomplete.com/mc/merck/current. Merck Index Online. Accessed 5–6 September 2009.

Anon. (1995) 1995 Encyclopedia of food ingredients. *Food in Canada*.

Ash, M. and Ash, I. (2008) *Handbook of Food Additives*, 3rd edn. Synapse Information Resources Inc., New York.

Lewis, R.J. Sr (1989) *Food Additives Handbook*. Van Nostrand Reinhold, New York.
Smoley, G.K. (1993) *Everything Added to Food in the United States*. U.S. Food and Drug Administration/ CRC Press, Boca Raton, FL.

ANY OTHER RELEVANT INFORMATION:

Department of Transport requires gas to be labelled as non-flammable gas
Manufacturer/Distributor: ADM Ethanol Sales; AF Pharmaceuticals; Air Liquide AM; Aldrich; BOC Gases: Praxair; Spectrum Quality Prods

NAME:	Hydrogen
CATEGORY:	Packaging gas
SYNONYMS:	Protium
FORMULA:	H_2
MOLECULAR MASS IN Daltons:	2.01588
PROPERTIES AND APPEARANCE:	Colourless, odourless, tasteless gas
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	−252.77
MELTING RANGE IN °C:	−259.34
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	0.08987
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 0°C** 2.14 **@ 20°C** 2.0 **@ 25°C** 1.91 **@ 50°C** 1.89
in ethanol solution:	**@ 100°C** 6.925
REFERENCE:	O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

NAME:	Nitrogen
CATEGORY:	Gas/Packaging gas
FOOD USE:	Fruit/Poultry/Various food in sealed containers/Wine
SYNONYMS:	Compressed nitrogen/Nitrogen gas/Refrigerated liquid nitrogen/CAS 7727-37-9/EINECS 231-783-9/UN1066 (compressed); UN1977 (refrig. Liq.); INS941; E941
FORMULA:	N_2
MOLECULAR MASS IN Daltons:	28.02
PROPERTIES AND APPEARANCE:	Colourless, odourless, flavourless gas. Colourless liquid or cubic crystals at low temperature. Condenses to liquid. Slightly soluble in water; soluble in liquid ammonia; slightly soluble in alcohol. Solidifies to a snow-white mass. Chemically non-reactive. Non-combustible
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	−195.79 (77.36 K)
MELTING RANGE IN °C:	−210 (63.14 K)
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	0°C 1.2506 g/L −195.8°C 0.808 g/L (liquid)
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 0°C** 100 volumes of water absorbs 2.4 volumes of gas **@ 20°C** 100 volumes of water absorbs 1.6 volumes of gas
in ethanol solution (5%)	**@ 20°C** 100 volumes of ethanol dissolves 0.1124 volumes of gas
FUNCTION IN FOODS:	Aerating agent; modified atmospheres for insect/microbial control; oxygen exclusion; propellant; processing aid; food-freezing processes; antioxidant
TECHNOLOGY OF USE IN FOODS:	An odourless flavourless gas that is slightly soluble in alcohol and water. In liquid form, used as a freezant in cryogenic freezing of food products to avoid formation of large ice crystals during freezing of food. In gas form, largely used to replace oxygen in the headspace, especially in packaged items that are susceptible to lipid oxidation during storage Combines with oxygen and hydrogen on sparking, forming nitric oxide and ammonia respectively. Forms cyanides when heated with carbon in presences of alkalis or barium oxide

FOOD SAFETY ISSUES:

Low toxicity. In high concentration is a simple asphyxiant. Release of nitrogen from solution in blood with formation of small bubbles can lead to symptoms of compressed air illness (caisson disease). Narcotic at high concentration and high pressure. Non-flammable gas, can react violently with lithium, neodymium, titanium under specificied conditions. Combustible

LEGISLATION:

USA:

FDA 21 CFR 184.1540. Substance affirmed GRAS for use as propellant, aerating agent and gas

USDA 9 CFR 318.7, 381.147. Sufficient for purpose

FDA 21 CFR 169.115, 169.140, 169.150

AUSTRALIA/PACIFIC RIM:

Japan: approved for use as natural processing aid

CANADA:

Approved for use according to GMP to improve spreadability in cream cheese and cream cheese spread; cream cheese and cream cheese spreads with (name added ingredients)

In unstandardised foods: approved for use as pressure dispensing agent according to GMP

DSL (Canadian Provisional Domestic Substance List)

REFERENCES:

www.medicinescomplete.com/mc/merck/current. Merck Index Online. Accessed 5–6 September 2009.

Anon. (1995) 1995 Encyclopedia of food ingredients. *Food in Canada*.

Ash, M. and Ash, I. (2008) *Handbook of Food Additives*, 3rd edn. Synapse Information Resources Inc., New York.

Lewis, R.J. Sr (1989) *Food Additives Handbook*. Van Nostrand Reinhold, New York.

Smoley, G.K. (1993) *Everything Added to Food in the United States*. U.S. Food and Drug Administration/ CRC Press, Boca Raton, FL.

ANY OTHER RELEVANT INFORMATION:

Department of Transport requires gas to be labelled as non-flammable gas

Manufacturer/Distributor: Air Liquide AM; Air Prods; Aldrich; BOC Gases; Messer; Praxair; Thomas Scientifc; Voltaix

NAME:	Nitrous oxide					
CATEGORY:	Packaging gas					
SYNONYMS:	Nitrogen monoxide/Nitrogen oxide/Dinitrogen monoxide/Laughing gas/CAS 10024-97-2					
FORMULA:	N_2O					
MOLECULAR MASS IN Daltons:	44.01					
PROPERTIES AND APPEARANCE:	Colourless gas, slightly sweet odour					
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	−88					
MELTING RANGE IN °C:	−91					
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.97					
PURITY %:	99					
WATER CONTENT MAXIMUM:	150 mg/m^3					
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	70	**@ 50°C**	Soluble	**@ 100°C**	Soluble
in vegetable oil:	**@ 20°C**	Soluble	**@ 50°C**	Soluble	**@ 100°C**	Soluble
in sucrose solution:						
10%	Soluble					
40%	Soluble					
60%	Soluble					
in sodium chloride solution:						
5%	Soluble					
10%	Soluble					
15%	Soluble					

in ethanol solution:	
5%	Freely soluble
20%	Freely soluble
95%	Freely soluble
100%	Freely soluble
in propylene glycol:	**@ 20°C** Freely soluble **@ 50°C** Freely soluble **@ 100°C** Freely soluble
FUNCTION IN FOODS:	Direct food additive; propellant; aerating agent; gas. Used in dairy products
LEGISLATION:	**USA:** FDA 21 CFR § 184.1545, GRAS
REFERENCES:	Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York. Committee on Food Chemicals Codex (1996) *Food Chemicals Codex*, 4th edn. Food and Nutrition Board, Institute of Medicine, National Academy of Sciences, National Academy Press, Washington, DC. O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.
ANY OTHER RELEVANT INFORMATION:	Precaution: does not burn, but will support combusion; oxidiser Toxicology: asphyxiant at high concentrations

NAME:	Ozone
CATEGORY:	Gas/Inorganic gas
FOOD USE:	Bottled water/Air
SYNONYMS:	Triatomic oxygen/CAS 10028-15-6/Ozon
FORMULA:	O_3
MOLECULAR MASS IN Daltons:	48.00
PROPERTIES AND APPEARANCE:	Unstable bluish gas or dark blue liquid; pungent characteristic odour, pleasant characteristic odour in concentration of less than 2 ppm. Irritating and injurious at higher concentration
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	−111.9
MELTING RANGE IN °C:	−192.7
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	2.144 (gas at −183°C), 1.614 (liquid at −195.4°C)

SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:

in water:	**@ 0°C**	49	**@ 50°C**	Soluble	**@ 100°C**	Soluble
in vegetable oil:	**@ 20°C**	Soluble	**@ 50°C**	Soluble	**@ 100°C**	Soluble
in sucrose solution:						
10%	Soluble					
40%	Soluble					
60%	Soluble					
in sodium chloride solution:						
5%	Soluble					
10%	Soluble					
15%	Soluble					

in ethanol solution:					
5%	Soluble				
20%	Soluble				
95%	Soluble				
100%	Soluble				
in propylene glycol:	**@ 20°C**	Soluble	**@ 50°C**	Soluble	**@ 100°C** Soluble

FUNCTION IN FOODS:

Used to disinfect water for direct consumption and water for use in surface treatment of fish, fruit and vegetables and other perishable food. Also used to fumigate and deodorise storage environments and processing equipment surfaces. Processing aid (Japan). May also be used in the bleaching of sugar

TECHNOLOGY OF USE IN FOODS:

Produced on-site by an ozone generator for air treatment. Added to water for direct consumption. Added to water to provide it with antimicrobial effect. Processing aid (Japan). Limitation 0.4 mg/L residual of bottled water. Concentrations of 0.015 ppm of ozone in air produce barely detectable odour; 1 ppm produces disagreeable sulphur-like odour. Highly reactive oxidising agent

Stability of ozone in aqueous solution decreases as alkalinity rises. This effect is reversed at high concentration (i.e. half-life of ozone is 2 minutes at 1 N NaOH and 83 hours at 20 N NaOH

ANTAGONISTS:

Incompatible with rubber and dinitrogen tetraoxide

FOOD SAFETY ISSUES:

Human poison by inhalation. May have, in large dosages, neoplastigen, tumorigenic, teratogenic and reprotoxicity effects (experimental). Human systemic effects by inhalation: visual field changes, eye lacrimation, headache, decreased pulse rate with fall in blood pressure, blood pressure decrease, skin dermatitis, cough, dyspnoea, respiratory stimulation and other pulmonary changes

Human mutagenic data. Skin, eye, upper respiratory system and mucous membrane irritant

Severe explosion hazard in liquid form when shocked and exposed to heat or flame or in concentrated form by chemical reaction with powerful reducing agent

LEGISLATION:

USA:
FDA 21 CFR 184.1563 Limitation of 0.4 mg/L in bottled water, affirmed as GRAS for use as an antimicrobial

CANADA:
Approved for use, according to GMP, as chemosterilant in water represented as mineral or spring water. Also approved as maturing agent in cider and wine, according to GMP

AUSTRALIA/PACIFIC RIM:
Japan: approved for use as a natural processing aid

REFERENCES:

www.medicinescomplete.com/mc/merck/current. Merck Index Online. Accessed 5–6 September 2009.
Anon. (1995) 1995 Encyclopedia of food ingredients. *Food in Canada*.
Ash, M. and Ash, I. (2008) *Handbook of Food Additives*, 3rd edn. Synapse Information Resources Inc., New York.
Compressed Gas Association (1999) *Handbook of Compressed Gases*, 4th edn. Compressed Gas Association/ Kluwer Academic Publishers, Boston, MA.
Lewis, R.J. Sr (1989) *Food Additives Handbook*. Van Nostrand Reinhold, New York.
Smoley, G.K. (1993) *Everything Added to Food in the United States*. U.S. Food and Drug Administration/ CRC Press, Boca Raton, FL.

ANY OTHER RELEVANT INFORMATION:

At 1 ppm, the sulphur-like odour may cause headache and irritation of eyes and upper respiratory tract; symptoms disappear on cessation of exposure

Part 9

Nutritive Additives

Gosia G. Zawadzka

This Part is based upon the First Edition contribution of Lori W. Léger and Gosia G. Zawadzka

Food Additives Data Book, Second Edition. Edited by Jim Smith and Lily Hong-Shum.

NAME:	L-Ascorbic acid
CATEGORY:	Nutritive additives
FOOD USE:	Bakery products/Beer/Canned fruits and vegetables/Cereal products/Cocoa confectionery and drink powders/Dairy products/Dietary supplements/Flour and bread/Fruit juices and drinks/Infant formulae/Meal replacements/Milk modifiers/Evaporated milk/Potato products/Sausages and other comminuted meats/Skim milk/Soft drinks/Sugar confectionery/Vegetable juices and wine
SYNONYMS:	Ascorbate/L-ascorbic acid/Cevitamic acid/Vitamin C/CAS 50-81-7/EINECS 200-066-2/FEMA 2109/INS No. 300/E300
FORMULA:	$C_6H_8O_6$
MOLECULAR MASS IN Daltons:	176.13
ALTERNATIVE FORMS:	Ascorbyl palmitate/Calcium ascorbate/Dehydroascorbic acid/Nicotinamide-ascorbic complex/Sodium ascorbate
PROPERTIES AND APPEARANCE:	Pleasant, sharp acidic taste. Various granulations available; fat-coated and ethyl cellulose-coated forms available. Stable to air when dry; not heat-stable at neutral pH White to slightly yellow crystalline powder
MELTING RANGE IN °C:	190–192
IONISATION CONSTANT AT 25°C:	$pK_1 = 4.17$; $pK_2 = 11.57$
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.65
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	1 g in ~3 mL **@ 45°C** 40 **@ 100°C** 80
in vegetable oil:	Insoluble

in ethanol solution:	
95%	1 g in ~30 mL
100%	1 g in ~50 mL
in propylene glycol:	**@ 20°C** 1 g in ~20 mL
FUNCTION IN FOODS:	Dry form used for fortification of infant formulae, meal replacements, fruit juices and drinks, cereal products, dairy products, sugar and cocoa confectionery. Antioxidant in fruit juices, soft drinks, beer, wine, canned fruit and vegetables, potato products and dairy products. Flour and bread improver. Curing agent and nitrosamine inhibitor in sausage and other comminuted meats Fat-coated and ethyl cellulose-coated forms used for fortification of milk modifiers, cocoa drink powders, bakery products; antioxidant in processed potatoes and sausages Also used as antimicrobial agent, antioxidant, colour fixative, flavouring, oxidant, preservative, raising agent, reducing agent
TECHNOLOGY OF USE IN FOODS:	Optimum pH is between 5 and 7; usage level as flour and bread improver is 50–200 ppm; usage level as a curing agent and nitrosamine inhibitor in sausage and other comminuted meats is 300–500 ppm
ANTAGONISTS:	Oxygen; light; minerals; heat-labile in neutral environments, but less so in highly acidic environments
FOOD SAFETY ISSUES:	Toxicology: LD_{50} (IV, mouse) 518 mg/kg. Some adverse effects can occur with extremely high repeated doses in the 500 mg to 10 g range
LEGISLATION:	**USA:** FDA 21 CFR §182.3013, 182.8013, GRAS Reference daily intake for adults and children over 4 years is 60 mg of vitamin C **UK and EUROPE:** Approved and listed, respectively RDA is 60 mg of vitamin C **CANADA:** For specific regulations, refer to Part D: Vitamins, Minerals and Amino Acids of the Food and Drug Regulations, Health and Welfare Canada Recommended daily intake of persons 2 years of age or older is 60 mg, for children less than 2 yrears of age is 20 mg of vitamin C **AUSTRALIA/PACIFIC RIM:** Japan: approved

REFERENCES:

Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT.

Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81.

Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

United Nations Joint FAO/WHO Expert Committee of Food Additives (2009) Electronic Codex Alimentarius. Available at: http://www.codexalimentarius.net/gsfaonline/additives/index.html. Accessed 28 February 2011.

U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.

ANY OTHER RELEVANT INFORMATION:

Potency of powder form is 100%; potency of fat-coated and ethyl cellulose-coated forms is 96% and 97.5%, respectively

One unit (USP or international) is the vitamin C activity of 0.05 mg of the USP ascorbic acid reference standard

NAME:	Ascorbyl palmitate
CATEGORY:	Nutritive additives
FOOD USE:	Beverages/Baked goods/Breads/Dietary supplements/Dietetic foods/Evaporated milk/Extruded cereals/Fats and oils/Fat-based products/Formulated liquid diets/Infant formulae/Meal replacements/Processed potatoes/Skim milk/Uncured frozen sausages
SYNONYMS:	L-Ascorbic acid 6-hexadecanoate/Palmitoyl L-ascorbic acid/Vitamin C/CAS 137-66-6/EINECS 205-305-4/E304
FORMULA:	$C_{22}H_{38}O_7$
MOLECULAR MASS IN Daltons:	414.52
ALTERNATIVE FORMS:	Calcium ascorbate/Sodium ascorbate
PROPERTIES AND APPEARANCE:	Citrus odour. White to yellowish crystalline powder. Not heat-stable
MELTING RANGE IN °C:	113–114
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in vegetable oil:	30 mg per 100 mL
FUNCTION IN FOODS:	Enrichment, fortification and restoration. Also used as antioxidant for fats and oils, colour preservative, emulsifier, sequestrant, stabiliser, antioxidant
TECHNOLOGY OF USE IN FOODS:	Optimum pH is between 5 and 7
SYNERGISTS:	α-Tocopherol
ANTAGONISTS:	Oxidation; light; minerals; heat-labile in neutral environments, but less so in highly acidic environments
FOOD SAFETY ISSUES:	Some adverse effects can occur with extremely high repeated doses in the 500 mg to 10 g ranges
LEGISLATION:	**USA:** FDA 21 CFR 182.3149 GRAS. Limitation of 0.02% in margarine. For adults and children 4 years or older, recommended daily intake is 60 mg of vitamin C **CANADA:** For specific regulations, refer to Part D: Vitamins, Minerals and Amino Acids of the Food and Drug Regulations, Health and Welfare Canada

UK and EUROPE:
Listed and approved, respectively
RDA is 60 mg vitamin C

For adults and children 2 years or older, recommended daily intake is 60 mg of vitamin C
For children less than 2 years old, recommended daily intake is 20 mg of vitamin C

AUSTRALIA/PACIFIC RIM:
Japan: approved

REFERENCES:

Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT.

Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81.

Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada.

U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.

ANY OTHER RELEVANT INFORMATION:

Potency is 43%

NAME:	Beta-carotene
CATEGORY:	Colours/Nutritive additives
FOOD USE:	Baked goods/Dairy products/Beverages/Soft drinks/Edible oils and fats/Vinegar, pickles and sauces/Sugars, sugar preserves and confectionery
SYNONYMS:	Provitamin A/Food Orange 5/Natural Yellow 26/C.I. 40800/C.I. 75130/CAS 7235-40-7/INS No. 160a(ii)
FORMULA:	$C_{40}H_{56}$
MOLECULAR MASS IN Daltons:	536.87
PROPERTIES AND APPEARANCE:	Oily suspensions: brick-red viscous oil stabilised with tocopherol, ascorbyl palmitate Emulsions: oil-in-water, stabilised with tocopherol or BHA/BHT Dry powders: red-brown, fine granular powder Fine orange powder
MELTING RANGE IN °C:	187.5
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** Insoluble **@ 100°C** Insoluble
in ethanol solution (100%):	Slightly soluble
FUNCTION IN FOODS:	Oily suspensions: coloration and fortification of oils and fats, dressings, butter, ice-cream, confectionery, fruit drinks Emulsions: coloration and fortification of fruit drinks, dairy products, pasta, bakery products, snacks, confectionery, dressings Dry powders: coloration and fortification of dairy products, pasta, snacks, bakery products, confectionery, beverages, soups, sauces, dressings Fine orange powder: coloration and fortification of instant products, confectionery, dairy products, pasta, snacks, bakery products
TECHNOLOGY OF USE IN FOODS:	Oily suspensions: soluble in warm fat or oil (50°C); colour range is yellow to orange Emulsions: water-dispersible; colour range is yellow to orange Dry powders: dispersible in hot water (60°C) to make stock solutions; colour range is orange Fine orange powder: cold water-dispersible; colour range is yellow Usage level: 20–50 ppm (as food colorant)

LEGISLATION:

USA:
FDA 21 CFR § 73.95, 73.1095, 73.2095, 166.110, 184.1245, GRAS
Reference daily intake for adults and children 4 years or older is 5000 IU of vitamin A

CANADA:
Food and Drug Regulations: D.03.002; B.16.100
Recommended daily intake of persons 2 years of age or older is 1000 RE, for children less than 2 years is 400 RE of vitamin A

UK and EUROPE:
UK: approved
Europe: listed

AUSTRALIA/PACIFIC RIM:
Japan: restricted

REFERENCES:

Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT.

Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81.

Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

United Nations Joint FAO/WHO Expert Committee of Food Additives (2009) Electronic Codex Alimentarius. Available at: http://www.codexalimentarius.net/gsfaonline/additives/index.html. Accessed 28 February 2011.

U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.

ANY OTHER RELEVANT INFORMATION:

Oily suspensions: 20–30% potency
Emulsions: 0.5–5% potency
Dry powders: 2.4–10% potency
Fine orange powder: 1% potency

NAME:	Biotin	
CATEGORY:	Nutritive additives	
FOOD USE:	Dietary supplements/Dietetic foods/Infant formulae/Meal replacements/Substitute foods	
SYNONYMS:	D-Biotin/Bios II B/Coenzyme R/Egg white injury factor/Vitamin H/CAS 58-85-5/EINECS 200-399-3	
FORMULA:	$C_{10}H_{16}N_2O_3S$	
MOLECULAR MASS IN Daltons:	244.31	
ALTERNATIVE FORMS:	There are eight stereoisomers, with naturally occurring D-biotin exhibiting the highest biological activity, while DL-biotin only contains half that activity and L-biotin is biologically inactive	
PROPERTIES AND APPEARANCE:	Heat stable. D-biotin is commercially available in white crystalline and powder forms	
MELTING RANGE IN °C:	232–233	
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:		
in water:	**@ 25°C** ~22 mg/100 mL	
in ethanol solution (95%):	~80 mg/100 mL	
FUNCTION IN FOODS:	Enrichment, fortification, or restoration	
TECHNOLOGY OF USE IN FOODS:	Serial dilution required; dilution can be made using dicalcium phosphate; pH is not critical for use. Biotin becomes inactive when combined with avidin in raw egg-white	
ANTAGONISTS:	Subject to oxidative deterioration when exposed to oxidising agents such as potassium permanganate or hydrogen peroxide; UV light	
FOOD SAFETY ISSUES:	No toxic symptoms as a result of heavy biotin dosage have been reported in humans	
LEGISLATION:	**USA:** FDA 21 CFR 182.8159 GRAS for specified applications For adults and children 4 years or older, reference daily intake is 300 μg of biotin	**CANADA:** For specific regulations, refer to Part D: Vitamins, Minerals and Amino Acids of the Food and Drug Regulations, Health and Welfare Canada Recommended daily intake for persons 2 years of age or older is 30 μg, for those less than 2 years is 8 μg biotin

UK and EUROPE:
RDA is 0.15 mg biotin

REFERENCES:

Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT.
Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81.
Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada.
O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.
U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.

ANY OTHER RELEVANT INFORMATION:

Potency of pure compound is 100%. The pure compound is stable to air and temperature. Moderately acid and neutral solutions are stable for several months; alkaline solutions are less stable but appear reasonably stable up to a pH of about 9. Aqueous solutions are very susceptible to mould growth. Acidic solutions can be heat-sterilised

NAME:	Calcium ascorbate
CATEGORY:	Nutritive additives
FOOD USE:	Breakfast cereals/Dietary supplements/Dietetic foods/Formulated liquid diets/Infant formulae/Low-sodium dietetic products/Meal replacements
SYNONYMS:	Ascorbic acid calcium salt/Vitamin C/CAS 5743-27-1/INS No. 302
FORMULA:	$C_{12}H_{14}CaO_{12}$
MOLECULAR MASS IN Daltons:	390.31
ALTERNATIVE FORMS:	Ascorbic acid/Ascorbyl palmitate/Sodium ascorbate
PROPERTIES AND APPEARANCE:	Odourless, bitter taste. Not heat-stable at neutral pH. White to slightly yellow powder
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	Freely soluble
FUNCTION IN FOODS:	Enrichment, fortification or restoration
TECHNOLOGY OF USE IN FOODS:	Optimum pH is between 5 and 7. Other uses include antioxidant, meat colour preservative, preservative
ANTAGONISTS:	Oxidation; light; minerals; heat-labile in neutral environments, but less so in highly acidic environments
FOOD SAFETY ISSUES:	Some adverse effects can occur with extremely high repeated doses in the 500 mg to 10 g range
LEGISLATION:	**USA:** FDA 21 CFR 182.3189 GRAS for specified applications For adults and children 4 years or older, reference daily intake is 60 mg vitamin C **UK and EUROPE:** RDA is 60 mg vitamin C **CANADA:** For specific regulations, refer to Part D: Vitamins, Minerals and Amino Acids of the Food and Drug Regulations, Health and Welfare Canada For adults and children 2 years or older, recommended daily intake is 60 mg vitamin C For children less than 2 years old, recommended daily intake is 20 mg vitamin C

REFERENCES:

Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT.
Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81.
Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada.
O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.
United Nations Joint FAO/WHO Expert Committee of Food Additives (2009) Electronic Codex Alimentarius. Available at: http://www.codexalimentarius.net/gsfaonline/additives/index.html. Accessed 28 February 2011.
U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.

ANY OTHER RELEVANT INFORMATION:

Potency is 83%. Aqueous solutions are neutral and oxidise quickly

NAME:	Calcium carbonate
CATEGORY:	Nutritive additives
FOOD USE:	Breads/Cornmeal/Dietary supplements/Dietetic foods/Farina/Flour/Formulated liquid diets/Infant formulae/Meal replacements/Pasta/Rice/Baking powder/Chewing gum
SYNONYMS:	Carbonic acid calcium salt (1:1)/Limestone/Precipitated calcium carbonate/Precipitated chalk/CAS 471-34-1/EINECS 207-439-9/INS No. 170(i)/E170
FORMULA:	$CaCO_3$
MOLECULAR MASS IN Daltons:	100.09
PROPERTIES AND APPEARANCE:	Odourless, tasteless white powder or crystals. Bioavailability of pure compound is fair, but may be altered in presence of other food components
MELTING RANGE IN °C:	825 (decomposes)
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	2.7–2.95
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	Not soluble
FUNCTION IN FOODS:	Enrichment, fortification or restoration. Also used as pH control agent, dough conditioner, firming agent, modifier for chewing gum, yeast food
ALTERNATIVES:	Calcium chloride; calcium citrate; calcium glycerophosphate; calcium hydroxide; calcium lactate pentahydrate; calcium oxide; calcium phosphate monobasic; calcium phosphate dibasic; calcium phosphate tribasic; calcium pyrophosphate; calcium sulphate; ground limestone
TECHNOLOGY OF USE IN FOODS:	Incompatible with acids
ANTAGONISTS:	Acids
FOOD SAFETY ISSUES:	Toxicology: LD_{50} (oral, rat) 6450 mg/kg

LEGISLATION:

WHO limitation: 40 g/kg (cheese); 200 mg/kg (jams, jellies)

USA:
GRAS for specified applications
For adults and children 4 years or older, reference daily intake is 1000 mg calcium

UK and EUROPE:
Approved and listed, respectively
RDA is 800 mg calcium

CANADA:
For specific regulations, refer to Part D: Vitamins, Minerals and Amino Acids of the Food and Drug Regulations, Health and Welfare Canada
For adults and children 2 years or older, recommended daily intake is 1100 mg calcium
For children less than 2 years old, recommended daily intake is 500 mg calcium

AUSTRALIA/PACIFIC RIM:
Japan: approved (1–2%)

REFERENCES:

Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT.

Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81.

Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

United Nations Joint FAO/WHO Expert Committee of Food Additives (2009) Electronic Codex Alimentarius. Available at: http://www.codexalimentarius.net/gsfaonline/additives/index.html. Accessed 28 February 2011.

U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.

ANY OTHER RELEVANT INFORMATION:

40.0% calcium

NAME:	Calcium glycerophosphate
CATEGORY:	Nutritive additives
FOOD USE:	Breads/Cereals/Cornmeal/Dietary supplements/Dietetic foods/Farina/Flour/Formulated liquid diets/Infant formulae/Meal replacements/Pasta/Rice/Gelatins/Puddings/Fillings
SYNONYMS:	β-Glycerophosphate (calcium salt)/Calcium glycerinophosphate/Calcium phosphoglycerate/CAS 126-95-4/EINECS 248-328-5
FORMULA:	$C_3H_7CaO_6P$
MOLECULAR MASS IN Daltons:	210.14
PROPERTIES AND APPEARANCE:	Odourless; almost tasteless; slightly hygroscopic; slightly alkaline. Bioavailability unknown. Fine white powder
MELTING RANGE IN °C:	Decomposes above 170
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	Moderate @ 20°C Soluble in about 50 parts water @ 100°C Almost insoluble
in ethanol solution:	Insoluble
FUNCTION IN FOODS:	Enrichment, fortification or restoration. Also used as a stabiliser
ALTERNATIVES:	Calcium carbonate; calcium chloride; calcium citrate; calcium hydroxide; calcium lactate pentahydrate; calcium oxide; calcium phosphate monobasic; calcium phosphate dibasic; calcium phosphate tribasic; calcium pyrophosphate; calcium sulphate; ground limestone
LEGISLATION:	**USA:** FDA 21 CFR 184.1201 GRAS for specified applications For adults and children 4 years or older, reference daily intake is 1000 mg calcium **CANADA:** For specific regulations, refer to Part D: Vitamins, Minerals and Amino Acids of the Food and Drug Regulations, Health and Welfare Canada For adults and children 2 years or older, recommended daily intake is 1100 mg calcium For children less than 2 years old, recommended daily intake is 500 mg of calcium

	UK and EUROPE: RDA is 800 mg calcium	**AUSTRALIA/PACIFIC RIM:** Japan: restricted (1% max. as calcium)

REFERENCES:

Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT.

Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.

ANY OTHER RELEVANT INFORMATION: Contains 19.1% calcium

NAME:	Calcium lactate pentahydrate
CATEGORY:	Nutritive additives
FOOD USE:	Beverages/Breads/Cereals/Cornmeal/Dietary supplements/Dietetic foods/Farina/Flour/Formulated liquid diets/Juices/Meal replacements/Pasta/Rice
SYNONYMS:	2-Hydroxypropanoic acid calcium salt/CAS 814-80-2/EINECS 212-406-7/INS No. 327
FORMULA:	$+ C_6H_{10}CaO6 \cdot xH_2O$ $(x = 0–5)$
MOLECULAR MASS IN Daltons:	218.22 (anhydrous)
PROPERTIES AND APPEARANCE:	Odourless; tasteless; neutral; hygroscopic. Bioavailability of pure compound is good, but may be altered in presence of other food components. White effervescent granules or powder
PURITY %:	98
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	Very soluble in hot water
FUNCTION IN FOODS:	Enrichment, fortification or restoration. Also used as a preservative
ALTERNATIVES:	Calcium carbonate; calcium chloride; calcium citrate; calcium glycerophosphate; calcium hydroxide; calcium oxide; calcium phosphate monobasic; calcium phosphate dibasic; calcium phosphate tribasic; calcium pyrophosphate; calcium sulphate; ground limestone
LEGISLATION:	**USA:** Regulations: FDA 21CFR 184.1207 GRAS. For adults and children 4 years or older, reference daily intake is 1000 mg calcium **UK and EUROPE:** Recommended daily allowance is 800 mg calcium **CANADA:** For specific regulations, refer to Part D: Vitamins, Minerals and Amino Acids of the Food and Drug Regulations, Health and Welfare Canada. For adults and children 2 years or older, recommended daily intake is 1100 mg calcium For children less than 2 years, recommended daily intake is 500 mg calcium

REFERENCES:

Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT.

Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81.

Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

United Nations Joint FAO/WHO Expert Committee of Food Additives (2009) Electronic Codex Alimentarius. Available at: http://www.codexalimentarius.net/gsfaonline/additives/index.html. Accessed 28 February 2011.

U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.

ANY OTHER RELEVANT INFORMATION:

Anhydrous compound is 18.4% calcium; hydrous compound is 13.0% calcium

NAME:	Calcium-D-pantothenate
CATEGORY:	Nutritive additives
FOOD USE:	Cereals and cereal products/Dairy products/Soft drinks/Sugars, sugar preserves and confectionery
SYNONYMS:	Calcium *N*-(2,4-dihydroxy-3,3-dimethyl-l-oxobutyl)-β-alanine/Vitamin B_5 (calcium salt)/Calcium pantothenate/CAS 137-08-6
FORMULA:	$C_9H_{16}NO_5 \cdot {}^1/_2Ca$
MOLECULAR MASS IN Daltons:	490.63
ALTERNATIVE FORMS:	Pantothenic acid
PROPERTIES AND APPEARANCE:	White powder
MELTING RANGE IN °C:	170–172
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	@ 20°C Soluble
in ethanol solution:	
5%	Insoluble
100%	Insoluble
FUNCTION IN FOODS:	Fortification of infant formulae, breakfast cereals, fruit drinks, sugar and cocoa confectionery, milk drinks, meal replacements
TECHNOLOGY OF USE IN FOODS:	Direct food additive. Only D isomer has vitamin activity; both D and DL isomers used in food
LEGISLATION:	**USA:** FDA 21 CFR §184.1212, GRAS Reference daily intake for adults and children 4 years or older is 10 mg of pantothenic acid **AUSTRALIA/PACIFIC RIM:** Japan: approved (1% max. as calcium)
	CANADA: Food and Drug Regulations: D.03.002 Recommended daily intake of persons 2 years of age or older is 7 mg, for less than 2 years old is 2 mg pantothenic acid or pantothenate

REFERENCES:

Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT.
Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81.
Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada.
O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.
U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.

ANY OTHER RELEVANT INFORMATION:

Potency 92.0%

NAME:	Calcium phosphate dibasic
CATEGORY:	Nutritive additives
FOOD USE:	Breads/Cereals/Cornmeal/Dietary supplements/Dietetic foods/Farina/Flour/Formulated liquid diets/Infant formulae/Meal replacements/Pasta/Rice/Desserts gels
SYNONYMS:	Calcium hydrogen orthophosphate/Calcium hydrogen phosphate anhydrous/Calcium monohydrogen phosphate/DCP-0/Dicalcium orthophophate/Dicalcium phosphate/Phosphoric acid calcium salt (1:1)/ Secondary calcium phosphate/CAS 7757-93-9/EINECS 231-826-1/INS No. 341(ii)/E341b
FORMULA:	$CaHPO_4$
MOLECULAR MASS IN Daltons:	136.06
ALTERNATIVE FORMS:	Calcium phosphate tribasic/Calcium phosphate monobasic
PROPERTIES AND APPEARANCE:	Odourless, tasteless, alkaline, white crystalline powder
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	2.306
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	Not soluble
FUNCTION IN FOODS:	Enrichment, fortification or restoration. Also used as antioxidant synergist, dough conditioner, firming agent, stabiliser, yeast food for baked goods
ALTERNATIVES:	Calcium carbonate; calcium chloride; calcium citrate; calcium glycerophosphate; calcium hydroxide; calcium lactate pentahydrate; calcium oxide; calcium phosphate monobasic; calcium phosphate tribasic; calcium pyrophosphate; calcium sulphate; ground limestone
TECHNOLOGY OF USE IN FOODS:	Affects vitamin B_1 stability
LEGISLATION:	**USA:** FDA 21CFR 181.29, 182.1217, 182.8217 GRAS when used in accordance with GMP **CANADA:** For specific regulations, refer to Part D: Vitamins, Minerals and Amino Acids of the Food and Drug Regulations, Health and Welfare Canada

GRAS for specified applications
For adults and children 4 years or older, reference daily intake is 1000 mg calcium

For adults and children 2 years or older, recommended daily intake is 1100 mg calcium
For children less than 2 years old, recommended daily intake is 500 mg calcium

UK and EUROPE:
Approved and listed respectively
RDA is 800 mg calcium

AUSTRALIA/PACIFIC RIM:
Japan: approved (1% max. as calcium)

REFERENCES:

Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT.

Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81.

Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

United Nations Joint FAO/WHO Expert Committee of Food Additives (2009) Electronic Codex Alimentarius. Available at: http://www.codexalimentarius.net/gsfaonline/additives/index.html. Accessed 28 February 2011.

U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.

ANY OTHER RELEVANT INFORMATION:

Anhydrous compound is 30% calcium; also a source of phosphorus

NAME:	Calcium phosphate tribasic
CATEGORY:	Nutritive additives
FOOD USE:	Breads/Cereals/Cornmeal/Dietary supplements/Dietetic foods/Farina/Flour/Formulated liquid diets/Infant formulae/Meal replacements/Pasta/Rice
SYNONYMS:	Calcium hydroxide phosphate/Calcium orthophosphate/Calcium phosphate tertiary/Precipitated calcium phosphate/TCP/Tertiary calcium phosphate/Tricalcium orthophosphate/Tribasic calcium phosphate/ Tricalcium phosphate/CAS 7758-87-4/EINECS 231-840-8/INS No. 341(iii)/E341c
FORMULA:	$Ca_3O_8P_2$
MOLECULAR MASS IN Daltons:	310.18
ALTERNATIVE FORMS:	Calcium phosphate dibasic/Calcium phosphate monobasic
PROPERTIES AND APPEARANCE:	Odourless, tasteless, white crystalline powder. Bioavailability of pure compound is fair and may be altered in presence of other food components; alkaline
MELTING POINT IN °C:	1670
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	3.14
PURITY %:	96
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	Practically insoluble
FUNCTION IN FOODS:	Enrichment, fortification or restoration. Also used as anti-caking agent, buffering agent, chewing gum base, clarifying agent, emulsifier (Japan), fat rendering aid, leavening agent, stabiliser, yeast nutrient
ALTERNATIVES:	Calcium carbonate; calcium chloride; calcium citrate; calcium glycerophosphate; calcium hydroxide; calcium lactate pentahydrate; calcium oxide; calcium phosphate monobasic; calcium phosphate dibasic; calcium pyrophosphate; calcium sulphate; ground limestone
TECHNOLOGY OF USE IN FOODS:	Affects vitamin B_1 stability

LEGISLATION:

USA:
GRAS for specified applications
For adults and children 4 years or older, reference daily intake is 1000 mg calcium

UK and EUROPE:
Approved and listed, respectively
RDA is 800 mg calcium

OTHER COUNTRIES:
FAO/WHO: ADI 0–70 mg/kg total phosphorus

CANADA:
For specific regulations, refer to Part D: Vitamins, Minerals and Amino Acids of the Food and Drug Regulations, Health and Welfare Canada
For adults and children 2 years or older, recommended daily intake is 1100 mg calcium
For children less than 2 years old, recommended daily intake is 500 mg calcium

AUSTRALIA PACIFIC RIM:
Japan: approved (1% max. as calcium), restricted intake

REFERENCES:

Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT.

Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81.

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U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.

ANY OTHER RELEVANT INFORMATION:

Anhydrous compound is 38.8% calcium

NAME:	Cholecalciferol
CATEGORY:	Nutritive additives
FOOD USE:	Breakfast cereals/Cereal products/Cornmeal/Dietary supplements/Dietetic foods/Egg products/Farina/Fats and oils/Formulated liquid diets/Infant formulae/Liquid milk/Margarine/Meal replacements/Milk powder/Pasta/Rice
SYNONYMS:	Calciol/5,7-Cholestadien-3-β-ol/Colecalciferol/Activated 7-dehydrocholesterol/Oleovitamin D_3/Vitamin D_3/CAS 67-97-0/EINECS 200-673-2
FORMULA:	$C_{27}H_{44}O$
MOLECULAR MASS IN Daltons:	384.64
ALTERNATIVE FORMS:	Calciferol/Provitamin 7-dehydrocholesterol
PROPERTIES AND APPEARANCE:	Unstable in light and air; oily blends stabilised with tocopherol Oily blends: clear, colourless to slightly yellow Dry blends: off-white to yellowish fine granular powder
MELTING RANGE IN °C:	84–85
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	Practically insoluble
in vegetable oil:	Slightly soluble
in ethanol solution:	Soluble
FUNCTION IN FOODS:	Enrichment, fortification or restoration
ALTERNATIVES:	Vitamin D_2
TECHNOLOGY OF USE IN FOODS:	Frequently diluted for use by preparing in either an oily blend or a dry powder. Oily blends are soluble in fats and oils; homogenising in a small amount of liquid is necessary prior to adding to milk and infant formulae. Dry powders are water dispersible
ANTAGONISTS:	Air; humidity; oxygen

FOOD SAFETY ISSUES:

Toxicology: LD_{50} (oral, rat) 42 mg/kg. Repeated daily dosages exceeding 400 IU for children and 1000 IU for adults should be avoided

LEGISLATION:

USA:
FDA 21 CFR 166.110, 184.1950
GRAS with limitation of 250 IU/100 g in breakfast cereals, 90 IU/100 g in grain products and pastas, 42 IU/100 g in milk, 89 IU/100 g in milk products when used in accordance with GMP
GRAS in specified application
For adults and children over 4 years, reference daily intake is 400 IU vitamin D

UK and EUROPE:
RDA is 5 µg vitamin D

CANADA:
For specific regulations, refer to Part D: Vitamins, Minerals and Amino Acids of the Food and Drug Regulations, Health and Welfare Canada
For adults and children over 2 years, recommended daily intake is 5 µg vitamin D
For children under 2 years old, recommended daily intake is 10 µg vitamin D

AUSTRALIA/PACIFIC RIM:
Japan: approved for use

REFERENCES:

Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT.
Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81.
Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada.
O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

ANY OTHER RELEVANT INFORMATION:

1 µg cholecalciferol = 40 IU vitamin D

Deterioration of pure crystal vitamin D_3 is negligible after 1 year of storage in amber evacuated ampoules at refrigerated temperatures

NAME:	Cupric gluconate
CATEGORY:	Nutritive additives
FOOD USE:	Dietary supplements/Dietetic foods/Formulated liquid diets/Infant formulae/Meal replacements
SYNONYMS:	Bis(D-gluconato) copper/Copper (II) gluconate/Cupric gluconate/CAS 527-09-3/EINECS 208-408-2
FORMULA:	$C_{12}H_{22}CuO_{14}$
MOLECULAR MASS IN Daltons:	453.85
ALTERNATIVE FORMS:	Cupric gluconate hydrate
PROPERTIES:	Light blue to blue/green crystalline powder. Odourless crystals; astringent taste. Good bioavailability, but may be altered in presence of other food components
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	Very soluble **@ 25°C** 30 g/100 mL
in ethanol solution:	Slightly soluble
FUNCTION IN FOODS:	Enrichment, fortification or restoration
ALTERNATIVES:	Cupric sulphate
TECHNOLOGY OF USE IN FOODS:	Affects vitamin C stability
LEGISLATION:	**USA:** GRAS for specified applications For adults and children 4 or older, reference daily intake is 2 mg copper **UK and EUROPE:** RDA is not available **CANADA:** For specific regulations, refer to Part D: Vitamins, Minerals and Amino Acids of the Food and Drug Regulations, Health and Welfare Canada Recommended daily intake for persons 2 years and older is 2 mg, for children less than 2 years old is 0.5 mg copper **AUSTRALIA/PACIFIC RIM:** Japan: approved (0.6 mg/L as copper in milk)

REFERENCES:

Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT.
Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81.
Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada.
O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.
U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.

ANY OTHER RELEVANT INFORMATION:

Anhydrous form is 14% copper; hydrous form is 13.5% copper

NAME:	Cyanocobalamin
CATEGORY:	Nutritive additives
FOOD USE:	Dietary supplement/Dietetic foods/Egg products/Formulated liquid diets/Heat-and-serve dinners/Infant formulae/Meal replacements
SYNONYMS:	Vitamin B_{12}/Cyanocon (III) alamin/α-(5,6-Dimethylbenzimidazolyl) cyanocobamide/Extrinsic factor/CAS 68-19-9/EINECS 200-680-0
FORMULA:	$C_{63}H_{88}CoN_{14}O_{14}P$
MOLECULAR MASS IN Daltons:	1355.37
ALTERNATIVE FORMS:	Methylcobalamin/Cobalamide (bioactive forms)
PROPERTIES AND APPEARANCE:	Dark red crystalline powder; can be diluted with sugar starch or dicalcium phosphate to give a fine pink powder. Very hygroscopic; fairly heat stable; odourless and tasteless
MELTING RANGE IN °C:	>300
WATER CONTENT MAXIMUM IN %:	12
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	1 g dissolves in 80 mL
in ethanol solution:	Soluble
FUNCTION IN FOODS:	Enrichment, fortification or restoration
TECHNOLOGY OF USE IN FOODS:	Serial dilution of pure compound required. Commercially available in crystalline form as spray-dried powders in low and medium concentrations of 0.1 and 1.0%, respectively; as triturate products in mannitol or dicalcium phosphate, or encapsulated in gelatin coating. The spray-dried low concentrate appears to be the form most used in food applications. Optimum pH for use is 4–5
ANTAGONISTS:	Light; reducing agents
FOOD SAFETY ISSUES:	There appears to be no hazard to humans due to excessive intake in foods

LEGISLATION:

USA:
FDA 21CFR 184.1945
GRAS when used in accordance with GMP for specified applications
For adults and children 4 years or older, reference daily intake is 6 μg of vitamin B_{12}

UK and EUROPE:
RDA is 1 μg vitamin B_{12}

CANADA:
For specific regulations, refer to Part D: Vitamins, Minerals and Amino Acids of the Food and Drug Regulations, Health and Welfare Canada
For adults and children 2 years or older recommended daily allowance is 2 μg of vitamin B_{12}
For children less than 2 years old, recommended daily allowance is 0.3 μg of vitamin B_{12}

AUSTRALIA/PACIFIC RIM:
Japan: approved

REFERENCES:

Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT.

Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81.

Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.

ANY OTHER RELEVANT INFORMATION:

Potency of pure compound is 100%

NAME:	Ergocalciferol
CATEGORY:	Nutritive additives
FOOD USE:	Breakfast cereals/Cereal products/Cornmeal/Dairy products/Dietary supplements/Dietetic foods/Egg products/Farina/Fats and oils/Formulated liquid diets/Infant formulae/Margarine/Meal replacements/Pasta/Rice
SYNONYMS:	Calciferol/Ercalciol/Ergosterol, activated or irradiated/Oleovitamin D_2/Viosterol/Vitamin D/CAS 50-14-6/EINECS 200-014-9
FORMULA:	$C_{28}H_{44}O$
MOLECULAR MASS IN Daltons:	396.65
ALTERNATIVE FORMS:	7-dehydrocholesterol/Ergosterol/7-Procholesterol
PROPERTIES AND APPEARANCE:	Crystalline white powder; odourless
MELTING RANGE IN °C:	115–118
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	Insoluble
in vegetable oil:	Slightly soluble
in propylene glycol:	Soluble
FUNCTION IN FOODS:	Enrichment, fortification or restoration
ALTERNATIVES:	Vitamin D_2
ANTAGONISTS:	Air; heat; light especially excess UV irradiation; oxygen
FOOD SAFETY ISSUES:	Repeated daily dosages exceeding 400 IU for children and 1000 IU for adults should be avoided

LEGISLATION:

USA:
FDA 21CFR 172.379; 184.1950 GRAS in specified applications
For adults and children over 4 years, reference daily intake is 400 IU vitamin D

UK and EUROPE:
RDA is 5 μg vitamin D

CANADA:
For specific regulations, refer to Part D: Vitamins, Minerals and Amino Acids of the Food and Drug Regulations, Health and Welfare Canada
For adults and children over 2 years, recommended daily intake is 5 μg vitamin D
For children under 2 years old, recommended daily intake is 10 μg vitamin D

AUSTRALIA/PACIFIC RIM:
Japan: approved for use

REFERENCES:

Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT.

Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81.

Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.

ANY OTHER RELEVANT INFORMATION:

May be kept without deterioration for 9 months in amber evacuated ampoules at refrigerated temperatures.
1 IU Vitamin $D_2 = 0.0258$ mg ergocalciferol

NAME:	Ferric orthophosphate
CATEGORY:	Nutritive additives
FOOD USE:	Breads/Cereals/Cornmeal/Dietary supplements/Dietetic foods/Egg products/Farina/Flour/Formulated liquid diets/Fruit-flavoured drinks and bases/Heat-and-serve dinners/Infant cereals/Infant formulae/Meal replacements/Rice/Pasta/Peanut spreads/Simulated meat and poultry products
SYNONYMS:	Iron phosphate/Iron (III) phosphate/Ferric phosphate/Ferric (III) phosphate/Ferriphosphate/CAS 10045-86-0 anhydrous, 14940-41-1 tetrahydrate/EINECS 233-149-7 anhydrous, 239-018-0 tetrahydrate
FORMULA:	$FePO_4 \cdot xH_2O$
MOLECULAR MASS IN Daltons:	150.82 (anhydrous)
PROPERTIES AND APPEARANCE:	Dihydrate is white, greyish-white, or light pink crystals or amorphous powder. Tasteless. Bioavailability of pure compound is poor
MELTING POINT IN °C:	Loses water above 140
DENSITY:	2.87 (dihydrate)
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	Practically insoluble in water
FUNCTION IN FOODS:	Enrichment, fortification or restoration
ALTERNATIVES:	Ferric choline citrate; ferric pyrophosphate; ferrous fumarate; ferrous gluconate; ferrous lactate; ferrous sulphate; reduced elemental iron; sodium iron pyrophosphate
TECHNOLOGY OF USE IN FOODS:	Used when whiteness and inertness are priorities. Phytic acid, fibres, phosphates, polyphenolics, some proteins, and organic acids can adversely affect iron absorption, whereas other compounds such as ascorbic acid and some amino acids enhance the absorption of this mineral
FOOD SAFETY ISSUES:	When heated to decomposition, toxic fumes of PO_x are emitted

LEGISLATION:

USA:
FDA 21 CFR 184.1301 GRAS for specified applications
For adults and children 4 years or older, reference daily intake is 18 mg iron

UK and EUROPE:
RDA 14 mg iron

CANADA:
For specific regulations, refer to Part D: Vitamins, Minerals and Amino Acids of the Food and Drug Regulations, Health and Welfare Canada
For adults and children 2 years or older, recommended daily intake is 14 mg iron
For children less than 2 years old, recommended daily intake is 7 mg iron

REFERENCES:

Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT.

Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81.

Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.

ANY OTHER RELEVANT INFORMATION:

29.9% iron

NAME:	Ferrous fumarate
CATEGORY:	Nutritive additive
FOOD USE:	Breads/Cereals/Cornmeal/Dietary supplements/Dietetic foods/Egg products/Farina/Flour/Formulated liquid diets/Fruit flavoured drinks and bases/Heat-and-serve dinners/Infant cereals/Infant formulae/Meal replacements/Rice/Pasta/Peanut spreads/Simulated meat and poultry products/Waffles
SYNONYMS:	Iron (II) fumarate/CAS 141-01-5/EINECS 205-447-7
FORMULA:	$C_4H_2FeO_4$
MOLECULAR MASS IN Daltons:	169.90
PROPERTIES AND APPEARANCE:	Reddish-orange to reddish-brown granular powder. Odourless; almost tasteless. Bioavailability of pure compound is excellent, but may be altered in presence of other food components
MELTING POINT IN °C:	Not melted at 280
DENSITY:	2.435 at 25°C
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 25°C** 0.14 g/100 mL
in ethanol solution (95%):	<0.01 g/100 mL
FUNCTION IN FOODS:	Enrichment, fortification or restoration
ALTERNATIVES:	Ferric choline citrate; ferric orthophosphate; ferric pyrophosphate; ferrous gluconate; ferrous lactate; ferrous sulphate; reduced elemental iron; sodium iron pyrophosphate
TECHNOLOGY OF USE IN FOODS:	Affects vitamin C stability. Phytic acid, fibres, phosphates, polyphenolics, some proteins, and organic acids can adversely affect iron absorption, whereas other compounds such as ascorbic acid and some amino acids enhance the absorption of this mineral
FOOD SAFETY ISSUES:	Toxicology: LD_{50} (oral, rat) 3850 mg/kg

LEGISLATION:

USA:
FDA 21 CFR 172.350; 184.1307d
GRAS for specified applications
For adults and children 4 years or older, reference daily intake is 18 mg iron

UK and EUROPE:
RDA 14 mg iron

CANADA:
For specific regulations, refer to Part D: Vitamins, Minerals and Amino Acids of the Food and Drug Regulations, Health and Welfare Canada
For adults and children 2 years or older, recommended daily intake is 14 mg iron
For children less than 2 years old, recommended daily intake is 7 mg iron

REFERENCES:

Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT.

Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81.

Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.

ANY OTHER RELEVANT INFORMATION:

Contains minimum 31.3% total iron

NAME:	Ferrous sulphate, anhydrous
CATEGORY:	Nutritive additives
FOOD USE:	Breads/Cereals/Cornmeal/Dietary supplements/Dietetic foods/Egg products/Farina/Flour/Formulated liquid diets/Fruit-flavoured drinks and bases/Heat-and-serve dinners/Infant cereals/Infant formulae/Meal replacements/Rice/Pasta/Peanut spreads/Simulated meat and poultry products
SYNONYMS:	Iron sulphate (ous)/Iron (II) sulphate (1:1)/Iron vitriol/Copperas/Green vitriol/Sal chalybis/CAS 7720-78-7/EINECS 231-753-5
FORMULA:	$FeSO_4$
MOLECULAR MASS IN Daltons:	151.91
ALTERNATIVE FORMS:	Monohydrate, heptahydrate
PROPERTIES AND APPEARANCE:	Greyish white to yellow crystalline powder. Metallic taste. Bioavailability of pure compound is excellent, but may be altered in presence of other food components
MELTING POINT IN °C:	64
DENSITY:	1.89
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	Slowly soluble
in ethanol solution:	Insoluble
FUNCTION IN FOODS:	Enrichment, fortification or restoration
ALTERNATIVES:	Ferric choline citrate; ferric orthophosphate; ferric pyrophosphate; ferrous fumarate; ferrous gluconate; ferrous lactate; reduced elemental iron; sodium iron pyrophosphate
TECHNOLOGY OF USE IN FOODS:	Affects vitamin C stability. Phytic acid, fibres, phosphates, polyphenolics, some proteins, and organic acids can adversely affect iron absorption, whereas other compounds such as ascorbic acid and some amino acids enhance the absorption of this mineral
FOOD SAFETY ISSUES:	Toxicology: LD_{50} (oral, rat) 319 mg/kg

LEGISLATION:

USA:
GRAS for specified applications
For adults and children 4 years and older, reference daily intake is 18 mg iron

UK and EUROPE:
RDA 14 mg iron

AUSTRALIA/PACIFIC RIM:
Japan: approved

CANADA:
For specific regulations, refer to Part D: Vitamins, Minerals and Amino Acids of the Food and Drug Regulations, Health and Welfare Canada
For adults and children 2 years and older, recommended daily intake is 14 mg iron
For children less than 2 years old, recommended daily intake is 7 mg iron

REFERENCES:

Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT.

Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81.

Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.

ANY OTHER RELEVANT INFORMATION:

36.8% iron

NAME:	Folic acid
CATEGORY:	Nutritive additives
FOOD USE:	Breakfast cereals/Fruit drinks/Dietary supplement/Dietetic foods/Egg products/Flour/Formulated liquid diets/Infant formulae/Meal replacements/Milk drinks/Sugar and cocoa confectionery/Peanut spreads
SYNONYMS:	Folacin/Folate/Pteroylglutamic acid/Vitamin M/CAS 59-30-3/EINECS 200-419-0
FORMULA:	$C_{19}H_{19}N_7O_6$
MOLECULAR MASS IN Daltons:	441.4
ALTERNATIVE FORMS:	Folinic acid or citrovorum factor/Pteroyltriglutamic acid/Pteroylheptaglutamic acid/7,8-dihydro- or 5,6,7,8-tetrahydrofolic
PROPERTIES AND APPEARANCE:	Yellow to orange crystalline powder. Odourless; not heat-stable
MELTING POINT IN °C:	No melting point; darkens and chars at 250
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 25°C** Very slightly soluble (0.0016 mg/mL) **@ 100°C** About 1%
in ethanol solution:	Insoluble
FUNCTION IN FOODS:	Enrichment, fortification or restoration
TECHNOLOGY OF USE IN FOODS:	Serial dilution may be required; optimum pH is 6–9
ANTAGONISTS:	Oxygen; light; reducing agents; labile to acid and light when in solution; heat lability depends on the type of compound, the pH of the heating medium, and the presence or absence of reducing agents
FOOD SAFETY ISSUES:	Toxicology: LD_{50} (IV, rat) 500 mg/kg; folacin has a low toxicity for humans
LEGISLATION:	**USA:** FDA 21 CFR 172.345 For adults and children 4 years or older, the reference daily intake is 400 μg of folate **CANADA:** For specific regulations, refer to Part D: Vitamins, Minerals and Amino Acids of the Food and Drug Regulations, Health and Welfare Canada

For pregnant or lactating women, the reference daily intake is 800 µg of folate
For children under 4 years old, the reference daily intake is 300 µg of folate
For infants, the reference daily intake is100 µg of folate

UK and EUROPE:
RDA 200 µg

For adults and children 2 years or older, the recommended daily intake is 220 µg of folacin
For children under 2 years old, the recommended daily intake is 65 µg of folacin

AUSTRALIA/PACIFIC RIM:
Japan: approved for use

REFERENCES:

Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT.

Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81.

Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.

ANY OTHER RELEVANT INFORMATION:

Potency of pure compound is 90%

NAME:	Magnesium carbonate hydroxide
CATEGORY:	Nutritive additives
FOOD USE:	Alimentary pastes/Breakfast cereals/Dietary supplements/Dietetic foods/Egg products/Flour/Formulated liquid diets/Infant formulae
SYNONYMS:	Magnesite/Magnesium carbonate basic/Magnesium hydroxide carbonate/CAS 39409-82-0/EINECS 235-192-7
FORMULA:	Approx. $(MgCO_3)_4 \cdot Mg(OH)_2 \cdot 5H_2O$
MOLECULAR MASS IN Daltons:	Approx. 485.0
ALTERNATIVE FORMS:	Aluminium magnesium hydroxide carbonate
PROPERTIES AND APPEARANCE:	White powder, odourless, tasteless to chalky. Excellent bioavailability, but may be altered in presence of other food components; slightly effervescent in water
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	Soluble in about 3300 parts CO_2-free water; more soluble in water containing CO_2
FUNCTION IN FOODS:	Enrichment, fortification or restoration. Also used as anti-caking agent, flour conditioner, lubricant, pH control agent, processing aid, release agent
ALTERNATIVES:	Magnesium carbonate; magnesium chloride; magnesium hydroxide; magnesium oxide; magnesium phosphate dibasic; magnesium stearate; magnesium sulphate
LEGISLATION:	**USA:** FDA 21 CFR 184.1425 GRAS for specified applications For adults and children 4 years or older, reference daily intake is 400 mg magnesium **CANADA:** For specific regulations, refer to Part D: Vitamins, Minerals and Amino Acids of the Food and Drug Regulations, Health and Welfare Canada For adults and children 2 or older, recommended daily intake is 250 mg magnesium For children under 2 years old, recommended daily intake is 55 mg

UK and EUROPE:
RDA 300 mg of magnesium

REFERENCES:

Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT.
Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81.
Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada.
O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.
U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.

ANY OTHER RELEVANT INFORMATION:
Magnesium content varies from 25 to 30%

NAME:	Magnesium oxide, heavy
CATEGORY:	Nutritive additives
FOOD USE:	Alimentary pastes/Breakfast cereals/Dietary supplements/Dietetic foods/Egg products/Flour/Formulated liquid diets/Infant formulae
SYNONYMS:	Magnesia/Calcined magnesia/Magnesia usta/Periclase/CAS 1309-48-4/EINECS 215-171-9/E530
FORMULA:	MgO
MOLECULAR MASS IN Daltons:	40.30
PROPERTIES AND APPEARANCE:	White, very fine powder. Chalky taste; odourless; hygroscopic; readily takes CO_2 and H_2O from air. Bioavailability is good, but may be altered in presence of other food components
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	3600
MELTING POINT IN °C:	2800
DENSITY:	3.58
PURITY %:	≥95
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	Moderately soluble (≤0.4%)
FUNCTION IN FOODS:	Enrichment, fortification or restoration. Also used as anti-caking agent, firming agent, lubricant, neutralising agent, pH control agent, processing aid (Japan), release agent
ALTERNATIVES:	Magnesium carbonate; magnesium carbonate hydroxide; magnesium chloride; magnesium hydroxide; magnesium phosphate dibasic; magnesium stearate; magnesium sulphate
TECHNOLOGY OF USE IN FOODS:	Soluble in acids

LEGISLATION:

USA:
FDA 21 CFR 184.1431 GRAS for specified applications
For adults and children 4 years or older, reference daily intake is 400 mg magnesium

UK and EUROPE:
Europe: listed
RDA 300 mg of magnesium

AUSTRALIA/PACIFIC RIM:
Japan: restricted use

CANADA:
For specific regulations, refer to Part D: Vitamins, Minerals and Amino Acids of the Food and Drug Regulations, Health and Welfare Canada
For adults and children 2 years or older, recommended daily intake is 250 mg magnesium
For children under 2 years old, recommended daily intake is 55 mg magnesium

REFERENCES:

Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT.

Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81.

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ANY OTHER RELEVANT INFORMATION:

Anhydrous compound contains 60.3% magnesium

NAME:	Natural tocopherols (mixture of δ-α, δ-β, δ-γ, δ-δ tocopherol forms)
CATEGORY:	Antioxidants
FOOD USE:	Edible oils and fats/Fish and seafoods and products/Meat, poultry and egg products/Baked goods/Vinegar, pickles and sauces/Fruit, vegetables and nut products
SYNONYMS:	Vitamin E
ALTERNATIVE FORMS:	DL-α-Tocopherol/DL-α-Tocopheryl acetate
PROPERTIES AND APPEARANCE:	Oily blends: red to reddish-brown, slightly viscous liquid Dry powders: off-white to pale yellow; not free-flowing
FUNCTION IN FOODS:	As antioxidant in animal fat, margarine, sausages, poultry products, shrimps (breaded), pasta, bakery products, snack foods, confectionery products, sauces, dehydrated vegetables
TECHNOLOGY OF USE IN FOODS:	Usage level: 0.02–0.1% fat and oil content
LEGISLATION:	**USA:** FDA 21 CFR §182.8890; 184.1890 GRAS; §101.9(c) Reference daily intake for adults and children 4 years or older is 30 IU of vitamin E **CANADA:** Food and Drug Regulations: D.03.002; D.01.013 Recommended daily intake of persons 2 years of age or older is 10 mg, for children less than 2 years is 3 mg of vitamin E
REFERENCES:	Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT. Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81. Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada. O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ. U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.
ANY OTHER RELEVANT INFORMATION:	In some cases, unsaturated vegetable oils do not benefit from adding a supplement of tocopherols because of the optimal level of tocopherols naturally present in oils after refining and processing (0.05–0.1%) Potency: 50–70% (oily blends); potency 30% (dry powders)

NAME:	Niacinamide
CATEGORY:	Nutritive additives
FOOD USE:	Cereals and cereal products/Dairy products
SYNONYMS:	Niacin/Nicotinamide/3-Pyridinecarboxamide/Nicotinic acid amide/CAS 98-92-0
FORMULA:	$C_5H_4NCONH_2$
MOLECULAR MASS IN Daltons:	122.12
ALTERNATIVE FORMS:	Nicotinic acid
PROPERTIES AND APPEARANCE:	White crystalline powder
MELTING RANGE IN °C:	129
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.40
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** Soluble
in ethanol solution (100%):	Soluble
FUNCTION IN FOODS:	Fortification of flour, breakfast cereals, infant formulas, fruit drinks, sugar and cocoa confectionery, pasta, meal replacements Colour stabilisation in meat products (if permitted) Addition level 50–100 ppm
TECHNOLOGY OF USE IN FOODS:	1 gram dissolves in about 1 mL water, in about 1.5 mL alcohol and in 10 mL glycerol
LEGISLATION:	**USA:** FDA 21 CFR §184.1535, GRAS Reference daily intake for adults and children 4 years or older is 20 mg niacin **CANADA:** Food and Drug Regulations: D.03.002; B.13.010.1(1) Recommended daily intake of persons 2 years of age or older is 23 NE, for children less than 2 years 8 NE niacin

REFERENCES:

Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT.

Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81.

Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

United Nations Joint FAO/WHO Expert Committee of Food Additives (2009) Electronic Codex Alimentarius. Available at: http://www.codexalimentarius.net/gsfaonline/additives/index.html. Accessed 28 February 2011.

U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.

ANY OTHER RELEVANT INFORMATION:

Niacin may cause vasodilatation; niacinamide does not. Niacinamide may cake. Coated form: 33.3% potency Niacin content and its derivatives is calculated in milligrams of nicotinic acid, plus the content of tryptophan, calculated in milligrams and divided by 60, with the total expressed as niacin equivalents (NE)

NAME:	Nicotinic acid
CATEGORY:	Nutritive additives/Colours
FOOD USE:	Cereals and cereal products/Dairy products/Sugars, sugar preserves and confectionery/Soft drinks
SYNONYMS:	Niacin (INCI)/Vitamin B_3/3-Picolinic acid/Pyridine-3-carboxylic acid/CAS 59-67-6
FORMULA:	$C_6H_5NO_2$
MOLECULAR MASS IN Daltons:	123.12
ALTERNATIVE FORMS:	Niacinamide
PROPERTIES AND APPEARANCE:	White crystalline powder
MELTING RANGE IN °C:	236
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.473
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** Soluble
in ethanol solution (100%):	Soluble
FUNCTION IN FOODS:	Fortification of flour, breakfast cereals, infant formulae, fruit drinks, sugar and cocoa confectionery, pasta, meal replacements Colour stabilisation in meat products (if permitted)
TECHNOLOGY OF USE IN FOODS:	Direct food additive
LEGISLATION:	**USA:** FDA 21 CFR § 135.115, 137, 139, amended at 64 FR 1760, January 12, 1999 184.1530; GRAS **CANADA:** Food and Drug Regulations: D.03.002; B.13.010.1(1)

	UK and EUROPE: Europe: listed UK: approved	**AUSTRALIA/PACIFIC RIM:** Japan: restricted

REFERENCES:

Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT.

Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81.

Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.

ANY OTHER RELEVANT INFORMATION:

Niacin may cause vasodilatation; niacinamide does not
Niacinamide may cake
Potency 100%

NAME:	Pantothenic acid
CATEGORY:	Not used in its pure form
SYNONYMS:	(*R*)-*N*-(2,4-Dihydroxy-3,3-dimethyl-1-oxobutyl)-β-alanine/Vitamin B_5/D(+)-*N*-(2,4-Dihydroxy-3,3-dimethylbutyryl)-β-alanine/Chick antidermatitis factor/CAS 79-83-4
FORMULA:	$C_9H_{17}NO_5$
MOLECULAR MASS IN Daltons:	219.23
ALTERNATIVE FORMS:	Calcium-D-pantothenate
FUNCTION IN FOODS:	N/A
TECHNOLOGY OF USE IN FOODS:	N/A
LEGISLATION:	**CANADA:** Food and Drug Regulations: D.03.002; B.13.010.1(1)
REFERENCES:	Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada. O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.
ANY OTHER RELEVANT INFORMATION:	Potency 100%

NAME:	Phytonadione
CATEGORY:	Nutritive additives
FOOD USE:	Dairy products/Edible oils and fats
SYNONYMS:	Vitamin K_1/Phylloquinone/Phytodione/CAS 84-80-0
FORMULA:	$C_{31}H_{46}O_2$
MOLECULAR MASS IN Daltons:	450.70
PROPERTIES AND APPEARANCE:	Oily blends: clear yellow to amber viscous oil stabilised with tocopherol Dry powders: off-white to yellow free-flowing powder
FUNCTION IN FOODS:	Fortification of infant formulae, liquid milk, oils and fats, dietetic products
TECHNOLOGY OF USE IN FOODS:	Soluble in fat and oil; homogenising in a small amount of liquid is necessary prior to adding to milk and infant formulae Dry powders: water-dispersible
LEGISLATION:	**USA:** FDA 21 CFR §101.9(c) Reference daily intake for adults and children 4 years or older is 80 μg vitamin K **CANADA:** Food and Drug Regulations: D.03.002 Recommended daily intake of persons 2 years of age or older is 80 μg, for children less than 2 years of age 30 μg of Vitamin K
REFERENCES:	Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT. Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81. Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada. O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ. U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.
ANY OTHER RELEVANT INFORMATION:	Oily blends: 100% potency Dry powders: 10–50 mg/g potency

NAME:	Pyridoxine	
CATEGORY:	Nutritive additives	
SYNONYMS:	Vitamin B_6	
ALTERNATIVE FORMS:	Pyridoxine hydrochloride	
FUNCTION IN FOODS:	Fortification	
TECHNOLOGY OF USE IN FOODS:	N/A	
LEGISLATION:	**USA:** FDA 21 CFR 101.9(c) Reference daily intake for adults and children 4 or more years old is 2 mg of vitamin B_6	**CANADA:** Food and Drug Regulations: D.03.002 Recommended daily intake for adults and children 2 years and older is 1.8 mg, for children less than 2 years old is 0.7 mg of vitamin B_6
REFERENCES:	Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada. U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.	
ANY OTHER RELEVANT INFORMATION:	Potency 100%	

NAME:	Pyridoxine hydrochloride
CATEGORY:	Nutritive additives
FOOD USE:	Cereals and cereal products/Soft drinks/Dairy products/Sugars, sugar preserves and confectionery/ Edible oils and fats
SYNONYMS:	Vitamin B_6 hydrochloride/Pyridoxol hydrochloride/5-Hydroxy-6-methyl-3,4-pyridinedimethanol hydrochloride/Pyridoxinium chloride/Adermine hydrochloride/3-Hydroxy-4,5-dihydroxymethyl-2-methylpyridine HCl/CAS 58-56-0
FORMULA:	$C_8H_{12}ClNO_3$
MOLECULAR MASS IN Daltons:	205.64
ALTERNATIVE FORMS:	Pyridoxine
PROPERTIES AND APPEARANCE:	White or almost white crystalline powder
MELTING RANGE IN °C:	204–206
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** Soluble
in ethanol solution (100%):	Soluble
in propylene glycol:	**@ 100°C** Soluble
FUNCTION IN FOODS:	Fortification of breakfast cereals, sugar and cocoa confectionery, infant formulae, fruit drinks, flour, cereal products, oils and fats, milk drinks, meal replacements
TECHNOLOGY OF USE IN FOODS:	1 gram dissolves in about 4.5 mL water or 90 mL alcohol. Also soluble in propylene glycol
LEGISLATION:	**USA:** FDA 21 CFR §184.1676, GRAS; §101.9 (c) Reference daily intake for adults and children 4 or more years old is 2 mg of vitamin B_6 **AUSTRALIA/PACIFIC RIM:** Japan: approved **CANADA:** Food and Drug Regulations: D.03.002 Recommended daily intake for adults and children 2 years and older is 1.8 mg, for children less than 2 years old is 0.7 mg of vitamin B_6

REFERENCES:

Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT.
Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81.
Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada.
O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.
U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.

ANY OTHER RELEVANT INFORMATION:

Potency 82.0%; coated form 33.3%

NAME:	Reduced elemental iron
CATEGORY:	Nutritive additives
FOOD USE:	Breads/Cereals/Cornmeal/Dietary supplements/Dietetic foods/Egg products/Farina/Flour/Formulated liquid diets/Fruit-flavoured drinks and bases/Heat-and-serve dinners/Infant cereals/Infant formulae/Meal replacements/Rice/Pasta/Peanut spreads/Simulated meat and poultry products
SYNONYMS:	Carbonyl iron/Electrolytic iron/Reduced iron/CAS 7439-89-6/EINECS 231-096-4
FORMULA:	Fe
MOLECULAR MASS IN Daltons:	55.84
ALTERNATIVE FORMS:	Ferric orthophosphate/Ferrous fumarate/Ferrous sulphate
PROPERTIES AND APPEARANCE:	Grey-black powder. Not water-soluble. Bioavailability of pure compound is good, but may be altered in the presence of other food components
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	3000
MELTING POINT IN °C:	1536
DENSITY:	7.87
FUNCTION IN FOODS:	Enrichment, fortification or restoration. Also used as processing aid in Japan
ALTERNATIVES:	Ferric choline citrate; ferric orthophosphate; ferric pyrophosphate; ferrous fumarate; ferrous gluconate; ferrous lactate; ferrous sulphate; sodium iron pyrophosphate
TECHNOLOGY OF USE IN FOODS:	Phytic acid, fibres, phosphates, polyphenolics, some proteins, and organic acids can adversely affect iron absorption, whereas other compounds such as ascorbic acid and some amino acids enhance the absorption of this mineral
FOOD SAFETY ISSUES:	Poison by intraperitoneal route; potentially toxic by all forms and routes

LEGISLATION:

USA:
FDA 21 CFR 184.1375 GRAS for specified applications
For adults and children 4 years or older, reference daily intake is 18 mg iron

UK and EUROPE:
RDA 14 mg iron

CANADA:
For specific regulations, refer to Part D: Vitamins, Minerals and Amino Acids of the Food and Drug Regulations, Health and Welfare Canada
For adults and children 2 years or older, recommended daily intake is 14 mg iron
For children less than 2 years old, the recommended daily intake is 7 mg iron

AUSTRALIA/PACIFIC RIM:
Japan: restricted use (can be used as a processing aid)

REFERENCES:

Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT.

Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81.

Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.

ANY OTHER RELEVANT INFORMATION:

100% iron, i.e. 100% by weight of the particles must pass through a 100-mesh sieve and at least 95% by weight of the particles must pass through a 325-mesh sieve; ultrafine powder is potentially explosive

NAME:	Retinol
CATEGORY:	Nutritive additives
FOOD USE:	Breakfast cereals/Dietary supplements/Dietetic foods/Egg products/Fats and oils/Formulated liquid foods/ Infant formulae/Liquid milk/Margarine/Meal replacements/Milk powder
SYNONYMS:	All *trans*-retinol/Axerophthol/Vitamin A/Vitamin A alcohol/CAS 68-26-8
FORMULA:	$C_{20}H_{30}O$
MOLECULAR MASS IN Daltons:	286.46
ALTERNATIVE FORMS:	Retinal/Retinyl acetate/Retinyl palmitate
PROPERTIES AND APPEARANCE:	Oily blends: yellow oil stabilised with tocopherol or BHA/BHT Dry powder: light yellow fine granular powder with antioxidants
MELTING RANGE IN °C:	54–58/62–64 (depending on form)
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	Practically insoluble
in vegetable oil:	Soluble
in ethanol solution:	Soluble
in propylene glycol:	Soluble
FUNCTION IN FOODS:	Enrichment, fortification or restoration
TECHNOLOGY OF USE IN FOODS:	Oily blends may crystallise upon storage; homogenise in small amount of liquid prior to adding to milk and infant formulae. Dry powders dispersible in water
SYNERGISTS:	pH >6
ANTAGONISTS:	Agitation; extreme heat; light; oxygen; minerals, especially in the presence of high humidity and moisture

FOOD SAFETY ISSUES:

Toxicology: LD_{50} (oral, rat) 2000 mg/kg

Toxic levels: infants, 100 000 IU single dose; children, 300 000 IU single dose; adults, 500 000 IU single dose.

Chronic toxicity can develop from prolonged daily intake of 25 000 IU

LEGISLATION:

USA:

FDA 21 CFR 184.1930 GRAS in specified applications

For adults and children over 4 years, reference daily intake is 5000 IU vitamin A

UK and EUROPE:

RDA 800 μg

CANADA:

For specific regulations, refer to Part D: Vitamins, Minerals and Amino Acids of the Food and Drug Regulations, Health and Welfare Canada

For adults and children over 2 years, recommended daily intake is 1000 RE vitamin A

For children under 2 years old, recommended daily intake is 400 RE vitamin A

REFERENCES:

Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT.

Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81.

Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.

ANY OTHER RELEVANT INFORMATION:

Nutritive activity measured in retinol equivalents (RE): 1 RE = 1 μg retinol = 1.147 μg retinyl acetate = 3.33 IU vitamin A

NAME:	Retinyl acetate
CATEGORY:	Nutritive additives
FOOD USE:	Breakfast cereals/Dietary supplements/Dietetic foods/Egg products/Fats and oils/Formulated liquid foods/Infant formulae/Liquid milk/Margarine/Meal replacements/Milk powder
SYNONYMS:	Acetic acid retinyl ester/Vitamin A acetate/Vitamin A alcohol acetate/CAS 127-47-9/EINECS 204-844-2
FORMULA:	$C_{22}H_{32}O_2$
MOLECULAR MASS IN Daltons:	328.5
ALTERNATIVE FORMS:	Retinol/Retinyl palmitate
PROPERTIES AND APPEARANCE:	Oily blends: yellow oil Dry blends: light yellow, fine granular powder
MELTING RANGE IN °C:	57–58
FUNCTION IN FOODS:	Enrichment, fortification or restoration
TECHNOLOGY OF USE IN FOODS:	Oily blends are soluble in oil and fat; homogenising in a small amount of liquid is necessary prior to adding to milk and infant formulae. Dry blends are water-dispersible
ANTAGONISTS:	Agitation; light; oxygen; extreme heat
FOOD SAFETY ISSUES:	Toxicology: LD_{50} (oral, mouse, 10 day) 4100 mg/kg
LEGISLATION:	**USA:** FDA 21 CFR 184.1930 GRAS for specified applications For adults and children 4 years or older, reference daily intake is 5000 IU vitamin A **UK and EUROPE:** RDA 800 µg vitamin A **CANADA:** For specific regulations, refer to Part D: Vitamins, Minerals and Amino Acids of the Food and Drug Regulations, Health and Welfare Canada For adults and children 2 years or older, recommended daily intake is 1000 RE vitamin A For children less than 2 years old, recommended daily intake is 400 RE

REFERENCES:

Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT.
Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81.
Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada.
O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.
U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.

ANY OTHER RELEVANT INFORMATION:

Oily blends are stabilised with tocopherol or BHA/BHT. Dry blends are stabilised with tocopherol, ascorbic acid, ascorbyl palmitate or BHA/BHT. Nutritive activity is measured in retinol equivalents (RE): 1 RE = 1 μg retinol = 1.147 μg retinyl acetate = 3.33 IU. Oily blends are two to four times more potent than dry blends. Biopotency 2.904×10^6 IU/g

NAME:	Retinyl palmitate
CATEGORY:	Nutritive additives
FOOD USE:	Breakfast cereals/Dietary supplements/Dietetic foods/Egg products/Fats and oils/Formulated liquid foods/Infant formulae/Liquid milk/Margarine/Meal replacements/Milk powder
SYNONYMS:	Retinol, hexadecanoate/Vitamin A palmitate/CAS 79-81-2/EINECS 201-228-5
FORMULA:	$C_{36}H_{60}O_2$
MOLECULAR MASS IN Daltons:	524.9
ALTERNATIVE FORMS:	Retinol/Retinyl acetate
PROPERTIES AND APPEARANCE:	Oily blends: yellow oil Dry blends: light yellow, fine granular powder
MELTING RANGE IN °C:	28–29
FUNCTION IN FOODS:	Enrichment, fortification or restoration
TECHNOLOGY OF USE IN FOODS:	Oily blends are soluble in oil and fat; homogenising in a small amount of liquid is necessary prior to adding to milk and infant formulae. Dry blends are water-dispersible
ANTAGONISTS:	Agitation; light; oxygen; extreme heat
FOOD SAFETY ISSUES:	Toxicology: LD_{50} (oral, rat, 10 day) 7910 mg/kg
LEGISLATION:	**USA:** FDA 21 CFR 184.1930 GRAS For adults and children 4 years or older, reference daily intake is 5000 IU vitamin A **UK and EUROPE:** RDA 800 µg vitamin A **CANADA:** For specific regulations, refer to Part D: Vitamins, Minerals and Amino Acids of the Food and Drug Regulations, Health and Welfare Canada For adults and children 2 years or older, recommended daily intake is 1000 RE vitamin A For children less than 2 years old, recommended daily intake is 400 RE vitamin A

REFERENCES:

Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT.
Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81.
Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada.
O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.
U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.

ANY OTHER RELEVANT INFORMATION:

Oily blends are stabilised with tocopherol or BHA/BHT. Dry blends are stabilised with tocopherol, ascorbic acid, ascorbyl palmitate or BHA/BHT. Nutritive activity is measured in retinol equivalents (RE): 1 RE = 1 μg retinol = 1.147 μg retinyl acetate = 3.33 IU. Biopotency 1.817×10^6 IU/g

NAME:	Riboflavin
CATEGORY:	Nutritive additives/Colours
FOOD USE:	Baked goods/Edible oils and fats/Sugars, sugar preserves and confectionery/Dairy products/Beverages/Cereals and cereal products/Soft drinks
SYNONYMS:	Vitamin B_2/7,8-Dimethyl-10-ribitylisoalloxazine/Lactoflavine/7,8-Dimethyl-10-(D-ribo-2,3,4,5-tetrahydroxypentyl)isoalloxazine/Vitamin G/Flavaxin/CAS 83-88-5/INS No. 101(i)
FORMULA:	$C_{17}H_{20}N_4O_6$
MOLECULAR MASS IN Daltons:	376.37
ALTERNATIVE FORMS:	Riboflavin-5′-phosphate sodium salt
PROPERTIES AND APPEARANCE:	Yellow to orange/yellow powder
MELTING RANGE IN °C:	282
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	@ 20°C Slightly soluble
in ethanol solution (5%):	Slightly soluble
FUNCTION IN FOODS:	Coloration of ice-creams, desserts, instant beverages, sauces, soups, confectionery products, pasta Fortification of flour, breakfast cereals, sugar and cocoa confectionery, soups, infant formulae, fruit drinks, oils and fats, desserts, milk drinks, meal replacements Usage level: ADI 0–0.5 mg/kg (EC)
TECHNOLOGY OF USE IN FOODS:	Riboflavin-5′-phosphate is more water soluble than pure riboflavin, and is particularly suitable for coloration or instant products Protect solutions from light Usage level: ADI 0–0.5 mg/kg (EC)

LEGISLATION:

USA:
FDA 21 CFR §73.450, 136.115, 137, 139, 184.1695, GRAS
§101.9(c) Reference daily intake for adults or children 4 or more years old is 1.7 mg of riboflavin

CANADA:
Food and Drug Regulations: D.03.002
Recommended daily intake for persons 2 years of age or older is 1.6 mg, for infants or children less than 2 years of age is 0.55 mg of riboflavin or vitamin B_2

UK and EUROPE:
Europe: listed
UK: approved

AUSTRALIA/PACIFIC RIM:
Japan: approved

REFERENCES:

Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT.

Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81.

Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

United Nations Joint FAO/WHO Expert Committee of Food Additives (2009) Electronic Codex Alimentarius. Available at: http://www.codexalimentarius.net/gsfaonline/additives/index.html. Accessed 28 February 2011.

U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.

ANY OTHER RELEVANT INFORMATION:

Potency 100%

NAME:	Riboflavin-5′-phosphate sodium salt
CATEGORY:	Nutritive additives/Colours
FOOD USE:	Baked goods/Edible oils and fats/Sugars, sugar preserves and confectionery/Dairy products/Beverages/Cereals and cereal products/Soft drinks
SYNONYMS:	Vitamin B_2 phosphate sodium/Riboflavin 5′-monophosphate sodium salt dihydrate/Riboflavin 5′-phosphate ester monosodium salt/CAS 130-40-5/INS No. 101(ii)
FORMULA:	$C_{17}H_{20}N_4O_9PNa \cdot 2H_2O$
MOLECULAR MASS IN Daltons:	514.36
ALTERNATIVE FORMS:	Riboflavin
PROPERTIES AND APPEARANCE:	Yellow to orange powder
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	@ 20°C Soluble
FUNCTION IN FOODS:	Fortification of flour, breakfast cereals, sugar and cocoa confectionery, soups, infant formulae, fruit drinks, oils and fats, desserts, milk drinks, meal replacements Coloration of ice-creams, desserts, instant beverages, sauces, soups, confectionery products, pasta
TECHNOLOGY OF USE IN FOODS:	Riboflavin-5′-phosphate is more water soluble than pure riboflavin, and is particularly suitable for coloration or instant products Protect solutions from light Usage level: ADI 0–0.5 mg/kg (EC)
LEGISLATION:	**USA:** FDA 21 CFR §184.1697, GRAS §101.9(c) Reference daily intake for adults and children 4 or older is 1.7 mg of riboflavin **UK and EUROPE:** Europe: listed UK: approved

CANADA:
Food and Drug Regulations: D.03.002
Recommended daily intake for persons 2 years of age or older is 1.6 mg, for infants or children less than 2 years of age is 0.55 mg of riboflavin or vitamin B_2

AUSTRALIA/PACIFIC RIM:
Japan: approved

REFERENCES:

Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT.

Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81.

Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

United Nations Joint FAO/WHO Expert Committee of Food Additives (2009) Electronic Codex Alimentarius. Available at: http://www.codexalimentarius.net/gsfaonline/additives/index.html. Accessed 28 February 2011.

U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.

ANY OTHER RELEVANT INFORMATION:

Potency 78.7%; coated forms 25–33.3% potency
Decomposed by light when in solution

NAME:	Sodium ascorbate
CATEGORY:	Nutritive additives
FOOD USE:	Cured meats/Dietary supplements/Dietetic foods/Formulated liquid diets/Infant formulae/Meal replacements/Milk products
SYNONYMS:	L(+)-Ascorbic acid sodium salt/Monosodium ascorbate/Vitamin C sodium salt/CAS 134-03-2/EINECS 205-126-1/E301
FORMULA:	$C_6H_7NaO_6$
MOLECULAR MASS IN Daltons:	198.11
ALTERNATIVE FORMS:	Ascorbic acid/Ascorbyl palmitate/Calcium ascorbate/Nicotinamide-ascorbic acid complex
PROPERTIES AND APPEARANCE:	White to slightly yellowish powder; various granulations available. Not heat-stable at neutral pH
MELTING POINT IN °C:	Decomposes at 218
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 25°C** Readily soluble (62%) **@ 75°C** 78%
in ethanol solution:	Very slightly soluble
FUNCTION IN FOODS:	Enrichment, fortification or restoration. Also used as antioxidant, curing agent and nitrosamine inhibitor in cured meats, preservative
TECHNOLOGY OF USE IN FOODS:	Optimum pH is between 5 and 7; usage level is 300–500 ppm
ANTAGONISTS:	Oxidation; light; minerals; heat-labile in neutral environments, but less so in highly acidic environments
FOOD SAFETY ISSUES:	Some adverse effects can occur with extremely high repeated doses in the 500 mg to 10 g range
LEGISLATION:	**USA:** FDA 21 CFR 182.3731 GRAS for specified applications For adults and children 4 years or older, reference daily intake is 60 mg of vitamin C **CANADA:** For specific regulations, refer to Part D: Vitamins, Minerals and Amino Acids of the Food and Drug Regulations, Health and Welfare Canada For adults and children 2 years or older, recommended daily intake is 60 mg of vitamin C

	UK and EUROPE:	For children less than 2 years old, recommended daily intake is 20 mg of vitamin C
	RDA 60 mg vitamin C	

REFERENCES:

Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT.

Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81.

Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.

ANY OTHER RELEVANT INFORMATION:

Potency is 88%, i.e. 1 mg of the sodium salt is equivalent to 0.8890 mg of ascorbic acid, or 1 mg of the acid is equivalent to 1.1248 mg of sodium ascorbate. The pH of aqueous solutions is 5.6–7.0 or higher. A 10% solution, made from commercial grade, may have a pH of 7.4–7.7. Aqueous solutions are unstable and subject to rapid oxidation by air at pH >6.0

NAME:	Thiamin	
CATEGORY:	Nutritive additives	
SYNONYMS:	Thiamine/Vitamin B_1/3-[(4-Amino-2-methyl-5-pyrimidinyl)-methyl]-5-(2-hydroxyethyl)-4-methylthiazolium chloride/CAS 59-43-8	
FORMULA:	$C_{12}H_{17}ClN_4OS$	
MOLECULAR MASS IN Daltons:	300.81	
ALTERNATIVE FORMS:	Thiamin hydrochloride/Thiamin mononitrate	
FUNCTION IN FOODS:	Enriched flours, enriched pre-cooked rice	
TECHNOLOGY OF USE IN FOODS:	N/A	
LEGISLATION:	**USA:** FDA 21 CFR § 101.9(c) Reference daily intake for adults and children 4 years or older is 1.5 mg thiamin	**CANADA:** Food and Drug Regulations: D.03.002; B.11.150; B.13.010.1 Recommended daily intake of persons 2 years of age or older is 1.3 mg, for children less than 2 years of age is 0.45 mg thiamin
REFERENCES:	Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT. Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81. Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada. O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ. U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.	
ANY OTHER RELEVANT INFORMATION:	Potency 100%	

NAME:	Thiamin hydrochloride
CATEGORY:	Nutritive additives
FOOD USE:	Cereals and cereal products/Dairy products/Sugars, sugar preserves and confectionery/Edible oils and fats
SYNONYMS:	Vitamin B_1 hydrochloride/Thiamin chloride/Thiamine dichloride/Aneurine hydrochloride/CAS 67-03-8
FORMULA:	$C_{12}H_{17}ClN_4OS \cdot HCl$
MOLECULAR MASS IN Daltons:	337.27
ALTERNATIVE FORMS:	Thiamin/Thiamin mononitrate
PROPERTIES AND APPEARANCE:	White or almost white hygroscopic crystals or crystalline powder
MELTING RANGE IN °C:	248
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** Soluble
in ethanol solution (100%):	Slightly soluble
FUNCTION IN FOODS:	Fortification of flour, breakfast cereals, infant formulae, soups, sugar and cocoa confectionery, oils and fats, milk drinks, pasta, meal replacements
TECHNOLOGY OF USE IN FOODS:	Soluble in water, slightly soluble in alcohol. Thiamin hydrochloride is more water soluble than thiamin mononitrate Usage level: limitation 2.26 g per 4546 L (0.005 lb/1000 gallons) for wine
LEGISLATION:	**USA:** FDA 21 CFR §184.1875, GRAS; BATF 27 CFR §240.1051 Reference daily intake for adults and children 4 or older is 1.5 mg thiamin **AUSTRALIA/PACIFIC RIM:** Japan: approved **CANADA:** Food and Drug Regulations: D.03.002; B.11.150; B.13.010.1 Recommended daily intake for persons 2 year of age or older is 1.3 mg, for infants or children less than 2 years of age is 0.45 mg of thiamin, thiamine or vitamin B_1

REFERENCES:

Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT.

Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81.

Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.

ANY OTHER RELEVANT INFORMATION:

Potency 89.3%

NAME:	Thiamin mononitrate
CATEGORY:	Flavour enhancers and modifiers
FOOD USE:	Soups and sauces
SYNONYMS:	Vitamin B_1 nitrate/Thiamine nitrate/Aneurine mononitrate/3-[(4-amino-2-methyl-5-pyrimidinyl)methyl]-4-(2-hydroxy ethyl)-4-methylthiazolium nitrate (salt)/CAS 532-43-4
FORMULA:	$C_{12}H_{17}N_4OS \cdot NO_3$
MOLECULAR MASS IN Daltons:	327.36
ALTERNATIVE FORMS:	Thiamin/Thiamin hydrochloride
PROPERTIES AND APPEARANCE:	White crystal or crystalline powder
MELTING RANGE IN °C:	196–200
WATER CONTENT MAXIMUM IN %:	Non-hygroscopic
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** Soluble
in ethanol solution (100%):	Slightly soluble
FUNCTION IN FOODS:	Used as reaction flavour component in flavouring for soups and sauces (meat flavour) Coated form used in dry products to mask taste
TECHNOLOGY OF USE IN FOODS:	Thiamin hydrochloride is more water soluble than thiamin mononitrate
LEGISLATION:	**USA:** FDA 21 CFR §184.1878, GRAS §101.9(c) Reference daily intake for adults and children 4 years or older is 1.5 mg of thiamin **AUSTRALIA/PACIFIC RIM:** Japan: approved **CANADA:** Food and Drug Regulations: D.03.002; B.11.150; B.13.010.1 Daily intake of persons 2 years of age or older is 1.3 mg, for less then 2 years of age is 0.45 mg of thiamin, thiamine or vitamin B_1

REFERENCES:

Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT.

Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81.

Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.

ANY OTHER RELEVANT INFORMATION:

Potency 92.0%; coated form 33.3%

NAME:	DL-α-Tocopherol	
CATEGORY:	Antioxidants/Nutritive additives	
FOOD USE:	Edible oils and fats/Meat products/Poultry products/Eggs and egg products	
SYNONYMS:	Vitamin E/All-*rac*-α-tocopherol/CAS 59-02-9/INS No. 307a	
FORMULA:	$C_{29}H_{50}O_2$	
MOLECULAR MASS IN Daltons:	430.71	
ALTERNATIVE FORMS:	DL-α-tocopheryl-acetate/Natural tocopherols mix	
PROPERTIES AND APPEARANCE:	Yellow viscous oil	
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	200–220	
MELTING RANGE IN °C:	2.5–3.5	
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	0.947–0.958 (25/25°C)	
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:		
in vegetable oil:	**@ 20°C** Soluble	
in ethanol solution (5%):	Soluble	
FUNCTION IN FOODS:	As antioxidant in oils, fats, fat-based products, sausages Nutrient, preservative, inhibitor of nitrosamine formation in pump-cured bacon	
TECHNOLOGY OF USE IN FOODS:	Soluble in fat and oil	
LEGISLATION:	**USA:** FDA 21 CFR § 182.3890, 182.8890, 184.1890 GRAS FDA 21 CFR 101.9(c) For adults and children 4 years or older reference daily intake is 30 IU of vitamin E	**CANADA:** Food and Drug Regulations: D.03.002 Recommended daily intake for adults and children 2 years and older is 10 mg, for children less than 2 years old is 3 mg of vitamin E

UK and EUROPE:
UK: approved

AUSTRALIA/PACIFIC RIM:
Japan: restricted for purpose of antioxidation

REFERENCES:

Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT.

Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81.

Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

United Nations Joint FAO/WHO Expert Committee of Food Additives (2009) Electronic Codex Alimentarius. Available at: http://www.codexalimentarius.net/gsfaonline/additives/index.html. Accessed 28 February 2011.

U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.

NAME:	DL-α-Tocopheryl acetate	
CATEGORY:	Nutritive additives	
FOOD USE:	Dairy products/Sugars, sugar preserves and confectionery/Edible oils and fats/Cereals and cereal products	
SYNONYMS:	Vitamin E acetate	
FORMULA:	$C_{31}H_{52}O_3$	
MOLECULAR MASS IN Daltons:	472.75	
ALTERNATIVE FORMS:	DL-α-tocopherol/Natural tocopherols	
PROPERTIES AND APPEARANCE:	Oily blends: slightly yellow viscous oil. Dry powders: slight yellowish free-flowing powder	
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	$bp_{0.01}$ 184 $bp_{0.025}$ 194 $bp_{0.3}$ 224	
MELTING RANGE IN °C:	−27.5	
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	0.9533 (21.3/4 °C)	
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:		
in ethanol solution (100%):	Soluble	
FUNCTION IN FOODS:	Fortification of infant formulae, sugar and cocoa confectionery, oils and fats, fruit drinks, flour, liquid milk and milk powder, breakfast cereals	
TECHNOLOGY OF USE IN FOODS:	Viscous oils are soluble in fat and oil; homogenising in a small amount of liquid is necessary prior to adding to milk, infant formulae and drinks. Dry powders are water-dispersible	
LEGISLATION:	**USA:** FDA 21 CFR § 182.8892, GRAS FDA 21CFR 101.9(c) Reference daily intake for adults and children 4 or more years old is 30 IU of vitamin E	**CANADA:** Food and Drug Regulations: D.03.002 Recommended daily intake for adults and children 2 years and older is 10 mg, for children less than 2 years old is 3 mgof vitamin E

REFERENCES:

Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT.
Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81.
Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada.
O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.
U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.

ANY OTHER RELEVANT INFORMATION:

Oily blends: 1000 IU/g potency
Dry powders: $0.25–0.50 \times 10^6$ IU/g potency

NAME:	Zinc sulphate monohydrate
CATEGORY:	Nutritive additives
FOOD USE:	Beverages/Breakfast cereals/Dietary supplements/Dietetic foods/Egg products/Formulated liquid diets/Infant formulae/Meal replacements/Peanut spreads
SYNONYMS:	Dried zinc sulfate/Sulphuric acid zinc salt (1:1)/White copperas/White vitriol/Zinc vitriol/CAS 7446-19-7/EINECS 231-793-3
FORMULA:	$ZnSO_4 \cdot H_2O$
MOLECULAR MASS IN Daltons:	161.44 anhydrous
ALTERNATIVE FORMS:	Zinc sulphate heptahydrate (cakes readily)
PROPERTIES AND APPEARANCE:	White, effervescent powder or granules. Astringent taste. Good bioavailability, but may be altered in presence of other food components
MELTING POINT IN °C:	740 (decomposes)
DENSITY AT 15°C:	3.74
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	Very soluble
in ethanol solution:	Practically insoluble
FUNCTION IN FOODS:	Enrichment, fortification or restoration
ALTERNATIVES:	Zinc oxide
ANTAGONISTS:	Phytates and dietary fibre present in plant foods have an adverse effect on zinc absorption
FOOD SAFETY ISSUES:	Toxicology: LD_{50} (oral, rat) 2949 mg/kg

LEGISLATION:

USA:
FDA 21 CFR 182.8997 GRAS for specified applications
For adults and children 4 years or older, reference daily intake is 15 mg zinc

UK and EUROPE:
RDA 15 mg zinc

AUSTRALIA/PACIFIC RIM:
Japan: approved, with restrictions

CANADA:
For specific regulations, refer to Part D: Vitamins, Minerals and Amino Acids of the Food and Drug Regulations, Health and Welfare Canada
For adults and children 2 years or older, recommended daily intake is 9 mg
For children less than 2 years old, recommended daily intake is 4 mg

REFERENCES:

Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook*. Gower Publishing Company, Brookfield, VT.

Augustin, J. and Scarbrough, F.E. (1990) Nutritional additives. In: Branen, A.L., Davidson, P.M. and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 33–81.

Health and Welfare Canada (2009) Part D: Vitamins, minerals and amino acids. In: *Food and Drug Regulations*. Department of Health, Ottawa, ON, Canada.

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U.S. Department of Health and Human Services (2009) FDA Code of Federal Regulations, Title 21. Available at: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm.

ANY OTHER RELEVANT INFORMATION:

Anhydrous form is 40.5% zinc; hydrous form is 36.4% zinc

Part 10

Polysaccharides

Rachel Shepherd

Food Additives Data Book, Second Edition. Edited by Jim Smith and Lily Hong-Shum.

NAME:	Agar
CATEGORY:	Polysaccharides/Thickeners and stabilisers
FOOD USE:	Meats/Poultry/Pet foods/Desserts/Baked goods/Confections/Beverages/Food packaging/Edible films/Coatings/All food products
SYNONYMS:	CAS 9002-18-0/EINECS 232-658-1/EEC 232-658-1/FEMA 2012/E406/Gelose/Bengal gelatin/Japan iisinglass/Agar-agar/Kanten/China glass/Gulaman/Dongfen
FORMULA:	Variable, a mixture of agaran (agarose) and agaropectin with variable methoxy and pyruvate substituents
MOLECULAR MASS IN Daltons:	Variable. Typically 120 000
ALTERNATIVE FORMS:	Agar is usually found as a calcium salt, although variable levels of sodium and magnesium salts are present in commerical preparations
PROPERTIES AND APPEARANCE:	White to pale yellow colour, either odourless or a slight charcoal odour
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	Solubility varies with molecular weight. Generally, agar is soluble in hot water, sucrose solutions, sodium chloride solution and ethanol solutions, but solubility in vegetable oils and propylene glycol is limited. Above 45°C viscosity is relatively constant at pH 4.5 to 9
in water:	**@ 20°C** Generally insoluble **@ 100°C** Soluble
FUNCTION IN FOODS:	Stabiliser; emulsifier; thickener; drying agent; flavouring agent; surface finisher; formulation aid; humectant; anti-staling in baking, confections, meats, poultry; gellant in desserts, beverages; protective colloid in foods
ALTERNATIVES:	Gellan; alginate; curdlan; gelatin (dependent on application)
TECHNOLOGY OF USE IN FOODS:	Agar should be dispersed in cold water and heated for 10 minutes at >85°C to melt and hydrate the polysaccharide. Typically agar preparations are autoclaved (retorted) at 121°C for at least 10 minutes. Agar is a mixture of agaran (agarose) and agaropectin. Agaran is a linear gelling polysaccharide which has a disaccharide (agarobiose) repeating unit composed of (1 → 3) β-D-galactopyranosyl (1 → 4) linked to a 3,6-anhydro-α-D-galactopyranosyl unit. Agaropectin is a closely related branched molecule. The gelling properties of agar are due to interacting strands of agaran. This polysaccharide dissolves above 85°C to form a low-viscosity solution (pumpable) that remains low viscosity as the temperature is reduced until about 30–40°C whereupon it sets to form a clear brittle gel. The gel remelts at >85°C.

SYNERGISTS:	Locust bean gum
ANTAGONISTS:	None known
FOOD SAFETY ISSUES:	Non-toxic. Limitations: 0.8% (baked goods/mixes); 2% (confections, frostings); 1.2% (soft candy); 0.25% (other foods) The powder is combustible
LEGISLATION:	**USA:** FDA 21 CFR § 150.141, 150.161, 184.1115, GRAS; USDA 9CFR § 318.7; GRAS (FEMA) **UK and EUROPE:** UK: approved Europe: listed **AUSTRALIA/PACIFIC RIM:** Japan: approved for use as a natural thickener and stabiliser
REFERENCE:	Selby, H.H. and Whistler, R.L. (1993) Agar. In: Whistler, R.L. and BeMiller, J.N. (eds) *Industrial Gums: Polysaccharides and Derivatives*, 3rd edn. Academic Press, San Diego, pp. 87–104.
ANY OTHER RELEVANT INFORMATION:	Agars are natural polysaccharides that can be extracted from some species of a class of seaweed called Rhodophyceae (red algae). The most commercially important species belong to the genus *Gelidium*, although other species (*Gracilaria*, *Pterocladia*, etc.) are also used. Polysaccharides with structures similar to agar are termed agaroids.

NAME:	Alginic acid
CATEGORY:	Polysaccharides
FOOD USE:	All food products, edible films/Coatings
SYNONYMS:	CAS 9005-32-7/EINECS 232-680-1/EC 232-680-1/E400/A02BX13/Polymannuronic acid/Norgine
FORMULA:	Variable, depending on ratio of mannuronic to guluronic acid, and the presence of other substituents
MOLECULAR MASS IN Daltons:	Variable: 10 000–600 000
ALTERNATIVE FORMS:	Algin/Ammonium alginate/Calcium alginate/Potassium alginate
PROPERTIES AND APPEARANCE:	White to yellow powders or hard flakes
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	Solubility in aqueous solution varies with differences in structure, molecular weight, pH and cations. Alginic acid (low pH) is insoluble in water, monovalent salts (sodium, potassium and ammonium) are also soluble, but divalent salts (including calcium) except magnesium are insoluble in water. Solubility declines with increasing molecular weight and increasing concentration. Viscosity is not affected in the pH 5 to 11 range, but increases at lower pH values (due to alginic acid formation).
FUNCTION IN FOODS:	Gelling agent; thickening agent; stabiliser; flocculant and bulking agent. It can be used to stabilise emulsions and to retard ice-crystal formation
ALTERNATIVES:	Carrageenans; gelatin; gellan; agar; xanthan; furcellaran (application-dependent)
TECHNOLOGY OF USE IN FOODS:	Alginates should be dispersed in cold deionised water and heated for 10 minutes at 80°C to hydrate the polysaccharide. A high shear mixer will aid dispersion, although prolonged shear of high-molecular-weight polymers will reduced the viscosity. Calcium gels can be prepared by addition of alginate solutions to a calcium solution (e.g. maraschino cherries), addition of calcium to a hot solution of alginate and then cooling (gel is thermo-irreversible), or by diffusion. Gels can also be formed by lowering the pH (alginic acid), but this can be technically difficult. Alginates are composed of blocks of polymannuronic acid, polyguluronic acid and mixed regions. Ribbon-like structures are formed in solution and alginates with a high percentage of guluronic blocks can be cross-linked (gelled) by divalent ions (e.g. calcium).
SYNERGISTS:	Divalent ion, pectins

ANTAGONISTS: None known

FOOD SAFETY ISSUES: Moderately toxic, LD_{50} (intraperitoneal, rat) 1600 mg/kg; ADI 0–50 mg/kg. The powder is combustible and emits irritating fumes when heated

LEGISLATION: Usage level: Limitation 1%, condiments; 6%, pimento for stuffed olives; 0.3%, confections; 4%, gelatins/puddings; 10%, hard candy; 2%, processed fruits; 1%, other foods

USA:	**UK and EUROPE:**	**AUSTRALIA/PACIFIC RIM:**
FDA 21CFR §184.1011. GRAS	UK: approved Europe: listed	Japan: approved

REFERENCES:

Ash, M. and Ash, I. (1996) *Food Additives*. Gower Publishing, Brookfield, VT.

Clare, K. (1993) Algin. In: Whistler R.L. and BeMiller, J.N. (eds) *Industrial Gums: Polysaccharides and Derivatives*, 3rd edn. Academic Press, San Diego, pp. 105–143.

ANY OTHER RELEVANT INFORMATION: Alginates are natural polysaccharides extracted from brown seaweeds (Phaeophyceae). *Macrocystis pyrifera*, *Laminera hyperborea*, *Laminaria digitata*, *Laminaria japonica*, *Ascophyllum nodosum*, *Ecklonia maxima* and *Lessonia nigrescens* are the most important commercial sources of alginates. Structurally distinct bacterial alginates can be obtained from *Pseudomonas* species and *Azotobacter* species. Although algin, alginic acid, ammonium alginate, calcium alginate, potassium alginate and sodium alginate are essentially different states of the same type of compound, for legislative purposes they are listed separately.

NAME:	Ammonium alginate
CATEGORY:	Polysaccharides
FOOD USE:	All food products/Edible films/Coatings
SYNONYMS:	CAS 9005-34-9/E403/Ammonium alginate/Alginic acid-ammonium salt/Ammonium polymannuronate
FORMULA:	Variable, depending on ratio of mannuronic to guluronic acid, and the presence of other substituents
MOLECULAR MASS IN Daltons:	Variable
ALTERNATIVE FORMS:	Alginic acid/Algin/Calcium alginate/Potassium alginate
PROPERTIES AND APPEARANCE:	White to yellow powders or hard flakes
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	Solubility in aqueous solution varies with differences in structure, molecular weight, pH and cations. Alginic acid (low pH) is insoluble in water, monovalent salts (sodium, potassium and ammonium) are also soluble, but divalent salts (including calcium) except magnesium are insoluble in water. Solubility declines with increasing molecular weight and increasing concentration. Viscosity is not affected in the pH 5 to 11 range but increases at lower pH values (due to alginic acid formation).
FUNCTION IN FOODS:	Gelling agent; thickening agent; stabiliser; flocculant and bulking agent. It can be used to stabilise emulsions and to retard ice-crystal formation
ALTERNATIVES:	Carrageenans; gelatin; gellan; agar; xanthan; furcellaran (application-dependent)
TECHNOLOGY OF USE IN FOODS:	Alginates should be dispersed in cold deionised water and heated for 10 minutes at 80°C to hydrate the polysaccharide. A high shear mixer will aid dispersion, although prolonged shear of high-molecular-weight polymers will reduce the viscosity. Calcium gels can be prepared by addition of alginate solutions to a calcium solution (e.g. maraschino cherries), addition of calcium to a hot solution of alginate and then cooling (gel is thermo-irreversible), or by diffusion. Gels can also be formed by lowering the pH (alginic acid), but this can be technically difficult. Ammonium alginate forms particularly viscous solutions. Alginates are composed of blocks of polymannuronic acid, polyguluronic acid and mixed regions. Ribbon-like structures are formed in solution and alginates with a high percentage of guluronic blocks can be cross-linked (gelled) by divalent ions (e.g. calcium).
SYNERGISTS:	Divalent ion, pectins

ANTAGONISTS: None known

FOOD SAFETY ISSUES: LD_{50} (intravenous, rat) 1000 mg/kg; ADI 0–50 mg/kg
The powder is combustible and emits toxic fumes when heated

LEGISLATION: Usage level: Limitation 0.4%, confections; 0.5%, fats/oils; 0.5%, gelatins/puddings; 0.4%, gravies/sauces; 0.5%, sweet sauces; 0.1%, other foods

USA:	**UK and EUROPE:**	**AUSTRALIA/PACIFIC RIM:**
FDA 21 CFR §173.310, 184.1133, GRAS, USDA 9CFR 318.7	UK: approved Europe: listed	Japan: approved

REFERENCES:

Clare, K. (1993) Algin. In: Whistler R.L. and BeMiller, J.N. (eds) *Industrial Gums: Polysaccharides and Derivatives*, 3rd edn. Academic Press, San Diego, pp. 105–143.

Rehm B.H.A. (ed.) (2009) *Alginates: Biology and Applications*. Microbiology Monographs 13. Springer-Verlag, Berlin, pp. 1–53.

ANY OTHER RELEVANT INFORMATION: Alginates are natural polysaccharides extracted from brown seaweeds (Phaeophyceae). *Macrocystis pyrifera*, *Laminera hyperborea*, *Laminaria digitata*, *Laminaria japonica*, *Ascophyllum nodosum*, *Ecklonia maxima* and *Lessonia nigrescens* are the most important commercial sources of alginates. Structurally distinct bacterial alginates can be obtained from *Pseudomonas* species and *Azotobacter* species. Although algin, alginic acid, ammonium alginate, calcium alginate, potassium alginate and sodium alginate are essentially different states of the same type of compound, for legislative purposes they are listed separately.

NAME:	Calcium alginate
CATEGORY:	Polysaccharides
FOOD USE:	All food products/Edible films/Coatings
SYNONYMS:	CAS 9005-35-0/E404/Calcium alginate/Alginic acid-calcium salt/Calcium polymannuronate
FORMULA:	Variable, depending on ratio of mannuronic to guluronic acid, and the presence of other substituents
MOLECULAR MASS IN Daltons:	Variable
ALTERNATIVE FORMS:	Alginic acid/Algin/Calcium alginate/Potassium alginate
PROPERTIES AND APPEARANCE:	White to yellow powders or hard flakes
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	Solubility in aqueous solution varies with differences in structure, molecular weight, pH and cations. Alginic acid (low pH) is insoluble in water, monovalent salts (sodium, potassium and ammonium) are also soluble, but divalent salts (including calcium) except magnesium are insoluble in water. Solubility declines with increasing molecular weight and increasing concentration. Viscosity is not affected in the pH 5 to 11 range, but increases at lower pH valuess (due to alginic acid formation).
FUNCTION IN FOODS:	Gelling agent; thickening agent; stabiliser; flocculant and bulking agent. It can be used to stabilise emulsions and to retard ice-crystal formation
ALTERNATIVES:	Carrageenans; gelatin; gellan; agar, xanthan; furcellaran (application-dependent)
TECHNOLOGY OF USE IN FOODS:	Alginates should be dispersed in cold deionised water and heated for 10 minutes at 80°C to hydrate the polysaccharide. A high shear mixer will aid dispersion, although prolonged shear of high-molecular-weight polymers will reduce the viscosity. Calcium gels can be prepared by addition of alginate solutions to a calcium solution (e.g. maraschino cherries), addition of calcium to a hot solution of alginate and then cooling (gel is thermo-irreversible), or by diffusion. Gels can also be formed by lowering the pH (alginic acid), but this can be technically difficult. Ammonium alginate forms particularly viscous solutions. Alginates are composed of blocks of polymannuronic acid, polyguluronic acid and mixed regions. Ribbon-like structures are formed in solution and alginates with a high percentage of guluronic blocks can be cross-linked (gelled) by divalent ions (e.g. calcium).
SYNERGISTS:	Divalent ion, pectins

ANTAGONISTS: None known

FOOD SAFETY ISSUES: ADI 0–25 mg/kg. The powder is combustible and emits toxic fumes when heated

LEGISLATION: Usage level: Limitation 0.002%, baked goods; 0.4%, alcoholic beverages; 0.4%, frostings; 0.6%, egg products; 0.5%, fats/oils; 0.25%, gelatins/puddings; 0.4%, gravies; 0.5%, sweet sauces; 0.3%, ther foods

USA:	**UK and EUROPE:**	**AUSTRALIA/PACIFIC RIM:**
FDA 21 CFR §184.1187	UK: approved	Japan: approved
GRAS, USDA 9CFR 318.7	Europe: listed	

REFERENCES:

Clare, K. (1993) Algin. In: Whistler R.L. and BeMiller, J.N. (eds) *Industrial Gums: Polysaccharides and Derivatives*, 3rd edn. Academic Press, San Diego, pp. 105–143.

Rehm B.H.A. (ed.) (2009) *Alginates: Biology and Applications*. Microbiology Monographs 13. Springer-Verlag, Berlin, pp. 1–53.

ANY OTHER RELEVANT INFORMATION: Alginates are natural polysaccharides extracted from brown seaweeds (Phaeophyceae). *Macrocystis pyrifera*, *Laminera hyperborea*, *Laminaria digitata*, *Laminaria japonica*, *Ascophyllum nodosum*, *Ecklonia maxima* and *Lessonia nigrescens* are the most important commercial sources of alginates. Structurally distinct bacterial alginates can be obtained from *Pseudomonas* species and *Azotobacter* species. Although algin, alginic acid, ammonium alginate, calcium alginate, potassium alginate and sodium alginate are essentially different states of the same type of compound, for legislative purposes they are listed separately.

NAME:	Carboxymethylcellulose
CATEGORY:	Polysaccharides
FOOD USE:	Soups/Syrups/Beverages/Dairy products/Dressings/Dry formulated products/Food packaging/Edible films and coatings/All food products
SYNONYMS:	Carboxymethylated β-D-(1 → 4) glucan/CAS 9004-32-4/E466/CMC/Sodium CMC/Cellulose gum/Sodium carboxymethylcellulose
FORMULA:	Variable, depending on the degree of substitution
MOLECULAR MASS IN Daltons:	Variable from 21 000 to 500 000
ALTERNATIVE FORMS:	None
PROPERTIES AND APPEARANCE:	A white powder
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	Solubility varies with molecular weight and carboxymethylation. Generally, carboxymethylcellulose is soluble in water, sucrose solutions, sodium chloride solution and ethanol solutions, but solubility in vegetable oils and propylene glycol is limited. Solubility declines with increasing molecular weight, decreasing methylation and increasing concentration. Solubility is pH-dependent, with the more insoluble acid form present below pH4.
FUNCTION IN FOODS:	Thickening agent; stabiliser; suspending agent; bulking agent
ALTERNATIVES:	Methyl ethyl cellulose (MEC); hydroxy propyl methyl cellulose (HPMC); hydroxy ethyl methyl cellulose (HEMC); methyl cellulose (MC); proteins; gum arabic; xanthan, carrageenans; dextrans; starches; locust bean gum; guar gum; gelatin; agar; alginate (application-dependent)
TECHNOLOGY OF USE IN FOODS:	Carboxymethylcellulose should be dispersed in hot water and cooled to hydrate the polysaccharide. A high shear mixer will aid dispersion, although prolonged shear of high-molecular-weight polymers will reduce the viscosity. The viscosity of carboxymethylcelluloses is relatively constant between pH 4 and 10, but increases below pH 4 due to formation of the acid form of the molecule. Medium to high-molecular-weight molecules with 0.9–1.2 substitutions per sugar unit exhibit pseudoplastic behaviour (shear-dependent thinning), whereas at 0.4–0.7% substitution the solutions exhibit thixotropy (time-dependent thinning). Gels can be formed in the presence of trivalent ions like aluminium.

SYNERGISTS:	Trivalent cations, non-ionic polymers		
ANTAGONISTS:	None known		
FOOD SAFETY ISSUES:	Non-toxic; ADI 0–25 mg/kg. The powder is combustible		
LEGISLATION:	**USA:** FDA 21 CFR §133.134, 133.178, 133.179, 1150.141, 150.161, 173.310, 175.105, 175.300, 182.70, 182.1745, GRAS, USDA 9 CFR §318.7	**UK and EUROPE:** UK: approved Europe: listed	**AUSTRALIA/PACIFIC RIM:** Japan: restricted (2% max.)

REFERENCES:

Ash, M. and Ash, I. (1996) *Food Additives*. Gower Publishing, Brookfield, VT.

Feddersen, R.L. and Thorp, S.N. (1993) Sodium carboxymethylcellulose. In: Whistler, R.L. and BeMiller, J.N. (eds) *Industrial Gums: Polysaccharides and Derivatives*, 3rd edn. Academic Press, San Diego, pp. 537–577.

ANY OTHER RELEVANT INFORMATION:

Chemically carboxymethylated natural cellulose.

See also methyl ethyl cellulose (MEC); hydroxy propyl methyl cellulose (HPMC); hydroxy propyl cellulose (HPC); and methyl cellulose (MC)

NAME:	Carrageenan
CATEGORY:	Polysaccharides
FOOD USE:	All food products/Edible films and coatings
SYNONYMS:	CAS 9004-07-1/EINECS 232-524-2/E407/E407a/Carrageenin/Carrageen/Carragheenan/Chondrus/Irish Moss/Processed Euchema Carrageenan (PES)/Philippine Natural Carrageenan (PNG)/Alternatively Refined Carrageenan (ARC)
FORMULA:	$(C_6H_{7-10}S_{0-6}O_{4.5-14})n$. Sulphated galactans with a disaccharide repeating unit composed of β-D-(1 → 4) galactose and α-D-(1 → 3) galactose units and close derivatives
MOLECULAR MASS IN Daltons:	Variable, but typically 100 000 to 5 million
ALTERNATIVE FORMS:	Kappa-carrageenan; iota-carrageenan; lambda-carrageenan; theta-carrageenan; mu-carrageenan; nu-carrageenan; xi-carrageenan; sodium salts; potassium salts; calcium salts; ammonium salts; Processed Euchema Carrageenan (PES); etc.
PROPERTIES AND APPEARANCE:	White to yellow powders or hard flakes
WATER CONTENT MAXIMUM IN %:	0–20
ASH MAXIMUM IN %:	19–42
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	Solubility in aqueous solution varies with differences in structure, molecular weight and cations. Lambda-carrageenans are generally more soluble than iota-carrageenans, which tend to be more soluble than kappa-carrageenans. Solubility declines with increasing molecular weight and increasing concentration and, generally, sodium salts are more soluble than calcium and potassium salts. Kappa-, iota- and lambda-carrageenans are soluble in hot concentrated sugar solutions, iota- and lambda-carrageenan are soluble in hot saturated salt solutions, and only the sodium salt of lambda carrageenan is soluble in 35% ethanol solution. Carrageenans are not soluble in non-polar solvents like vegetable oils and propylene glycol. Optimum solubility occurs at pH 9 and declines as the pH is reduced (<4). Carrageenans degrade spontaneously at low pH. Elevated temperatures significantly improve the dispersion of carrageenans, particularly potassium and calcium salts of kappa- and iota-carrageenans which require temperatures above 60°C for dissolution.

FUNCTION IN FOODS: Gelling agent; thickening agent; stabiliser; flocculant and bulking agent. It can be used to stabilise emulsions and to retard ice-crystal formation

ALTERNATIVES: Gelatin; gellan; agar; alginate; xanthan; furcellaran (application-dependent)

TECHNOLOGY OF USE IN FOODS: Carrageenans should be dispersed in cold water and heated for 10 minutes at 80°C to hydrate the polysaccharide. A high shear mixer will aid dispersion, although prolonged shear of high-molecular-weight polymers will reduce the viscosity.

Commercially available grades of carrageenan are complex mixtures of a wide range of carrageenans (kappa, iota, lambda, etc.) with different molecular weights, a range of different cations (chiefly potassium, sodium and calcium) and other constituents (e.g. polysorbate 80, celluloses in PES). Consequently, the functional properties of carrageenan extracts are extremely diverse. Extracts with a high concentration of kappa-carrageenan form strong thermoreversible gels with high melting points, especially in combination with potassium ions or casein. Iota-carrageenan-enriched carrageenans can be used for compliant gels and form stronger gels with calcium ions than potassium ions. Lambda-carrageenans do not gel at all, but can be useful thickeners.

Carrageenans are particularly suitable for dairy applications because the strong synergistic interaction with casein allows gel formation at very low carrageenan concentrations (e.g. 0.04% w/w). The flocculation properties of carrageenans have traditionally been used to clarify beers and wines. Carrageenans can interact with proteins below the protein isoelectric point, and this interaction has been used to improve the stability of protein products.

SYNERGISTS: Casein; chitosan; locust bean gum; potassium; calcium

ANTAGONISTS: Any positive or negatively charged molecule is a potential antagonist

FOOD SAFETY ISSUES: Suspected carcinogen. May induce colonic ulcers. The powder is combustible

LEGISLATION:

USA:
FDA 21 CFR §172.620, 172.623, 172.626, 182.7255. GRAS
USDA 9 CFR §318.7
ADI 75 mg/kg

UK and EUROPE:
UK: approved
Europe: listed. Carrageenans extracted using traditional aqueous extraction methods are labelled E407
Carrageenans (PES, PNC, ARC) extracted using an alternative commercial method are labelled E407a

AUSTRALIA/PACIFIC RIM:
Japan: approved for use as a natural thickener and stabiliser

REFERENCES:

Ash, M. and Ash, I. (1996) *Food Additives*. Gower Publishing, Brookfield, VT.

Craighie, J.S. and Leigh, C. (1978) Carrageenans and agars. In: Hellebust, J.A. and Craigie, J.S. (eds) *Handbook of Phycological Methods: Physiological and Biochemical Methods*. Cambridge University Press, Cambridge, p. 114.

Shepherd, R. (1996) Extraction, purification and characterization of novel carrageenans with potential applications in dairy products, NZBA 1996.

Therkelsen, G.H. (1993) Carrageenan. In: Whistler, R.L. and BeMiller, J.N. (eds) *Industrial Gums: Polysaccharides and Derivatives*, 3rd edn. Academic Press, San Diego, pp. 145–180.

ANY OTHER RELEVANT INFORMATION:

Carrageenans are natural sulphated polysaccharides extracted from red seaweeds (Rhodophyceae). *Euchema* spp., *Chondrus crispus*, *Iridaea* spp. and *Gigartina* spp. are the most important commercial sources of carrageenans. There is concern that low-molecular-weight fractions of carrageenan could be toxic, and many manufacturers have voluntarily stopped using carrageenans in baby foods.

Semi-refined carrageenans are not water extracts from seaweeds and as such did not match the legal definition of a carrageenan. They are extracted from seaweeds using an alternative process and differ from other carrageenans in that they contain significant amounts of celluloses.

See also: kappa-carrageenan, iota-carrageenan, lambda-carrageenan and furcellaran

NAME:	Iota-carrageenan
CATEGORY:	Polysaccharides
FOOD USE:	All food products/Edible films and coatings
SYNONYMS:	CAS 9004-07-1/EINECS 232-524-2/EC 232-524-2/E407/E407a/Carrageenin/Carrageen/Carragheenan/ Chondr Irish Moss/Processed Euchema Carrageenan (PES)/Philippine Natural Carrageenan (PNG)/ Alternatively Refined Carrageenan (ARC)
FORMULA:	$(C_6H_{7.5}S_1O_{7.5})n$. A polymer formed from a disaccharide repeating unit composed of a 4-*O*-sulfato-β-D-galactopyranosyl unit and a 3,6-anhydro-2-*O*-sulfato-α-D-galactopyranosyl unit
MOLECULAR MASS IN Daltons:	Variable, but typically 700 000 to 5 million
ALTERNATIVE FORMS:	Blends including iota-carrageenans; polymers in which most but not all the units are of the iota-carrageenan type; sodium salts; potassium salts; calcium salts; ammonium salts, etc.
PROPERTIES AND APPEARANCE:	White to yellow powders or flakes
WATER CONTENT MAXIMUM IN %:	0–22
ASH MAXIMUM IN %:	19–42
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	The sodium salt of iota-carrageenans is soluble in cold water, but potassium and calcium salts must be heated to > 60°C. Iota-carrageenan is slightly soluble in hot concentrated sugar solutions, soluble in hot concentrated salt solutions, but insoluble in 35% ethanol, vegetable oils and propylene glycol. Optimum solubility occurs at pH 9 and declines as the pH is reduced (<4). Carrageenans degrade spontaneously at low pH. Elevated temperatures significantly improve the dispersion of carrageenans, particularly potassium and calcium salts of iota-carrageenan which require temperatures above 60°C for dissolution.
FUNCTION IN FOODS:	Gelling agent; thickening agent; stabiliser; flocculant and bulking agent. It can be used to stabilise emulsions and to retard ice-crystal formation
ALTERNATIVES:	Gelatin; gellan; agar; alginate; xanthan; furcellaran (application-dependent)

TECHNOLOGY OF USE IN FOODS:

Carrageenans should be dispersed in cold water and heated for 10 minutes at 80°C to hydrate the polysaccharide. A high shear mixer will aid dispersion, although prolonged shear of high-molecular-weight polymers will reduce the viscosity.

Commercially available grades of carrageenan are complex mixtures of a wide range of carrageenans (kappa, iota, lambda, etc.) with different molecular weights, a range of different cations (chiefly potassium, sodium and calcium) and other constituents (e.g. polysorbate 80, celluloses in semi-refined carrageenans). Consequently, the functional properties of carrageenan extracts are extremely diverse. Extracts with a high concentration of kappa-carrageenan form strong thermoreversible gels with high melting points, especially in combination with potassium ions or casein. Iota-carrageenan-enriched carrageenans can be used for compliant gels, and form stronger gels with calcium ions than potassium ions. Iota-carrageenans can interact with proteins below the protein isoelectric point, and this interaction has been used to improve the stability of protein products.

SYNERGISTS:

Casein; chitosan; locust bean gum; potassium; calcium

ANTAGONISTS:

Any positive or negatively charged molecule is a potential antagonist

FOOD SAFETY ISSUES:

Suspected carcinogen. May induce colonic ulcers. The powder is combustible

LEGISLATION:

USA:	**UK and EUROPE:**	**AUSTRALIA/PACIFIC RIM:**
FDA 21 CFR §172.620, 172.623, 172.626, 182.7255. GRAS. USDA 9 CFR §318.7 ADI 75 mg/kg	UK: approved Europe: listed. Carrageenans extracted using traditional aqueous extraction methods are labelled E407. Carrageenans (PES, PNC, ARC) extracted using an alternative commercial method are labelled E407a	Japan: approved for use as a natural thickener and stabiliser

REFERENCES:

Ash, M., and Ash, I. (1996) *Food Additives*. Gower Publishing, Brookfield, VT.

Craighie, J.S. and Leigh, C. (1978) Carrageenans and agars. In: Hellebust, J.A. and Craigie, J.S. (eds) *Handbook of Phycological Methods: Physiological and Biochemical Methods*. Cambridge University Press, Cambridge, p. 114.

Shepherd, R. (1996) Extraction, purification and characterization of novel carrageenans with potential applications in dairy products, NZBA 1996.

Therkelsen, G.H. (1993) Carrageenan. In: Whistler, R.L. and BeMiller, J.N. (eds) *Industrial Gums: Polysaccharides and Derivatives*, 3rd edn. Academic Press, San Diego, pp. 145–180.

ANY OTHER RELEVANT INFORMATION:

Carrageenans are natural sulphated polysaccharides extracted from red seaweeds (Rhodophyceae). *Euchema* spp., *Chondrus crispus*, *Iridaea* spp. and *Gigartina* spp. are the most important commercial sources of carrageenan. There is concern that low-molecular-weight fractions of carrageenan could be toxic, and many manufacturers have voluntarily stopped using carrageenans in baby foods.

Semi-refined carrageenans are not water extracts from seaweeds and as such did not match the legal definition of a carrageenan. They are extracted from seaweeds using an alternative process and differ from other carrageenans in that they contain significant amounts of celluloses.

See also: carrageenan, kappa-carrageenan, lambda-carrageenan and furcellaran

NAME:	Kappa-carrageenan
CATEGORY:	Polysaccharides
FOOD USE:	All food products/Edible films and coatings
SYNONYMS:	CAS 9004-07-1/EINECS 232-524-2/EC-232-524-2/E407/E407a/Carrageenin/Carrageen/Carragheenan/ Chondrus/Irish Moss/Processed Euchema Carrageenan (PES)/Philippine Natural Carrageenan (PNG)/ Alternatively Refined Carrageenan (ARC)
FORMULA:	$(C_6H_8S_{0.5}O_6)n$. A polymer formed from a disaccharide repeating unit composed of a 4-*O*-sulfato-β-D-galactopyranosyl unit and a 3,6- anhydro-α-D-galactopyranosyl unit
MOLECULAR MASS IN Daltons:	Variable, but typically 700 000 to 5 million
ALTERNATIVE FORMS:	Blends including kappa-carrageenans; polymers in which most but not all the units are of the kappa-carrageenan type; sodium salts; potassium salts; calcium salts; ammonium salts, etc.
PROPERTIES AND APPEARANCE:	White to yellow powders or flakes
WATER CONTENT MAXIMUM IN %:	0–22
ASH MAXIMUM IN %:	19–42
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	The sodium salt of kappa-carrageenans is soluble in cold water, but potassium and calcium salts must be heated to >60°C. Kappa- carrageenan will dissolve in hot concentrated sugar solutions but is insoluble in concentrated salt solutions and 35% ethanol. It is insoluble in vegetable oils and propylene glycol. Optimum solubility occurs at pH 9 and declines as the pH is reduced (<4). Carrageenans degrade spontaneously at low pH. Elevated temperatures significantly improve the dispersion of carrageenans, particularly potassium and calcium salts of kappa-carrageenans which require temperatures above 60°C for dissolution.
FUNCTION IN FOODS:	Gelling agent; thickening agent; stabiliser; flocculant and bulking agent. It can be used to stabilise emulsions and to retard ice-crystal formation
ALTERNATIVES:	Gelatin; gellan; agar; alginate; xanthan; furcellaran (application-dependent)

TECHNOLOGY OF USE IN FOODS:

Carrageenans should be dispersed in cold water and heated for 10 minutes at 80°C to hydrate the polysaccharide. A high shear mixer will aid dispersion, although prolonged shear of high-molecular-weight polymers will reduce the viscosity.

Commercially available grades of carrageenan are complex mixtures of a wide range of carrageenans (kappa, iota, lambda, etc.) with different molecular weights, a range of different cations (chiefly potassium, sodium and calcium) and other constituents (e.g. polysorbate 80, celluloses in semi-refined carrageenans). Consequently, the functional properties of carrageenan extracts are extremely diverse. Extracts with a high concentration of kappa-carrageenan form strong thermoreversible gels with high melting points, especially in combination with potassium ions or casein.

Kappa-carrageenans are particularly suitable for dairy applications because the strong synergistic interaction with casein allows gel formation at very low carrageenan concentrations (e.g. 0.04% w/w). The flocculation properties of carrageenans (Irish moss) have traditionally been used to clarify beers and wines. Kappa-carrageenans can interact with proteins below the protein isoelectric point, and this interaction has been used to improve the stability of protein products.

SYNERGISTS:

Casein; chitosan; locust bean gum; potassium; calcium

ANTAGONISTS:

Any positive or negatively charged molecule is a potential antagonist

FOOD SAFETY ISSUES:

Suspected carcinogen. May induce colonic ulcers. The powder is combustible

LEGISLATION:

USA:
FDA 21 CFR §172.620, 172.623, 172.626, 182.7255. GRAS
USDA 9 CFR §318.7
ADI 75 mg/kg

UK and EUROPE:
UK: approved
Europe: listed. Carrageenans extracted using traditional aqueous extraction methods are labelled E407
Carrageenans (PES, PNC, ARC) extracted using an alternative commercial method are labelled E407a

AUSTRALIA/PACIFIC RIM:
Japan: approved for use as a natural thickener and stabiliser

REFERENCES:

Ash, M. and Ash, I. (1996) *Food Additives*. Gower Publishing, Brookfield, VT.

Craighie, J.S. and Leigh, C. (1978) Carrageenans and agars. In: Hellebust, J.A. and Craigie, J.S. (eds) *Handbook of Phycological Methods: Physiological and Biochemical Methods*. Cambridge University Press, Cambridge, p. 114.

Shepherd, R. (1996) Extraction, purification and characterization of novel carrageenans with potential applications in dairy products, NZBA 1996.

Therkelsen, G.H. (1993) Carrageenan. In: Whistler, R.L. and BeMiller, J.N. (eds) *Industrial Gums: Polysaccharides and Derivatives*, 3rd edn. Academic Press, San Diego, pp. 145–180.

ANY OTHER RELEVANT INFORMATION:

Carrageenans are natural sulphated polysaccharides extracted from red seaweeds (Rhodophyceae). *Euchema* spp., *Chondrus crispus*, *Iridaea* spp. and *Gigartina* spp. are the most important commercial sources of carrageenan. There is concern that low-molecular-weight fractions of carrageenan could be toxic, and many manufacturers have voluntarily stopped using carrageenans in baby foods.

Semi-refined carrageenans are not water extracts from seaweeds and as such did not match the legal definition of a carrageenan. They are extracted from seaweeds using an alternative process and differ from other carrageenans in that they contain significant amounts of celluloses.

See also: carrageenan, iota-carrageenan, lambda-carrageenan and furcellaran

NAME:	Lambda-carrageenan
CATEGORY:	Polysaccharides
FOOD USE:	All food products/Edible films and coatings
SYNONYMS:	CAS 9004-07-1/EINECS 232-524-2/EC 232-254-2/E407/E407a/Carrageenin/Carrageen/Carragheenan/ Chondrus/Irish Moss/Processed Euchema Carrageenan (PES)/Philippine Natural Carrageenan (PNG)/ Alternatively Refined Carrageenan (ARC)
FORMULA:	$(C_6H_{8.5}S_{1.5}O_{9.5})n$. A polymer formed from a disaccharide repeating unit composed of a 2-*O*-sulfato-β-D-galactopyranosyl unit and a 2,6- sulfato-α-D-galactopyranosyl unit
MOLECULAR MASS IN Daltons:	Variable, but typically 700 000 to 5 million
ALTERNATIVE FORMS:	Blends including lambda-carrageenans; polymers in which most but not all the units are of the lambda-carrageenan type; sodium salts; potassium salts; calcium salts; ammonium salts, etc
PROPERTIES AND APPEARANCE:	White to yellow powders or flakes
WATER CONTENT MAXIMUM IN %:	0–22
ASH MAXIMUM IN %:	19–42
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	Salts of lambda-carrageenan are soluble in cold water, concentrated sugar solutions, concentrated salt solutions and 35% ethanol. Lambda-carrageenan is insoluble in vegetable oils and propylene glycol. Optimum solubility occurs at pH 9 and declines as the pH is reduced (<4). Carrageenans degrade spontaneously at low pH. Elevated temperatures significantly improve the dispersion of carrageenans.
FUNCTION IN FOODS:	Thickening agent; stabiliser; flocculant and bulking agent. It can be used to stabilise emulsions and to retard ice-crystal formation
ALTERNATIVES:	Xanthan; furcellaran (application-dependent)
TECHNOLOGY OF USE IN FOODS:	Carrageenans should be dispersed in cold water and heated for 10 minutes at 80°C to hydrate the polysaccharide. A high shear mixer will aid dispersion, although prolonged shear of high-molecular-weight polymers will reduce the viscosity.

Commercially available grades of carrageenan are complex mixtures of a wide range of carrageenans (kappa, iota, lambda, etc.) with different molecular weights, a range of different cations (chiefly potassium, sodium and calcium) and other constituents (e.g. polysorbate 80, celluloses in semi-refined carrageenans). Consequently, the functional properties of carrageenan extracts are extremely diverse. Extracts with a high concentration of lambda-carrageenans do not gel at all but can be useful thickeners. Lambda-carrageenans can interact with proteins below the protein isoelectric point, and this interaction has been used to improve the stability of protein products.

SYNERGISTS: Proteins; chitosan

ANTAGONISTS: Any positive or negatively charged molecule is a potential antagonist

FOOD SAFETY ISSUES: Suspected carcinogen. May induce colonic ulcers. The powder is combustible

LEGISLATION:

USA:	**UK and EUROPE:**	**AUSTRALIA/PACIFIC RIM:**
FDA 21 CFR §172.620, 172.623, 172.626, 182.7255. GRAS USDA 9 CFR §318.7 ADI 75 mg/kg	UK: approved Europe: listed. Carrageenans extracted using traditional aqueous extraction methods are labelled E407 Carrageenans (PES, PNC, ARC) extracted using an alternative commercial method are labelled E407a	Japan: approved for use as a natural thickener and stabiliser

REFERENCES:

Ash, M. and Ash, I. (1996) *Food Additives*. Gower Publishing, Brookfield, VT.

Craighie, J.S. and Leigh, C. (1978) Carrageenans and agars. In: Hellebust, J.A. and Craigie, J.S. (eds) *Handbook of Phycological Methods: Physiological and Biochemical Methods*. Cambridge University Press, Cambridge, p. 114.

Shepherd, R. (1996) Extraction, purification and characterization of novel carrageenans with potential applications in dairy products, NZBA 1996.

Therkelsen, G.H. (1993) Carrageenan. In: Whistler, R.L. and BeMiller, J.N. (eds) *Industrial Gums: Polysaccharides and Derivatives*, 3rd edn. Academic Press, San Diego, pp. 145–180.

ANY OTHER RELEVANT INFORMATION:

Carrageenans are natural sulphated polysaccharides which are extracted from red seaweeds (Rhodophyceae). *Eurchema* spp., *Chondrus crispus, Iridaea* spp. and *Gigartina* spp. are the most important commercial sources of carrageenan. There is concern that low molecular-weight fractions of carrageenan could be toxic, and many manufacturers have voluntarily stopped using carrageenans in baby foods.

Semi-refined carrageenans are not water extracts from seaweeds and as such did not match the legal definition of a carrageenan. They are extracted from seaweeds using an alternative process and differ from other carrageenans in that they contain significant amounts of celluloses.

See also: carrageenan, kappa-carrageenan, lambda-carrageenan and furcellaran

NAME:	Cellulose
CATEGORY:	Polysaccharides
FOOD USE:	Dry formulated products/Confectionery processing aid/Low-calorie foods/All food products
SYNONYMS:	β-D-(1 → 4) glucan/CAS 9004-34-6/EINECS 232-674-9/EC 232-674-9/E460/α-cellulose/Bleached wood pulp/Cotton fibre
FORMULA:	$(C_6H_{10}O_5)n$
MOLECULAR MASS IN Daltons:	Variable, generally 160 000–560 000
ALTERNATIVE FORMS:	None
PROPERTIES AND APPEARANCE:	A white powder or crystals
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	Cellulose is insoluble in water and organic solvents
FUNCTION IN FOODS:	Can be used as a processing aid, dietary fibre, a texturising agent, bulking agent and an anti-caking agent. It is not digestible, so it can be used in low-calorie preparations
ALTERNATIVES:	Starch hydrolysis products (SHPs) and polydextrose (application-dependent)
TECHNOLOGY OF USE IN FOODS:	Cellulose powder can be mixed with the dry ingredients or dispersed in an aqueous preparation.
SYNERGISTS:	None known
ANTAGONISTS:	None known
FOOD SAFETY ISSUES:	Non-toxic. The powder is combustible
LEGISLATION:	**USA:** FDA GRAS **UK and EUROPE:** UK: not permitted in baby foods Europe: listed **AUSTRALIA/PACIFIC RIM:** Japan: approved for use as a natural processing aid

REFERENCES:

Ash, M. and Ash, I. (1996) *Food Additives*. Gower Publishing, Brookfield, VT.

ANY OTHER RELEVANT INFORMATION:

Cellulose is natural polysaccharide particles extracted from various plant sources. See also Microcrystalline cellulose.

NAME:	Chitosan
CATEGORY:	Polysaccharides
FOOD USE:	Food packaging/Edible films and coatings/All food products
SYNONYMS:	2-Acetamido-2-deoxy-β-1,4-D-glucan/CAS 9012-76-4/Chitan/Deacetylated chitin/Profloc/Seacure
FORMULA:	Variable, depending on degree of acetylation
MOLECULAR MASS IN Daltons:	Variable
ALTERNATIVE FORMS:	Chitosans with different molecular weights and acetyl contents will have different properties
PROPERTIES AND APPEARANCE:	White/off-white/brown powder or soft flakes
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	Solubility varies with molecular weight. Generally, chitosan is insoluble in water, sucrose solutions, sodium chloride solution, ethanol solutions, vegetable oils and propylene glycol. It is soluble in aqueous solutions of acids (acetic, citric, etc.). Solubility declines with increasing molecular weight and increasing concentration. It is pH-dependent (<4). Colloidal suspensions can be prepared at higher pH. Elevated temperatures will improve the dispersion of high-molecular-weight chitosan.
FUNCTION IN FOODS:	Viscosifier; stabilising agent; suspending agent; coating in food contact surfaces; bulking agent
ALTERNATIVES:	Pectins; xanthan; locust bean gum; guar gum; starches (application-dependent)
TECHNOLOGY OF USE IN FOODS:	Chitosan should be dispersed in an aqueous solution of an organic acid (pH <4) and heated for 10 minutes at 80°C to hydrate the polysaccharide. A high shear mixer will aid dispersion, although prolonged shear of high-molecular-weight polymers will reduce the viscosity. Chitosan is a partially deacetylated polymer of acetylglucosamine (2-acetamido-2-deoxy-β-1,4-D-glucan). It is essentially a natural, water-soluble derivative of cellulose with unique properties. In comparison with many other polysaccharides it is relatively insoluble, although it forms viscous solutions at low pH and colloidal suspensions of chitosan at higher pH. Viscosity increases with increasing molecular weight and concentration. Like most polysaccharides, it starts to degrade above pH 8 and below pH 3, with concomitant reductions in viscosity.
SYNERGISTS:	Xanthan

ANTAGONISTS:	None known	
FOOD SAFETY ISSUES:	Non-toxic. The powder is combustible	
LEGISLATION:	**USA:** GRAS status applied for	**AUSTRALIA/PACIFIC RIM:** Japan: approved for use as a natural thickener and stabiliser
REFERENCES:	Ash, M. and Ash, I. (1996) *Food Additives*. Gower Publishing, Brookfield, VT. Shepherd, R., Reader, S. and Falshaw, A. (1997) Chitosan functional properties. *Glycoconjugate Journal* **14**, 535–542. Whistler, R.L. (1993) Chitin. In: Whistler, R.L. and BeMiller, J.N. (eds) *Industrial Gums: Polysaccharides and Derivatives*, 3rd edn. Academic Press, San Diego, chapter 22.	
ANY OTHER RELEVANT INFORMATION:	Chitosan is usually prepared from chitin found in a wide range of natural sources: crustaceans, fungi, insects, annelids, molluscs, coelenterata. However, chitosan is only manufactured from crustaceans (crab, krill and crayfish), primarily because a large amount of the crustacean exoskeleton is available as a by-product of food processing. Chitosan from mushroom and squid pens may soon be available commercially.	

NAME:	Dextran
CATEGORY:	Polysaccharides
FOOD USE:	Food packaging/Edible films and coatings/All food products
SYNONYMS:	α-D-(1 → 6) glucan/CAS 9004-54-0/EINECS 232-677-5/EC 232-677-5/Macrose/Dextraven/Gentran/Hemodex/Intradex/Onkotin/Plavolex/Polyglucin/Promit
FORMULA:	$(C_6H_{10}O_5)n$
MOLECULAR MASS IN Daltons:	Variable; ranges from 2000 to 500 million
ALTERNATIVE FORMS:	None
PROPERTIES AND APPEARANCE:	White/off-white powder or soft flakes
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	Solubility varies with molecular weight. Generally, dextran is soluble in water, sucrose solutions, sodium chloride solution and ethanol solutions, but solubility in vegetable oils and propylene glycol is limited. Solubility declines with increasing molecular weight and increasing concentration. It is pH-independent (pH 4–8). Elevated temperatures will significantly improve the dispersion of high-molecular-weight dextrans; however, technically, increasing the temperature slightly reduces the solubility of dextrans.
FUNCTION IN FOODS:	Coating in food contact surfaces; thickening agent; stabiliser; bulking agent
ALTERNATIVES:	Dextrins; polydextrose; gum arabic and xanthan (application-dependent)
TECHNOLOGY OF USE IN FOODS:	Dextran should be dispersed in cold water and heated for 10 minutes at 80°C to hydrate the polysaccharide. A high shear mixer will aid dispersion, although prolonged shear of high-molecular-weight polymers will reduce the viscosity. Dextran is a linear polymer of glucose molecules that adopts a random coil conformation in aqueous solution with minimal interactions between dextran molecules and no known synergistic interactions. In comparison with many other polysaccharides it is relatively soluble in aqueous solutions and relatively low in viscosity. Viscosity increases with increasing molecular weight and concentration. The viscosity is pH-independent, although like most polysaccharides it starts to degrade above pH 8 and below pH 4 with concomitant reductions in viscosity.
SYNERGISTS:	None known

ANTAGONISTS:	None known	
FOOD SAFETY ISSUES:	Non-toxic. The powder is combustible	
LEGISLATION:	**USA:** FDA 21 CFR §186, GRAS as indirect additive. Until 1977, dextran was permitted as a direct additive in the USA, but approval has lapsed as legislation has been updated	**AUSTRALIA/PACIFIC RIM:** Japan: approved for use as a natural thickener and stabiliser
REFERENCES:	Ash, M. and Ash, I. (1996) *Food Additives*. Gower Publishing, Brookfield, VT. De Belder, A.N. (1993) Dextran. In: Whistler, R.L. and BeMiller, J.N. (eds) *Industrial Gums: Polysaccharides and Derivatives*, 3rd edn. Academic Press, San Diego, pp. 399–425. Jeanes, A. (1978) *Dextran Bibliography*. Misc. Pub. 1355, U.S. Department of Agriculture.	
ANY OTHER RELEVANT INFORMATION:	Dextran is a natural polysaccharide produced by a wide range of microorganisms. It is generally obtained from cultures of the food-grade microorganism *Leuconostoc mesenteroides*. Commercially available grades of dextran often contain some α-D-(1 → 3) links and other linkages that could affect functional properties.	

NAME:	Furcellaran
CATEGORY:	Polysaccharides
FOOD USE:	All food products/Edible films and coatings
SYNONYMS:	CAS 9000-21-9/EINECS 232-531-0/EC 232-531-0/E408/Furcellaran/Danish gum
FORMULA:	A polymer formed from a disaccharide repeating unit composed of a 4-*O*-sulfato-β-D-galactopyranosyl unit and a 3,6-anhydro-α-D-galactopyranosyl unit
MOLECULAR MASS IN Daltons:	Variable
ALTERNATIVE FORMS:	Very similar in structure to kappa-carrageenan, differing primarily in level of sulphate substitution. In kappa-carrageenan the sulphated hydroxyl unit is in theory 100% sulphated, whereas in furcellaran the hydroxyl is in theory 50% sulphated.
PROPERTIES AND APPEARANCE:	White to yellow powder or flakes
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	The sodium salt of furcellaran is soluble in cold water, but potassium and calcium salts must be heated. Furcellaran will dissolve in hot concentrated sugar solutions, but is insoluble in concentrated salt solutions and 35% ethanol. It is insoluble in vegetable oils and propylene glycol. Solubility declines as the pH is reduced (<4). Furcellaran degrades spontaneously at low pH. Elevated temperatures significantly improve the dispersion of furcellaran, particularly potassium and calcium salts of furcellarans.
FUNCTION IN FOODS:	Gelling agent; thickening agent; stabiliser; flocculant and bulking agent. It can be used to stabilise emulsions and to retard ice-crystal formation
ALTERNATIVES:	Kappa-carrageenan; gelatin; gellan; agar; alginate; xanthan (application-dependent)
TECHNOLOGY OF USE IN FOODS:	Furcellaran should be dispersed in cold water and heated for 10 minutes at 80°C to hydrate the polysaccharide. A high shear mixer will aid dispersion, although prolonged shear of high-molecular-weight polymers will reduce the viscosity. Commercially available grades of furcellaran are complex mixtures of a wide range of polysaccharides. Consequently, the functional properties of furcellaran extracts may vary.
SYNERGISTS:	Casein; chitosan; locust bean gum; potassium; calcium
ANTAGONISTS:	Any positive or negatively charged molecule is a potential antagonist

FOOD SAFETY ISSUES:	Moderately toxic; LD_{50} (oral, rat) 5000 mg/kg. The powder is combustible	
LEGISLATION:	**USA:** FDA 21 CFR §172.655	**AUSTRALIA/PACIFIC RIM:** Japan: approved
REFERENCE:	Ash, M. and Ash, I. (1996) *Food Additives*. Gower Publishing, Brookfield, VT.	
ANY OTHER RELEVANT INFORMATION:	Furcellaran is a natural sulphated polysaccharide extracted from a red seaweed *Furcellaria fastigiata* (Rhodophyceae). See also kappa-carrageenan	

NAME:	Gellan
CATEGORY:	Polysaccharides
FOOD USE:	Water gels/Dessert gels/Pet foods/Jams/Dairy products/Food packaging/Edible films and coatings/All food products
SYNONYMS:	CAS 71010-52-1/EINECS/275-117-5/EC 275-117-5/E418/Gum gellan/Gelrite/Kelcogel
FORMULA:	Polymer with a tetrasaccharide repeating unit composed of a β-D-(1 → 3) glucopyranosyl unit, β-D-(1 → 4) glucuronopyranosyl unit, β-D-(1 → 4) glucopyranosyl unit and α-L-(1 → 4) rhamnopyranosyl unit with some acetyl and glycerol groups attached
MOLECULAR MASS IN Daltons:	1–2 million
ALTERNATIVE FORMS:	Salts of potassium; sodium; calcium; magnesium, etc.
PROPERTIES AND APPEARANCE:	White/off-white powder or soft flakes
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	Solubility varies with molecular weight and associated cations. Generally, not fully soluble until about 100°C in water, sucrose or sodium chloride. Solubility declines with increasing molecular weight and increasing concentration. It is not pH-independent.
FUNCTION IN FOODS:	Gelling agent; coating in food contact surfaces; thickening agent; stabiliser; bulking agent
ALTERNATIVES:	Gelatin; agar; alginate; curdlan; carrageenan (application-dependent)
TECHNOLOGY OF USE IN FOODS:	Gellan should be dispersed in cold water and autoclaved at 121°C for 10 minutes to hydrate the polysaccharide. A high shear mixer will aid dispersion, although prolonged shear of high-molecular-weight polymers will reduce the viscosity. Gellan is a linear polymer of glucose molecules that forms stacked interacting double helices when heated and cooled in aqueous solution. Cations (particularly divalent cations) are required for gel formation. Synergistic interactions with gelatin and gum arabic. Forms strong brittle gels which are optically clearer than agar and have similar gel strengths at half the concentration of the equivalent agar gel. In comparison with agar, calcium gellan gels have improved thermostability; they melt above 80°C.
SYNERGISTS:	Gelatin; gum arabic

ANTAGONISTS:	None known			
FOOD SAFETY ISSUES:	Non-toxic. The powder is combustible			
LEGISLATION:	**USA:** FDA 21 CFR §172.665	**UK and EUROPE:** Europe: E418	**CANADA:** Approved	**AUSTRALIA/PACIFIC RIM:** Japan: approved for use as a natural thickener and stabiliser
REFERENCES:	Ash, M. and Ash, I. (1996) *Food Additives*. Gower Publishing, Brookfield, VT. Kang, K.S. and Pettitt, D.J. (1993) Xanthan, gellan, welan and rhamsan. In: Whistler, R.L. and BeMiller, J.N. (eds) *Industrial Gums: Polysaccharides and Derivatives*, 3rd edn. Academic Press, San Diego, pp. 341–395.			
ANY OTHER RELEVANT INFORMATION:	Gellan is a natural polysaccharide obtained from cultures of the microorganism *Pseudomonas elodea*.			

NAME:	Guar gum
CATEGORY:	Polysaccharides
FOOD USE:	Dairy products/Pet foods/Baked goods/Confectionery/Dry formulated products/Food packaging/Edible films and coatings/All food products
SYNONYMS:	β-D-(1 → 4) mannan with some attached D-galactose molecules linked via α-(1 → 6) bonds/CAS 9000-30-0/EINECS 232-536-8/EC 232-536-8/E412/FEMA 2537/Galactomannan/Guar flour/Jaguar gum/Gum cyamopsis
FORMULA:	Variable, depending on the ratio of galactose to mannose
MOLECULAR MASS IN Daltons:	Variable. Generally 300 000 to 360 000
ALTERNATIVE FORMS:	Guar gum
PROPERTIES AND APPEARANCE:	White/brown powder
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	Solubility varies with molecular weight. Generally, guar gum is soluble in water, sucrose solutions and sodium chloride solution, but solubility in ethanol, vegetable oils and propylene glycol is limited. Solubility declines with increasing molecular weight and increasing concentration. It is pH-independent (pH 4–8).
FUNCTION IN FOODS:	Thickening agent; stabiliser; bulking agent; suspending agent
ALTERNATIVES:	Locust bean gum; tara gum; carrageenans; dextrans; starches; xanthan; gelatin; agar; alginate (application-dependent)
TECHNOLOGY OF USE IN FOODS:	Guar gum should be dispersed in cold water and heated to 80°C for 10 minutes to hydrate the polysaccharide. A high shear mixer will aid dispersion, although prolonged shear of high-molecular-weight polymers will reduce the viscosity. Guar gum molecules have a high hydrodynamic volume and can entangle with adjacent molecules, resulting in viscous properties. Synergistic interactions with xanthan gum result in gel formation. The synergistic interaction with xanthan is less pronounced with guar gum than locust bean gum, primarily because regions of the molecule that are not galactose-substituted are responsible for the interaction and locust bean gum has a lower galactose to mannose ratio than guar.
SYNERGISTS:	Xanthan; agar; carrageenan; anionic polymer; anionic surfactants
ANTAGONISTS:	None known

FOOD SAFETY ISSUES: Mildly toxic. The powder is combustible

LEGISLATION: Usage level: Limitation 0.35%, baked goods; 1.2%, cereal; 0.8%, cheese; 1%, dairy products; 2%, fats, oils; 1.2%, gravies; 1%, jam; 0.6%, milk products, nuts; 2%, processed vegetables; 0.8%, soups; 1%, sweet sauces; 0.5%, other foods

USA:	**UK and EUROPE:**	**AUSTRALIA/PACIFIC RIM:**
FDA 21 CFR §133.124, 133.133, 133.134, 133.162, 133.178, 133.179, 150.141, 150.161, 184.1339, GRAS	UK: approved Europe: listed	Japan: approved

REFERENCES:

Ash, M. and Ash, I. (1996) *Food Additives*. Gower Publishing, Brookfield, VT.

Maier, H., Anderson, M., Kurt, C. and Magnusen, K. (1993) Guar, locust bean, tara and fenugreek gums. In: Whistler, R.L. and BeMiller, J.N. (eds) *Industrial Gums: Polysaccharides and Derivatives*, 3rd edn. Academic Press, San Diego, pp. 188–226.

ANY OTHER RELEVANT INFORMATION: Guar gum is a natural polysaccharide extracted from the endosperm of the seeds of *Cyamopsis tetragonolobus*. Guar gum is similar in structure to tara gum and locust bean gum, differing primarily in that guar gum has a higher galactose to mannose ratio (approx. 1: 1.8).

NAME:	Gum arabic
CATEGORY:	Polysaccharides
FOOD USE:	Confectionery/Beverages/Baked goods/Emulsified foods
SYNONYMS:	CAS 9000-01-5/EINECS 232-519-5/EC 232-519-5/E414/Acacia gum/Sudan gum/Gum arabica/Gum hashab/Kordofan gum/Arabic gum/Kami
MOLECULAR MASS IN Daltons:	Variable, although typically 384 000
ALTERNATIVE FORMS:	Gum arabic is slightly acidic, so different salt forms are possible
PROPERTIES AND APPEARANCE:	White/off-white powder or amber to dark brown crystals
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	Gum arabic is soluble in water, sucrose solutions, sodium chloride solution and ethanol solutions, but solubility in vegetable oils and propylene glycol is limited. Viscosity is optimal at pH 6, although the variation across the pH range 3–10 is almost negligible
FUNCTION IN FOODS:	Emulsifier; flavouring agent; adjuvant; formulation aid; humectant; surface-finishing agent; stabiliser; thickener; firming agent; processing aid; texturiser; crystallisation inhibitor; for confections, flavour syrups; dietary fibre; foam stabiliser
ALTERNATIVES:	Gum karaya; gum ghatti; gum tragacanth; maltodextrins; pyrodextrins; polydextroses; methyl celluloses; milk proteins (application-dependent)
TECHNOLOGY OF USE IN FOODS:	Solution of gum arabic can be prepared by dispersing in aqueous solution at room temperature. Emulsions should be prepared with a high shear mixer. Gum arabic is a complex branched arabinogalactan with a (1 → 3) β-D-galactopyranosyl main chain with numerous branched and unbranched side-chains composed of D-galactose, L-arabinose, D-glucuronic acid, L-rhamnose and some methyl substituents. It forms a globular structure in aqueous solution with few interactions with other food ingredients. It is thought that small amounts of protein may be important in gum arabic emulsifying properties. Large quantities of gum arabic are used in confectionery where it inhibits sugar crystallisation, emulsifies lipid and helps to bind water. Gum arabic is also used as an encapsulating agent, to emulsify flavour/colour in beverages, and as a general emulsifier.

In comparison with many other polysaccharides it is highly soluble in aqueous solutions and very low in viscosity. Viscosity increases with increasing molecular weight and concentration. The viscosity is pH-independent, although like most polysaccharides it starts to degrade above pH 8 and below pH 4, with concomitant reductions in viscosity.

SYNERGISTS: None known

ANTAGONISTS: None known

FOOD SAFETY ISSUES: Non-toxic. The powder is combustible

LEGISLATION: Usage level: Limitation 2%, beverages; 5.6%, chewing gum; 12.4%, confections; 1.3%, dairy products; 1.5%, fats, oils; 2.5%, gelatins, puddings; 46.5%, hard candy; 8.3%, nuts; 6%, frozen confections; 4%, snack foods; 85%, soft candy; 1%, other foods

USA:	**UK and EUROPE:**	**AUSTRALIA/PACIFIC RIM:**
FDA 21 CFR §169.179, 169.182, 184.1330, GRAS	UK: approved Europe: listed	Japan: approved for use as a natural thickener and stabiliser

REFERENCES:

Anderson, D.M.W., Gill, M.L.C., Jeffrey, A.M. and McDougall, F.J. (1985) The gum exudates from some closely related Acacia species of the subseries *Uninerves racemosae* (section *phyllodineae*). *Phytochemistry* **24**, 71–75.

Ash, M. and Ash, I. (1995) *Food Additives*. Gower Publishing, Brookfield, VT.

Whistler, R.L. (1993) Exudate gums. In: Whistler, R.L. and BeMiller, J.N. (eds) *Industrial Gums: Polysaccharides and Derivatives*, 3rd edn. Academic Press, San Diego, pp. 311–318.

ANY OTHER RELEVANT INFORMATION: This is a natural polysaccharide that is produced as a protective sticky exudate by acacia trees in response to a wound. The primary species are *Acacia senegal*, *Acacia laetia*, *Acacia famesiana* and *Acacia seyal*. Gum arabic has traditionally been produced in Sudan and neighbouring African countries. Droughts and wars have dramatically affected the price and supply of this product in recent years. Product quality has also proved variable. Alternative products that can adequately reproduce all of the functionalities of gum arabic have proved elusive, although some novel microbial polysaccharides are producing promising results.

NAME:	Gum ghatti
CATEGORY:	Polysaccharides
FOOD USE:	Confectionery/Beverages/Baked goods/Emulsified foods
SYNONYMS:	Indian gum/EC 232-534-7/CAS 9000-28-6
MOLECULAR MASS IN Daltons:	Variable
ALTERNATIVE FORMS:	Gum ghatti is slightly acidic, so different salt forms are possible, EC 95009-09-9, CAS 305-736-9
PROPERTIES AND APPEARANCE:	White/off-white powder or amber to dark brown lumps
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	Gum ghatti is a complex mixture of which 10% are insoluble in water. The remainder are soluble in water, sucrose solutions, sodium chloride solution and ethanol solutions, but solubility in vegetable oils and propylene glycol is limited. Maximum viscosity is observed at pH 8.
FUNCTION IN FOODS:	Emulsifier; flavouring agent; adjuvant; formulation aid; humectant; surface-finishing agent; stabiliser; thickener; firming agent; processing aid; texturiser; crystallisation inhibitor; for confections, flavour syrups, dietary fibre; foam stabiliser
ALTERNATIVES:	Gum arabic; karaya gum; gum tragacanth; maltodextrins; pyrodextrins; polydextroses; methyl celluloses; milk proteins (application-dependent)
TECHNOLOGY OF USE IN FOODS:	Solution of gum ghatti can be prepared by dispersing in aqueous solution at room temperature. Emulsions should be prepared with a high shear mixer. Gum ghatti is a complex branched arabinogalactan with a (1 → 6) β-D-galactopyranosyl main chain with (1 → 4) β-D-glucuronic acid, (1 → 2) mannose and some L-arabinose attached. In comparison with gum arabic it is more viscous, darker in colour and contains more insoluble material.
SYNERGISTS:	None known
ANTAGONISTS:	None known
FOOD SAFETY ISSUES:	Non-toxic. The powder is combustible

LEGISLATION: Usage level: Limitation 0.2%, alcoholic beverages; 0.1%, other foods

USA:	**UK and EUROPE:**	**AUSTRALIA/PACIFIC RIM:**
FDA 21 CFR §184.1333, GRAS	UK: approved Europe: listed	Japan: approved

REFERENCES:

Anderson, D M.W., Gill, M.L.C., Jeffrey, A.M. and McDougall, F.J. (1985) The gum exudates from some closely related Acacia species of the subseries *Uninerves racemosae* (section *phyllodineae*). *Phytochemistry* **24**, 71–75.

Ash, M. and Ash, I. (1996) *Food Additives*. Gower Publishing, Brookfield, VT.

Whistler, R.L. (1993) Exudate gums. In: Whistler, R.L. and BeMiller, J.N. (eds) *Industrial Gums: Polysaccharides and Derivatives*, 3rd edn. Academic Press, San Diego, pp. 311–318.

ANY OTHER RELEVANT INFORMATION: This is a natural polysaccharide that is produced as a protective sticky exudate by *Anogeissus latifolia* in response to a wound.

See also gum arabic and tragacanth gum

NAME:	Hydroxy ethyl cellulose
CATEGORY:	Polysaccharides
FOOD USE:	Food packaging/Edible films and coatings
SYNONYMS:	Hydroxylated and ethylated β-D-(1 → 4) glucan/HEC/CAS 9004-62-0
FORMULA:	Variable, depending on the degree of hydroxylation and ethylation
MOLECULAR MASS IN Daltons:	Variable
ALTERNATIVE FORMS:	None
PROPERTIES AND APPEARANCE:	A white powder or fibrous flakes
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	Solubility varies with molecular weight and hydroxylation/ethylation. Generally, hydroxy ethyl celluloses with molar substitutions (MS) greater than 1.6 are soluble in water, sucrose solutions, sodium chloride solution, but solubility in ethanol solutions, vegetable oils and propylene glycol is limited. Solubility declines with increasing molecular weight, decreasing hydroxylation/ethylation and increasing concentration. It is essentially pH-independent (pH 4–8).
FUNCTION IN FOODS:	Films and packaging associated with food
ALTERNATIVES:	Methyl cellulose (MEC); hydroxy propyl methyl cellulose (HPMC); hydroxyethyl methyl cellulose (HEMC); carboxy methyl cellulose (CMC); xanthan; carrageenans; dextrans; starches; locust bean gum; guar gum; gelatin; agar; alginate (application-dependent)
TECHNOLOGY OF USE IN FOODS:	Hydroxy ethyl cellulose should be dispersed in cold water and heated to 80°C for 10 minutes to hydrate the polysaccharide. A high shear mixer will aid dispersion, although prolonged shear of high-molecular-weight polymers will reduce the viscosity. Alternatively, it can be dispersed in a water-miscible non-solvent or with other dry powders prior to dispersion at room temperature. Hydroxy ethyl cellulose has useful properties in that it is non-ionic, and forms viscous pseudoplastic (viscosity decreases as the shear rate increases) solutions that become more viscous as temperature is lowered. However, it is not currently permitted in foods as a direct additive.
SYNERGISTS:	None known
ANTAGONISTS:	None known

FOOD SAFETY ISSUES:	Non-toxic. The powder is combustible
LEGISLATION:	**USA:** FDA 21 CFR §176.170, 176.180, 175.300
REFERENCES:	Ash, M. and Ash, I. (1996) *Food Additives*. Gower Publishing, Brookfield, VT. Desmarais, A.J. and Wint, R.F. (1993) Hydroxy alkyl and ethyl ethers of cellulose. In: Whistler, R.L. and BeMiller, J.N. (eds) *Industrial Gums: Polysaccharides and Derivatives*, 3rd edn. Academic Press, San Diego, pp. 505–535.
ANY OTHER RELEVANT INFORMATION:	Chemically hydroxylated and ethylated natural cellulose. See methyl cellulose (MEC); hydroxy propyl methyl cellulose (HPMC); hydroxy propyl cellulose (HPC); carboxy methyl cellulose (CMC)

NAME:	Hydroxy propyl cellulose
CATEGORY:	Polysaccharides
FOOD USE:	Soups/Syrups/Beverages/Dairy products/Dressings/Dry formulated products/Food packaging/Edible films and coatings/All food products
SYNONYMS:	Hydroxylated and propylated β-D-(1 → 4) glucan/CAS 9004-64-2/E463/Cellulose 2-hydroxypropyl ether/ Oxypropylated cellulose/Propylene glycol ether of cellulose/HPC
FORMULA:	Variable, depending on the degree of hydroxylation and propylation
MOLECULAR MASS IN Daltons:	Variable
ALTERNATIVE FORMS:	None
PROPERTIES AND APPEARANCE:	A white powder or fibrous flakes
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	Solubility varies with molecular weight and hydroxylation/propylation. Generally, commercially available hydroxy propyl celluloses have molar substitutions (MS) greater than 2. In contrast to hydroxy ethyl celluloses they are soluble not only in aqueous solution but also in a wide range of polar solvents. Hydroxy propyl celluloses are soluble in water, sucrose solutions, sodium chloride solutions, ethanol solutions and propylene glycol, but solubility in vegetable oils is limited. Also in contrast to hydroxyethyl celluloses they are insoluble in hot aqueous solutions (as are methyl celluloses). Solubility declines with increasing molecular weight, decreasing hydroxylation/propylation and increasing concentration. It is essentially pH-independent (pH 4–8).
FUNCTION IN FOODS:	Emulsifier; thickening agent; stabiliser; suspending agent; bulking agent
ALTERNATIVES:	Methyl ethyl cellulose (MEC); hydroxy propyl methyl cellulose (HPMC); hydroxy ethyl methylcellulose (HEMC); carboxy methyl cellulose (CMC); proteins; gum arabic; xanthan; carrageenans; dextrans; starches; locust bean gum; guar gum; gelatin; agar; alginate (application-dependent)
TECHNOLOGY OF USE IN FOODS:	Hydroxy propyl cellulose should be dispersed in hot water and cooled to hydrate the polysaccharide. A high shear mixer will aid dispersion, although prolonged shear of high-molecular-weight polymers will reduce the viscosity.

Hydroxy propyl celluloses have similar properties to methyl cellulose, but they are soluble in a wider range of solvents. They can form aqueous solutions with a wide range of viscosities (variable thickening, stabilising and bulking properties); they are surface-active (emulsifying properties); they can have a high yield point (suspending properties); and they form gel-like structures at high temperatures that melt on cooling (stabilising agents for foods with heat-sensitive components such as the toppings in pizzas). Properties (viscosity, melting points, etc.) vary considerably with the molecular weight and molar substitution.

SYNERGISTS: None known

ANTAGONISTS: None known

FOOD SAFETY ISSUES: LD_{50} (oral, rat) 10 200 mg/kg; ADI 0–25 mg/kg. Slightly toxic. The powder is combustible

LEGISLATION:

USA:
FDA 21 CFR §172.870, 177.1200

UK and EUROPE:
UK: approved
Europe: listed

REFERENCES:

Ash, M. and Ash, I. (1996) *Food Additives*. Gower Publishing, Brookfield, VT.

Desmarais, A.J. and Wint, R.F. (1993) Hydroxy alkyl and ethyl ethers of cellulose. In: Whistler, R.L. and BeMiller, J.N. (eds) *Industrial Gums: Polysaccharides and Derivatives*, 3rd edn. Academic Press, San Diego, pp. 505–535.

ANY OTHER RELEVANT INFORMATION: Chemically hydroxylated and ethylated natural cellulose.

See methyl cellulose (MEC); hydroxy propyl methyl cellulose (HPMC); hydroxy ethyl cellulose (HEC); carboxy methyl cellulose (CMC)

NAME:	Hydroxy propyl methyl cellulose
CATEGORY:	Polysaccharides
FOOD USE:	Soups/Syrups/Beverages/Dairy products/Dressings/Dry formulated products/Food packaging/Edible films and coatings/All food products
SYNONYMS:	Hydroxylated, methylated and propylated β-D-(1 → 4) glucan/CAS 9004-65-3/E464/Cellulose 2-hydroxypropyl methyl ether/Hypromellose/Propylene glycol ether of methyl cellulose/HPMC
FORMULA:	Variable, depending on the degree of hydroxylation, methylation and propylation
MOLECULAR MASS IN Daltons:	Variable
ALTERNATIVE FORMS:	None
PROPERTIES AND APPEARANCE:	A white powder or fibrous flakes
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	Solubility varies with molecular weight and hydroxylation/propylation/methylation. Generally hydroxy propyl celluloses have similar properties to hydroxy propyl methyl celluloses. In contrast to hydroxy ethyl celluloses, they are not only soluble in aqueous solution but also in a wide range of polar solvents. Hydroxy propyl celluloses are soluble in water, sucrose solutions, sodium chloride solutions, ethanol solutions and propylene glycol, but solubility in vegetable oils is limited. Also in contrast to hydroxy ethyl celluloses they are insoluble in hot aqueous solutions (as are methyl celluloses). Solubility declines with increasing molecular weight, decreasing hydroxylation/propylation/methylation and increasing concentration. It is essentially pH-independent (pH 4–8).
FUNCTION IN FOODS:	Emulsifier; thickening agent; stabiliser; suspending agent; bulking agent
ALTERNATIVES:	Methyl ethyl cellulose (MEC); hydroxy propyl cellulose (HPMC); hydroxy ethyl methylcellulose (HEMC); carboxy methyl cellulose (CMC); proteins; gum arabic; xanthan; carrageenans; dextrans; starches; locust bean gum; guar gum; gelatin; agar; alginate (application-dependent)
TECHNOLOGY OF USE IN FOODS:	Hydroxy propyl methyl cellulose should be dispersed in hot water and cooled to hydrate the polysaccharide. A high shear mixer will aid dispersion, although prolonged shear of high-molecular-weight polymers will reduce the viscosity.

Hydroxy propyl methyl celluloses have similar properties to methyl cellulose but they are soluble in a wider range of solvents. They can form aqueous solutions with a wide range of viscosities (variable thickening, stabilising and bulking properties); they are surface-active (emulsifying properties); they can have a high yield point (suspending properties); and they form gel-like structures at high temperatures that melt on cooling (stabilising agents for foods with heat-sensitive components such as the toppings in pizzas). Properties (viscosity, melting points, etc.) vary considerably with the molecular weight and molar substitution.

SYNERGISTS: None known

ANTAGONISTS: None known

FOOD SAFETY ISSUES: LD_{50} (intraperitoneal, rat) 5200 mg/kg. Mildly toxic. The powder is combustible

LEGISLATION:

USA:
FDA 21 CFR §172.87, 175.105, 175.300

UK and EUROPE:
Europe: listed

REFERENCES:

Ash, M. and Ash, I. (1996) *Food Additives*. Gower Publishing, Brookfield, VT.

Desmarais, A.J. and Wint, R.F. (1993) Hydroxy alkyl and ethyl ethers of cellulose. In: Whistler, R.L. and BeMiller, J.N. (eds) *Industrial Gums: Polysaccharides and Derivatives*, 3rd edn. Academic Press, San Diego, pp. 505–535.

ANY OTHER RELEVANT INFORMATION: Chemically hydroxylated, methylated and ethylated natural cellulose.

See methyl cellulose (MEC); hydroxy propyl cellulose (HPC); hydroxy ethyl cellulose (HEC); carboxy methyl cellulose (CMC)

NAME:	Karaya gum
CATEGORY:	Polysaccharides
FOOD USE:	Meringue/Sherbet/Ices/Cheese spreads/Ground meat products/French dressing
SYNONYMS:	CAS 9000-36-6/EINECS 232-539-4/EC 232-539-4/E416/Sterculia gum/Sterculia urens gum/India tragacanth/Indian tragacanth/Kadaya gum/Gum karaya
MOLECULAR MASS IN Daltons:	9 500 000
ALTERNATIVE FORMS:	Karaya gum is slightly acidic, so different salt forms are possible, chiefly calcium and magnesium
PROPERTIES AND APPEARANCE:	White/off-white powder
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	Karaya gum is poorly soluble in water and sparingly soluble in other liquids. Optimum solubility is at pH 6–8. Viscosity is dependent primarily on initial particle size
FUNCTION IN FOODS:	Stabiliser; thickener; texturiser; crystallisation inhibitor
ALTERNATIVES:	Gum ghatti; gum tragacanth (application-dependent)
TECHNOLOGY OF USE IN FOODS:	Karaya gum swells in water; larger particles will produce textured pastes whereas smaller particle sizes yield more homogeneous, viscous preparations. Tannins in the karaya gum result in a lightening of the solution colour in acidic pH and a darkening in alkaline pH. Karaya gum is a complex polysaccharide aned the structure has not been fully determined. It contains galactose, rhamnose and D-glucuronic acid. It is acetylated (8%) and contains a substantial quantity of uronic acid (37%).
SYNERGISTS:	None known
ANTAGONISTS:	None known
FOOD SAFETY ISSUES:	Mildly toxic. ADI 0–20 mg/kg. The powder is combustible
LEGISLATION:	Usage level: Limitation 0.9%, soft candy; 0.02%, milk products; 0.3%, frozen dairy desserts; 0.002%, other foods

USA:
FDA 21 CFR §133.133, 133.134, 133.162, 133.178, 133.179, 150.141, 150.161, 184.1349, GRAS

UK and EUROPE:
UK: approved
Europe: listed

AUSTRALIA/PACIFIC RIM:
Japan: approved for use as a natural thickener and stabiliser

REFERENCES:

Anderson, D.M.W., Gill, M.L.C., Jeffrey, A M. and McDougall, F.J. (1985) The gum exudates from some closely related Acacia species of the subseries *Uninerves racemosae* (section *phyllodineae*). *Phytochemistry* **24**, 71–75.

Ash, M. and Ash, I. (1996) *Food Additives*. Gower Publishing, Brookfield, VT.

Whistler, R.L. (1993) Exudate gums. In: Whistler, R.L. and BeMiller, J.N. (eds) *Industrial Gums: Polysaccharides and Derivatives*, 3rd edn. Academic Press, San Diego, pp. 311–318.

ANY OTHER RELEVANT INFORMATION:

This is a natural polysaccharide extracted from the trunks of the tree *Sterculia urens*. Originally introduced as an alternative to tragacanth gum.

NAME:	Locust bean gum
CATEGORY:	Polysaccharides
FOOD USE:	Dairy products/Pet foods/Baked goods/Confectionery/Dry formulated products/Food packaging/Edible films and coatings/All food products
SYNONYMS:	β-D-(1 → 4) mannan with some attached D-galactose molecules linked via α (1 → 6) bonds/CAS 9000-40-2/EINECS 232-541-5/EC 232-541-5/E410/Galactomannan/Carob flour/Carob bean gum/St John's bread/Algoroba
FORMULA:	Variable, depending on the ratio of galactose to mannose
MOLECULAR MASS IN Daltons:	Variable. Generally 300 000 to 360 000
PROPERTIES AND APPEARANCE:	White/brown powder
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	Solubility varies with molecular weight. Generally, locust bean gum is soluble in water, sucrose solutions and sodium chloride solution, but solubility in ethanol, vegetable oils and propylene glycol is limited. Solubility declines with increasing molecular weight and increasing concentration. It is pH-independent (pH 4–8).
FUNCTION IN FOODS:	Thickening agent; stabiliser; bulking agent; suspending agent
ALTERNATIVES:	Guar gum; tara gum; carrageenans; dextrans; starches; xanthan; gelatin; agar; alginate (application-dependent)
TECHNOLOGY OF USE IN FOODS:	Locust bean gum should be dispersed in cold water and heated to 80°C for 10 minutes to hydrate the polysaccharide. A high shear mixer will aid dispersion, although prolonged shear of high-molecular-weight polymers will reduce the viscosity. Locust bean gum molecules have a high hydrodynamic volume and can entangle with adjacent molecules, resulting in viscous properties. Synergistic interactions with xanthan gum result in gel formation. The synergistic interaction with xanthan is more pronounced with locust bean gum than guar, primarily because regions of the molecule that are not galactose-substituted are responsible for the interaction and locust bean gum has a lower galactose to mannose ratio than guar.
SYNERGISTS:	Xanthan; agar; carrageenan; anionic polymer; anionic surfactants
ANTAGONISTS:	None known
FOOD SAFETY ISSUES:	Mildly toxic. ADI not specified. LD_{50} (rat, oral) 13 g/kg. The powder is combustible

LEGISLATION:

Usage level: Limitation 0.15%, baked goods; 0.25%, beverages; 0.8%, cheese; 0.75%, gelatins, puddings; 0.75%, jams/jellies; 0.5%, other foods

USA:	**UK and EUROPE:**	**AUSTRALIA/PACIFIC RIM:**
FDA 21 CFR §133.133, 133.134, 133.162, 133.178, 133.179, 150.141, 150.161, 182.20, 184.1343, 240.1051, GRAS	UK: approved Europe: listed	Japan: approved

REFERENCES:

Ash, M. and Ash, I. (1996) *Food Additives*. Gower Publishing, Brookfield, VT.

Maier, H., Anderson, M., Kurt, C. and Magnusen, K. (1993) Guar, locust bean, tara and fenugreek gums. In: Whistler, R.L. and BeMiller, J.N. (eds) *Industrial Gums: Polysaccharides and Derivatives*, 3rd edn. Academic Press, San Diego, pp. 188–226.

ANY OTHER RELEVANT INFORMATION:

Locust bean gum is a natural polysaccharide extracted from the endosperm of the seeds of the carob tree *Ceretonia siliqua*. Locust bean gum is similar in structure to guar gum, differing primarily in that locust bean gum has a lower galactose to mannose ratio (approx. 1: 3.9).

NAME:	Methyl cellulose
CATEGORY:	Polysaccharides
FOOD USE:	Soups/Syrups/Beverages/Dairy products/Dressings/Dry formulated products/Food packaging/Edible films and coatings/All food products
SYNONYMS:	Methylated β-D-(1 → 4) glucan/CAS 9004-67-5/E461/MC/Cellulose methyl ether/Cologel/Methocel
FORMULA:	Variable, depending on the degree of methylation
MOLECULAR MASS IN Daltons:	Variable
ALTERNATIVE FORMS:	None
PROPERTIES AND APPEARANCE:	A white powder
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	Solubility varies with molecular weight and methylation. Generally, methylcellulose is soluble in water, sucrose solutions, sodium chloride solution and ethanol solutions, but solubility in vegetable oils and propylene glycol is limited. Solubility declines with increasing molecular weight, decreasing methylation and increasing concentration. It is essentially pH-independent (pH 4–8). Methyl celluloses are soluble in cold aqueous solution, but not in hot aqueous solutions; hence, elevated temperatures can be used to produce a homogeneous dispersion prior to dissolution.
FUNCTION IN FOODS:	Emulsifier; thickening agent; stabiliser; suspending agent; bulking agent
ALTERNATIVES:	Methyl ethyl cellulose (MEC); hydroxy propyl methyl cellulose (HPMC); hydroxy ethyl methylcellulose (HEMC); carboxy methyl cellulose (CMC); proteins; gum arabic; xanthan; carrageenans; dextrans; starches; locust bean gum; guar gum; gelatin; agar; alginate (application-dependent)
TECHNOLOGY OF USE IN FOODS:	Methyl cellulose should be dispersed in hot water and cooled to hydrate the polysaccharide. A high shear mixer will aid dispersion, although prolonged shear of high-molecular-weight polymers will reduce the viscosity. Methyl celluloses have four important properties. They can form aqueous solutions with a wide range of viscosities (variable thickening, stabilising and bulking properties); they are surface-active (emulsifying properties); they can have a high yield point (suspending properties); and they form gels ar high temperatures that melt on cooling (stabilising agents for foods with heat-sensitive components like the toppings in pizzas). Properties (viscosity, melting points, etc.) vary considerably with the molecular weight and degree of methylation.

SYNERGISTS:	None known		
ANTAGONISTS:	None known		
FOOD SAFETY ISSUES:	Non-toxic. The powder is combustible		
LEGISLATION:	**USA:** FDA 21 CFR §150.141, 150.161, 175.105, 175.210, 175.300, 176.200, 182.1480, GRAS, USDA 9CFR § 318.7 (0.15% max. in meat and vegetable products)	**UK and EUROPE:** UK: approved Europe: listed	**AUSTRALIA/PACIFIC RIM:** Japan: restricted (2% max)
REFERENCES:	Ash, M. and Ash, I. (1996) *Food Additives*. Gower Publishing, Brookfield, VT. Grover, J.S. (1993) Methyl cellulose and its derivatives. In: Whistler, R.L. and BeMiller, J.N. (eds) *Industrial Gums: Polysaccharides and Derivatives*, 3rd edn. Academic Press, San Diego, pp. 475–504.		
ANY OTHER RELEVANT INFORMATION:	Chemically methylated natural cellulose. See also methyl ethyl cellulose (MEC); hydroxy propyl methyl cellulose (HPMC); hydroxy propyl cellulose (HPC); carboxy methyl cellulose (CMC)		

NAME:	Methyl ethyl cellulose
CATEGORY:	Polysaccharides
FOOD USE:	Whipped toppings/Soups/Syrups/Beverages/Dairy products/Dressings/Dry formulated products/Food packaging/Edible films and coatings/All food products
SYNONYMS:	Methylated and ethylated β-D-(1 → 4) glucan/CAS 9004-67-5/E465/MEC/Ethylmethylcellulose
FORMULA:	Variable, depending on the degree of methylation and ethylation
MOLECULAR MASS IN Daltons:	Variable
ALTERNATIVE FORMS:	None
PROPERTIES AND APPEARANCE:	A white powder or fibrous flakes
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	Solubility varies with molecular weight and methylation/ethylation. Generally, methyl ethyl cellulose is soluble in water, sucrose solutions, sodium chloride solution and ethanol solutions, but solubility in vegetable oils and propylene glycol is limited. Solubility declines with increasing molecular weight, decreasing methylation/ethylation and increasing concentration. It is essentially pH-independent (pH 4–8).
FUNCTION IN FOODS:	Emulsifier; foaming stabiliser; thickening agent; general stabiliser; bulking agent; suspending agent
ALTERNATIVES:	Methyl cellulose (MEC); hydroxy propyl methyl cellulose (HPMC); hydroxyethyl methyl cellulose (HEMC); carboxy methyl cellulose (CMC); proteins; gum arabic; xanthan; carrageenans; dextrans; starches; locust bean gum; guar gum; gelatin; agar; alginate (application-dependent)
TECHNOLOGY OF USE IN FOODS:	Some similarities to methyl cellulose and ethyl cellulose (not food-grade).
SYNERGISTS:	None known
ANTAGONISTS:	None known
FOOD SAFETY ISSUES:	Non-toxic. The powder is combustible. ADI 0–25 mg/kg body weight
LEGISLATION:	**USA:** FDA 21 CFR §172.872
	UK and EUROPE: UK: approved Europe: listed

REFERENCES:

Ash, M. and Ash, I. (1996) *Food Additives*. Gower Publishing, Brookfield, VT.
Grover, J.S. (1993) Methyl cellulose and its derivatives. In: Whistler, R.L. and BeMiller, J.N. (eds) *Industrial Gums: Polysaccharides and Derivatives*, 3rd edn. Academic Press, San Diego, pp. 475–504.

ANY OTHER RELEVANT INFORMATION:

Chemically methylated and ethylated natural cellulose.

See also methyl cellulose (MEC); hydroxy propyl methyl cellulose (HPMC); hydroxy propyl cellulose (HPC); carboxy methyl cellulose (CMC)

NAME:	Microcrystalline cellulose
CATEGORY:	Polysaccharides
FOOD USE:	Low-fat salad creams/Low-fat meat spreads/Dry formulated products/Low-calorie foods/Confectionery processing aid/All food products
SYNONYMS:	β-D-(1 → 4) glucan/CAS 9004-34-6/EINECS 232-674-9/EC 232-674-9/E460/cellulose gel/Avicel
FORMULA:	$(C_6H_{10}O_5)n$
MOLECULAR MASS IN Daltons:	Variable
ALTERNATIVE FORMS:	None
PROPERTIES AND APPEARANCE:	A white powder or gel
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	Microcrystalline cellulose is insoluble in water, but commercial preparations are generally colloidal mixtures of microcrystalline cellulose and carboxymethyl cellulose that can be dispersed in aqueous solutions.
FUNCTION IN FOODS:	Can be used as a processing aid; fat mimetic; dietary fibre; thickening agent; stabiliser; bulking agent. It is not digestible and so can be used in low-calorie preparations
ALTERNATIVES:	Starch hydrolysis products (SHPs); polydextrose; xanthan (application-dependent)
TECHNOLOGY OF USE IN FOODS:	Microcrystalline cellulose can be dispersed in cold water. Mixing with a high shear mixer could change the physical properties of the preparation. Commercial preparations of microcrystalline cellulose consist of fine particles of crystalline cellulose mixed with carboxymethylcellulose. The fine cellulose particles simulate the mouthfeel of fat crystals, whereas the carboxymethylcellulose lubricates the particles and provides thickening properties.
SYNERGISTS:	None known
ANTAGONISTS:	None known
FOOD SAFETY ISSUES:	Non-toxic. The powder is combustible LD_{50} > 5 g/kg. No significant hazard

LEGISLATION:	USA:	UK and EUROPE:	AUSTRALIA/PACIFIC RIM:
	FDA GRAS	UK: approved Europe: listed	Japan: approved for use as a natural processing aid

REFERENCE:

Ash, M. and Ash, I. (1996) *Food Additives*. Gower Publishing, Brookfield, VT.

ANY OTHER RELEVANT INFORMATION:

Microcrystalline cellulose is natural crystalline polysaccharide particles extracted from plant cellulose (which is composed of chains of crystalline and amorphous cellulose).

See also cellulose

NAME:	Pectin
CATEGORY:	Polysaccharides
FOOD USE:	All food products/Edible films and coatings
SYNONYMS:	CAS 9005-69-5/EINECS 232-553-0/EC 232-553-0/E440a/Citrus pectin/Pectinate/Pectinic acids/Pectic acids/Pectates/Polygalacturonic acid/E440b/Amidated pectin
FORMULA:	Variable, depending on degree of methanol esterification and the presence of other substituents (acetyl units, neutral sugar side-chains, rhamnose, ferulic acid, etc.)
MOLECULAR MASS IN Daltons:	Variable, generally 100 000
ALTERNATIVE FORMS:	Polygalacturonic acids (low-methoxyl pectins) are called pectinic acids; salts of pectic acids are pectates (e.g. sodium pectate). Polygalacturonic acids esterified with methanol (high-methoxyl pectins) are called pectinic acids and salts are called pectinates. Amidated pectins and salts
PROPERTIES AND APPEARANCE:	White powder or syrup
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	Solubility in aqueous solution varies with differences in structure, molecular weight, pH and cations. Generally, pectins are soluble in water, sucrose solutions, sodium chloride solution and low concentration ethanol solutions, but solubility in vegetable oils and propylene glycol is limited. Pectins are insoluble in the presence of divalent or trivalent salts. Above pH 5 pectins start to de-esterify spontaneously; below pH 2.5, hydrolysis occurs so pectins are primarily suited for acidic foods.
FUNCTION IN FOODS:	Gelling agent; thickening agent; stabiliser; flocculant; bulking agent. It can be used to stabilise emulsions and to retard ice-crystal formation
ALTERNATIVES:	Alginates; carrageenans; chitosan; xanthan; furcellaran (application-dependent)
TECHNOLOGY OF USE IN FOODS:	Pectins should be dispersed in cold water and heated to 80°C for 10 minutes to hydrate the polysaccharide. A high shear mixer will aid dispersion, although prolonged shear of high-molecular-weight polymers will reduce the viscosity.

High-methoxyl pectins (pectinates/pectinic acid) can, in the presence of large quantities of material (usually sugar), spontaneously form gels in the absence of polyvalent ions. Gel strength increases with increasing molecular weight and decreasing pH (until the polymer starts to hydrolyse). Gelation rate is related to the degree of methoxylation. High-methoxyl pectins with 70–75% methoxylation are called 'rapid-set'; 65–70% are 'medium-set' and 55–65% are 'slow-set'. Low-methoxyl pectins (<50% methoxyl substitution) require polyvalent ions (usually calcium) for gelation. High-methoxyl pectins generally do not form gels above pH 3.5, whereas low-methoxyl pectins can form gels up to pH 6.5. Low-methoxyl pectins set rapidly at the gelation temperature, whereas high-methoxyl pectins set slowly.

Amidated low-methoxyl pectins (typically 15–22% amidated) generally have higher gelation temperatures than the un-amidated pectins and are less affected by natural variations in calcium ion content. Hence, they have been found to be more consistent in functional properties and thus more controllable. Amidation increases gel strength.

Ferulic acid-containing pectins (sugar beet, spinach) can be enzymically gelled with a peroxidase and hydrogen peroxide.

SYNERGISTS: Proteins, polyvalent ions

ANTAGONISTS: Proteins, polyvalent ions

FOOD SAFETY ISSUES: Non-toxic. The powder is combustible and emits irritating fumes when heated

LEGISLATION:

USA:	**UK and EUROPE:**	**AUSTRALIA/PACIFIC RIM:**
FDA 21 CFR §135.40, 145.150, 172.385, 184.1588, GRAS	UK: approved Europe: listed	Japan: approved

REFERENCES:

Ash, M. and Ash, I. (1996) *Food Additives*. Gower Publishing, Brookfield, VT.

Rolin, C. (1993) Pectin. In: Whistler, R.L. and BeMiller, J.N. (eds) *Industrial Gums: Polysaccharides and Derivatives*, 3rd edn. Academic Press, San Diego, pp. 257–293.

ANY OTHER RELEVANT INFORMATION: High-methoxy pectins are natural polysaccharides extracted from plant material, usually from orange peel (by-product of juice manufacture) or apple pomace (by-product of cider manufacture). Low-methoxy pectins are chemically synthesised (de-esterified) from high-methoxy pectins. Pectin can also be synthesised from sugar beet and sunflower seeds, but the higher acetylation of these pectins significantly alters functional properties. Sucrose is added to most commercial pectin preparations to standardise functional properties.

NAME:	Potassium alginate
CATEGORY:	Polysaccharides
FOOD USE:	All food products/Edible films and coatings
SYNONYMS:	CAS 9005-36-1/E402/Potassium alginate/Alginic acid-potassium salt/Potassium polymannuronate
FORMULA:	Variable, depending on ratio of mannuronic to guluronic acid, and the presence of other substituents
MOLECULAR MASS IN Daltons:	Variable
ALTERNATIVE FORMS:	Alginic acid; algin; calcium alginate; potassium alginate
PROPERTIES AND APPEARANCE:	White to yellow powders or hard flakes
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	Solubility in aqueous solution varies with differences in structure, molecular weight, pH and cations. Alginic acid (low pH) is insoluble in water, monovalent salts (sodium, potassium and ammonium) are also soluble, but divalent salts (including calcium) except magnesium are insoluble in water. Solubility declines with increasing molecular weight and increasing concentration. Viscosity is not affected in the pH 5 to 11 range, but increases at lower pH (due to alginic acid formation).
FUNCTION IN FOODS:	Gelling agent; thickening agent; stabiliser; flocculant; bulking agent. It can be used to stabilise emulsions and to retard ice-crystal formation
ALTERNATIVES:	Carrageenans; gelatin; gellan; agar; xanthan; furcellaran (application-dependent)
TECHNOLOGY OF USE IN FOODS:	Alginates should be dispersed in cold deionised water and heated for 10 minutes at 80°C to hydrate the polysaccharide. A high shear mixer will aid dispersion, although prolonged shear of high-molecular-weight polymers will reduce the viscosity. Calcium gels can be prepared by addition of alginate solutions to a calcium solution (e.g. maraschino cherries), addition of calcium to a hot solution of alginate and then cooling (gel is thermo-irreversible), or by diffusion. Gels can also be formed by lowering the pH (alginic acid), but this can be technically difficult. Ammonium alginate forms particularly viscous solutions. Alginates are composed of blocks of polymannuronic acid, polyguluronic acid and mixed regions. Ribbon-like structures are formed in solution and alginates with a high percentage of guluronic blocks can be cross-linked (gelled) by divalent ions (e.g. calcium).
SYNERGISTS:	Divalent ion, pectins

ANTAGONISTS: None known

FOOD SAFETY ISSUES: ADI 0–25 mg/kg. The powder is combustible and emits irritating fumes when heated

LEGISLATION: Usage level: Limitation 0.01%, confections, frostings; 0.7%, gelatins/puddings; 0.25%, processed fruits, fruit juices; 0.01%, other foods

USA:	**UK and EUROPE:**	**AUSTRALIA/PACIFIC RIM:**
FDA 21 CFR §184.1610. GRAS	UK: approved Europe: listed	Japan: approved

REFERENCES:

Clare, K. (1993) Algin. In: Whistler, R.L. and BeMiller, J.N. (eds) *Industrial Gums: Polysaccharides and Derivatives*, 3rd edn. Academic Press, San Diego, pp. 105–143.

Rehm B.H.A. (ed.) (2009) *Alginates: Biology and Applications*. Microbiology Monographs 13. Springer-Verlag, Berlin, pp. 1–53.

ANY OTHER RELEVANT INFORMATION: Alginates are natural polysaccharides extracted from brown seaweeds (Phaeophyceae). *Macrocystis pyrifera*, *Laminera hyperborea*, *Laminaria digitata*, *Laminaria japonica*, *Ascophyllum nodosum*, *Ecklonia maxima* and *Lessonia nigrescens* are the most important commercial sources of alginates. Structurally distinct bacterial alginates can be obtained from *Pseudomonas* species and *Azotobacter* species. Although algin, alginic acid, ammonium alginate, calcium alginate, potassium alginate and sodium alginate are essentially different states of the same type of compound, for legislative purposes they are listed separately.

NAME:	Propyleneglycol alginate
CATEGORY:	Polysaccharides
FOOD USE:	All food products/Edible films and coatings
SYNONYMS:	CAS 9005-32-2/E405/PGA/Hydroxypropyl alginate/Alginic acid ester with 1,2-propanediol/Propane-1,2-diol alginate
FORMULA:	Variable, depending on propylene glycol substitution, ratio of mannuronic to guluronic acid, and the presence of other substituents
MOLECULAR MASS IN Daltons:	Variable
ALTERNATIVE FORMS:	None
PROPERTIES AND APPEARANCE:	White powder
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	Solubility in aqueous solution varies with differences in structure, molecular weight, pH and cations. The primary property of propylene glycol is that, unlike other alginates, it is soluble at low pH.
FUNCTION IN FOODS:	Gelling agent; thickening agent; stabiliser; flocculant; bulking agent. It can be used to stabilise emulsions and to retard ice-crystal formation
ALTERNATIVES:	Alginates; carrageenans; methylcellulose; gum ghatti; xanthan; furcellaran (application-dependent)
TECHNOLOGY OF USE IN FOODS:	Propyleneglycol alginate should be dispersed in cold water and heated to 80°C for 10 minutes to hydrate the polysaccharide. A high shear mixer will aid dispersion, although prolonged shear of high-molecular-weight polymers will reduce the viscosity. In addition to viscosity, propylene glycol alginate has surface-active properties due to the hydrophobic nature of parts of the molecule. This makes it a useful emulsifier.
SYNERGISTS:	Proteins
ANTAGONISTS:	None known
FOOD SAFETY ISSUES:	Mildly toxic. LD_{50} (oral, rat) 7200 mg/kg. ADI 0–25 mg/kg. The powder is combustible and emits irritating fumes when heated

LEGISLATION:

Usage level: Limitation 0.6%, condiments; 6%, frozen dairy desserts; 0.5%, baked goods; 0.9%, cheese; 0.5%, gravies; 1.7%, seasonings; 0.4%, jams/jellies; 1.1%, fats/oils; 0.6%, gelatins/puddings; 0.3%, other foods

USA:	**UK and EUROPE:**	**AUSTRALIA/PACIFIC RIM:**
FDA 21 CFR §133.133, 133.134, 133.162, 133.178, 133.179, 172.210, 172.820, 172.858, 173.340, 176.170. GRAS	UK: approved Europe: listed	Japan: approved (1% max)

REFERENCES:

Ash, M. and Ash, I. (1996) *Food Additives*. Gower Publishing, Brookfield, VT.

Clare, K. (1993) Algin. In: Whistler, R.L. and BeMiller, J.N. (eds) *Industrial Gums: Polysaccharides and Derivatives*, 3rd edn. Academic Press, San Diego, pp. 105–143.

ANY OTHER RELEVANT INFORMATION:

Chemically synthesised using propylene oxide and the natural polysaccharide alginate. Although algin, alginic acid, ammonium alginate, calcium alginate, potassium alginate and sodium alginate are essentially different states of the same type of compound, for legislative purposes they are listed separately.

NAME:	Tragacanth gum
CATEGORY:	Polysaccharides
FOOD USE:	Salad dressings/Sauces/Baked goods/Confectionery/All food products
SYNONYMS:	CAS 9000-65-1/EINECS 232-552-5/EC 232-552-5/E413/Gum tragacanth/Gum dragon
MOLECULAR MASS IN Daltons:	Variable, generally approx. 840 000
ALTERNATIVE FORMS:	Tragacanth gum is slightly acidic, so different salt forms are possible, chiefly calcium, sodium and magnesium
PROPERTIES AND APPEARANCE:	White/off-white powder, granules or yellowish ribbons
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	Tragacanth is composed of water-soluble tragacanthin and water-swellable bassorin. Generally, tragacanth gum is soluble in sucrose solutions, sodium chloride solution and partially soluble in 70% ethanol (tragacanthin). Solubility in vegetable oils and propylene glycol is limited. Maximum viscosity is observed at pH 8.
FUNCTION IN FOODS:	Stabiliser; thickener; crystallisation inhibitor
ALTERNATIVES:	Gum ghatti; Karaya gum (application-dependent)
TECHNOLOGY OF USE IN FOODS:	Tragacanth gum should be dispersed in cold water and heated to 80°C for 10 minutes to hydrate the polysaccharide. A high shear mixer will aid dispersion, although prolonged shear of high-molecular-weight polymers will reduce the viscosity. Tragacanth gum is a complex polysaccharide mixture composed of neutral arabinogalactan and polymers composed primarily of α-D-(1 → 4) galacturonic acid with galactose, xylose and fucose substituents. There is also thought to be some methylation and associated protein.
SYNERGISTS:	None known
ANTAGONISTS:	None known
FOOD SAFETY ISSUES:	Mildly toxic. LD_{50} (oral, rat) 16.4 g/kg. The powder is combustible
LEGISLATION:	Usage level: Limitation 0.2%, baked goods; 0.7%, condiments; 1.3%, fats and oils; 0.8%, gravies, sauces; 0.2%, meat products; 0.2%, processed fruits, fruit juices; 0.1%, other foods

	USA:	UK and EUROPE:	AUSTRALIA/PACIFIC RIM:
	FDA 21 CFR §133.133, 133.134, 133.162, 133.178, 133.179, 150.141, 150.161, 184.1351, GRAS	Europe: listed UK: approved	Japan: approved

REFERENCES:

Anderson, D.M.W., Gill, M.L.C., Jeffrey, A.M. and McDougall, F.J. (1985) The gum exudates from some closely related Acacia species of the subseries *Uninerves racemosae* (section *phyllodineae*). *Phytochemistry* **24**, 71–75.

Ash, M. and Ash, I. (1996) *Food Additives*. Gower Publishing, Brookfield, VT.

Whistler, R.L. (1993) Exudate gums. In: Whistler, R.L. and BeMiller, J.N. (eds) *Industrial Gums: Polysaccharides and Derivatives*, 3rd edn. Academic Press, San Diego, pp. 311–318.

ANY OTHER RELEVANT INFORMATION:

This is a natural polysaccharide exudate from trees of the genus *Astragalus*. Occasionally used as an emulsifier.

NAME:	Xanthan
CATEGORY:	Polysaccharides
FOOD USE:	Soups/Syrups/Beverages/Dairy products/Dressings/Dry formulated products/Food packaging/Edible films and coatings/All food products
SYNONYMS:	β-D-(1 → 4) glucose polymer with a trisaccharide side-chain composed of alternate glucopyranosyl units. The side-chain is composed of a β-D-pyranosyl unit between two mannopyranosyl units with pyruvate and acetyl substituents/CAS 11138-66-2/EINECS 234-394-2/EC 234-394-2/E415/Gum xanthan/Corn sugar gum/Alginoid/Dariloid/Merecol/Merezan/Rhodigel/Ticaxan
MOLECULAR MASS IN Daltons:	3 million to 50 million
PROPERTIES AND APPEARANCE:	White/off-white powder or soft flakes
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	Solubility varies with molecular weight. Generally, xanthan is soluble in water, sucrose solutions, sodium chloride solution and ethanol solutions, but solubility in vegetable oils and propylene glycol is limited. Solubility declines with increasing molecular weight and increasing concentration. It is essentially pH-independent (pH 4–8). Elevated temperatures will significantly improve the dispersion of high-molecular-weight xanthans
FUNCTION IN FOODS:	Thickening agent; stabiliser; bulking agent; suspending agent
ALTERNATIVES:	Carrageenans; dextrans; starches; locust bean gum; guar gum; gelatin; agar; alginate (application-dependent)
TECHNOLOGY OF USE IN FOODS:	Xanthan should be dispersed in cold water and heated to 80°C for 10 minutes to hydrate the polysaccharide. A high shear mixer will aid dispersion, although prolonged shear of high-molecular-weight polymers will reduce the viscosity. Xanthan forms aggregates of single or double helices in solution with a weak gel interaction. This weak gel formation manifests as a high yield point which helps suspend particles (herbs, fruit chunks, emulsion droplets) in viscous solutions. Synergistic interactions with gelatin and gum arabic. Forms gels with locust bean gum and guar gum.
SYNERGISTS:	Guar; locust bean gum
ANTAGONISTS:	None known
FOOD SAFETY ISSUES:	Non-toxic. The powder is combustible

LEGISLATION:

USA:
FDA 21 CFR §133.124, 133.133, 133.134, 133.162, 133.178, 133.179, 172.695, USDA9CFR § 318.7, 381.147

UK and EUROPE:
Europe: E418. ADI 10 mg/kg

CANADA:
Approved

AUSTRALIA/PACIFIC RIM:
Japan: approved for use as a natural thickener and stabiliser

REFERENCES:

Ash, M. and Ash, I. (1996) *Food Additives*. Gower Publishing, Brookfield, VT.
Kang, K.S. and Pettitt, D.J. (1993) Xanthan, gellan, welan and rhamsan. In: Whistler, R.L. and BeMiller, J.N. (eds) *Industrial Gums: Polysaccharides and Derivatives*, 3rd edn. Academic Press, San Diego, pp. 341–395.

ANY OTHER RELEVANT INFORMATION:

Xanthan is a natural polysaccharide obtained from cultures of the microorganism *Xanthomonas campestris*.

Part 11

Preservatives

Jim Smith

Food Additives Data Book, Second Edition. Edited by Jim Smith and Lily Hong-Shum.

NAME:	Acetic acid, glacial
CATEGORY:	Preservative
FOOD USE:	Bread/Cheese products/Preserved meat and fish
SYNONYMS:	Ethanoic acid/INS No. 260/CAS 64-19-7
FORMULA:	$C_2H_4O_2$
MOLECULAR MASS IN Daltons:	60.05
ALTERNATIVE FORMS:	Acetates
PROPERTIES AND APPEARANCE:	Colourless liquid, having a pungent characteristic odour. Miscible with water, ethanol, glycerol and diethyl ether
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	118
MELTING RANGE IN °C:	16.7
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.049
PURITY %:	99.5
WATER CONTENT MAXIMUM IN %:	Not applicable
HEAVY METAL CONTENT MAXIMUM IN ppm:	Pb 0.5
ARSENIC CONTENT MAXIMUM IN ppm:	None
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** Miscible
in ethanol solution (100%):	Soluble
FUNCTION IN FOODS:	Preservative in bread to prevent mould and rope growth. Preservative in cheese products, preserved meat and fish

ALTERNATIVES: In bread, propionic acid and propionates

TECHNOLOGY OF USE IN FOODS: Vinegar may be used at 1 L/100 kg flour in breadmaking as preservative

SYNERGISTS: Other organic acids

ANTAGONISTS: Bases

FOOD SAFETY ISSUES: Acetic acid has an odour and taste that limits its use in food

LEGISLATION:

USA:
B&N/FEED, GRAS/FS, Part 133, Cheese; Part 582. 1005, In animal feed practices; 184.1005, 172.814

CANADA:
Permitted in selected foods to certain maximum levels of use

UK and EUROPE:
GMP

AUSTRALIA/PACIFIC RIM:
Permitted in specified food types to maximum permitted levels

REFERENCES:

http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010.

www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010.

Food Standards Australia New Zealand Act 1991 Food Standards Code Schedule 1 'Permitted uses of food additives by food type'. Available at: www.foodstandards.gov.au/_srcfiles/Standard_1_3_1_Additives_Part_2_v115.pdf. Accessed 4 May 2010.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

NAME:	Benzoic acid
CATEGORY:	Antimicrobial preservative
FOOD USE:	Beverages/Margarine/Bakery products/Fish products/Fruit juice, fruit pulp/Jam/Liquid egg, whole egg, egg yolk/Mayonnaise/Mustard/Pickles, sauces, ketchup/Sausage
SYNONYMS:	Benzenecarboxylic acid/Phenylformic acid/Dracylic acid/E210/CAS 65-85-0/EINECS 200-618-2/FEMA 2131
FORMULA:	$C_7H_6O_2$
MOLECULAR MASS IN Daltons:	122.12
ALTERNATIVE FORMS:	Sodium benzoate; potassium benzoate; calcium benzoate
PROPERTIES AND APPEARANCE:	White crystals, needles or scales, phenolic taste
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	@ 760 mmHg 249.2 @ 400 mmHg 227.0 @ 200 mmHg 205.8 @ 100 mmHg 186.2 @ 60 mmHg 172.8 @ 40 mmHg 162.6 @ 20 mmHg 146.7 @ 10 mmHg 132.1
MELTING RANGE IN °C:	122.4
FLASH POINT IN °C:	121–131
IONISATION CONSTANT AT 25°C:	6.4×10^{-5}
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.2659
PURITY %:	>99.5 (anhydrous basis)
WATER CONTENT MAXIMUM IN %:	0.7

HEAVY METAL CONTENT MAXIMUM IN ppm:	10 (as Pb)
ASH MAXIMUM IN %:	0.05
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 4°C** 0.18 **@ 18°C** 0.27 **@ 20°C** 0.29 **@ 50°C** 0.95 **@ 75°C** 2.2 **@ 95°C** 6.8
FUNCTION IN FOODS:	Antimycotic and antibacterial
ALTERNATIVES:	Other microbials where suitable
TECHNOLOGY OF USE IN FOODS:	Effective versus yeasts and moulds, food-poisoning bacteria, spore-forming bacteria. Not effective against many spoilage bacteria. pK_a is 4.2, so should be used in foods with pH less than 4.2. Levels for general use: carbonated beverages, 0.03–0.05%; non-carbonated beverages, 0.1%; beverage syrups, 0.1%; fruit drinks, 0.1%; fruit juices, 0.1%; purées and concentrates, 0.1%; cider, 0.05–0.1%; salted margarine, 0.1%; pie and pastry fillings, 0.1%; icings, 0.1%; soy sauce, 0.1%; mincemeat, 0.1%; salads, 0.1%; salad dressings, 0.1%; fruit salads, 0.1%; pickles, 0.1%; relishes, 0.1%; fruit cocktails, 0.1%; olives, 0.1%; sauerkraut, 0.1%; preserves, 0.1%; dried fruits, 0.1%; jams, 0.1%; jellies, 0.1%; fish, 0.15–0.35%; dipping solutions, 0.15–0.34%; ice glaze, 0.15–0.30%
SYNERGISTS:	Sulphur dioxide; carbon dioxide; sodium chloride; sucrose; sorbates; thermal processing; refrigeration; boric acid
ANTAGONISTS:	Lipids (partitioning); ferric salts; anionic surfactants
LEGISLATION:	**USA:** GRAS, 0.1% FDA 21 CFR §150.141, 150.161, 166.110, 175.300, 177.1390, 184.1021 **UK and EUROPE:** Conditionally permitted **CANADA:** Permitted in selected foods to certain maximum levels of use **AUSTRALIA/PACIFIC RIM:** Australia: permitted in specified food types to maximum permitted levels Japan: 0.2% max.

REFERENCES:

http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010.

www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010.

Food Standards Australia New Zealand Act 1991 Food Standards Code Schedule 1 'Permitted uses of food additives by food type'. Available at: www.foodstandards.gov.au/_srcfiles/Standard_1_3_1_Additives_Part_2_v115.pdf. Accessed 4 May 2010.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

ANY OTHER RELEVANT INFORMATION:

Effect of pH on the dissociation of benzoic acid:

pH	*% Undissociated acid*
3	93.5
4	59.3
5	12.8
6	1.44
7	0.144

p*K* 4.19

Most berries contain appreciable amounts of benzoic acid (*c*. 0.05%). It is excreted mainly as hippuric acid by most vertebrates, except fowl.

NAME:	Biphenyl
CATEGORY:	Antimicrobial preservative
FOOD USE:	Citrus fruit wrappers
SYNONYMS:	CAS 92-52-4/EINECS 202-163-5/FEMA 3129/E230/PHPH/Bibenzene/Phenylbenzene/Diphenyl/Xenene/1,1′-Biphenyl
FORMULA:	$C_6H_5C_6H_5$
MOLECULAR MASS IN Daltons:	154.22
PROPERTIES AND APPEARANCE:	White scales, pleasant odour
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	760 mmHg 256 22 mmHg 145
MELTING RANGE IN °C:	69–71
FLASH POINT IN °C:	112.7
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	0.8660
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	Insoluble
in vegetable oil:	Soluble
in sucrose solution:	Insoluble
in sodium chloride solution:	Soluble
in ethanol solution:	Soluble
in propylene glycol:	Soluble
FUNCTION IN FOODS:	Broad-spectrum fungicide
TECHNOLOGY OF USE IN FOODS:	Impregnated citrus wrap. Citrus surface application (70 ppm) 1–5 g/m in impregnated wrappers

SYNERGISTS: Other fungicides

LEGISLATION:

USA:	CANADA:	UK and EUROPE:	AUSTRALIA/PACIFIC RIM:
Not permitted	Not permitted	Conditionally permitted	Not permitted

REFERENCES:

http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010.

www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010.

Food Standards Australia New Zealand Act 1991 Food Standards Code Schedule 1 'Permitted uses of food additives by food type'. Available at: www.foodstandards.gov.au/_srcfiles/Standard_1_3_1_Additives_Part_2_v115.pdf. Accessed 4 May 2010.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

NAME:	Calcium acetate
CATEGORY:	Antimicrobial preservative
FOOD USE:	Beer, ale, stout, porter/Malt beverages
SYNONYMS:	INS No. 263/CAS 62-54-4
FORMULA:	Anhydrous: $C_4H_6CaO_4$ Hydrates: $C_4H_6CaO_4 \cdot H_2O$; $C_4H_6CaO_4 \cdot xH_2O$ ($x < 1$)
MOLECULAR MASS IN Daltons:	Anhydrous 158.17; Monohydrate 176.18
ALTERNATIVE FORMS:	Acetic acid and other acetates
PROPERTIES AND APPEARANCE:	White, hygroscopic, bulky, crystalline solid; a slight odour of acetic acid may be present; the monohydrate may be needles, granules or powder. Freely soluble in water, insoluble in ethanol
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.6
PURITY %:	98
WATER CONTENT MAXIMUM IN %:	11
HEAVY METAL CONTENT MAXIMUM IN ppm:	Pb 2
ARSENIC CONTENT MAXIMUM IN ppm:	None
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C**
FUNCTION IN FOODS:	Antimould and antirope agent, stabiliser, buffer
ALTERNATIVES:	Acetic acid
TECHNOLOGY OF USE IN FOODS:	Used as a preservative in breadmaking

SYNERGISTS:	Propionic acid and propionates; acetic acid			
ANTAGONISTS:	Bases			
FOOD SAFETY ISSUES:	Calcium acetate has an odour and taste that limits its use in food			
LEGISLATION	**USA:**	**CANADA:**	**UK and EUROPE:**	**AUSTRALIA/NZ:**
	SEQ, GRAS 184.1185	Not permitted	GMP	Permitted in specified food types to maximum permitted levels

REFERENCES:

http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010.

www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010.

Food Standards Australia New Zealand Act 1991 Food Standards Code Schedule 1 'Permitted uses of food additives by food type'. Available at: www.foodstandards.gov.au/_srcfiles/Standard_1_3_1_Additives_Part_2_v115.pdf. Accessed 4 May 2010.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

NAME:	Calcium benzoate
CATEGORY:	Antimicrobial preservative
FOOD USE:	Beverages/Margarine/Bakery products/Fish products/Fruit juice, fruit pulp/Jam/Liquid egg, whole egg, egg yolk/Mayonnaise, mustard, pickles, sauces, ketchup/Sausage
SYNONYMS:	Benzoic acid, calcium salt/E213/CAS 2090-05-3/EINECS 218-235-4
FORMULA:	$C_{14}H_{10}O_4 \cdot 3H_2O$
MOLECULAR MASS IN Daltons:	374.26
ALTERNATIVE FORMS:	Other salts; benzoic acid
PROPERTIES AND APPEARANCE:	Orthorhombic crystals or powder
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.44
TECHNOLOGY OF USE IN FOODS:	Effective versus yeasts and moulds, food-poisoning bacteria, spore-forming bacteria. Not effective against many spoilage bacteria. pK_a is 4.2, so should be used in foods with pH less than 4.2. Levels for general use: carbonated beverages, 0.03–0.05%; non-carbonated beverages, 0.1%; beverage syrups, 0.1%; fruit drinks, 0.1%; fruit juices, 0.1%; purées and concentrates, 0.1%; cider, 0.05–0.1%; salted margarine, 0.1%; pie and pastry fillings, 0.1%; icings, 0.1%; soy sauce, 0.1%; mincemeat, 0.1%; salads, 0.1%; salad dressings, 0.1%; fruit salads, 0.1%; pickles, 0.1%; relishes, 0.1%; fruit cocktails, 0.1%; olives, 0.1%; sauerkraut, 0.1%; preserves, 0.1%; dried fruits, 0.1%; jams, 0.1%; jellies, 0.1%; fish, 0.15–0.35%; dipping solutions, 0.15–0.35%; ice glaze, 0.15–0.30%.
SYNERGISTS:	Sulphur dioxide; carbon dioxide; sodium chloride; sucrose; sorbates; thermal processing; refrigeration; boric acid
ANTAGONISTS:	Lipids (partitioning); ferric salts; anionic surfactants
LEGISLATION:	**USA:** There is no reported use of the substance and there is no toxicology information available in PAFA FDA 21 CFR §166.110, 178.2010 **CANADA:** Permitted in selected foods to certain maximum levels of use

	UK and EUROPE: Conditionally permitted	**AUSTRALIA/PACIFIC RIM:** Australia: permitted in specified food types to maximum permitted levels

REFERENCES:

http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010.

www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010.

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O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

ANY OTHER RELEVANT INFORMATION:

Effect of pH on the dissociation of benzoic acid:

pH	*% Undissociated acid*
3	93.5
4	59.3
5	12.8
6	1.44
7	0.144
p*K*	4.19

NAME:	Calcium bisulphite
CATEGORY:	Antimicrobial preservative
FOOD USE:	Bleaching agent/Antimicrobial/Preservative/Dough modifier/Vitamin C stabiliser. Not for use in meats, sources of vitamin B_1, raw fruits and vegetables, or fresh potatoes
SYNONYMS:	Dihydrogen sulfite/Calcium hydrogen sulfite/E227
FORMULA:	$Ca(HSO_3)_2$
MOLECULAR MASS IN Daltons:	202.21
ALTERNATIVE FORMS:	Sodium sulphite; sodium bisulphite; sodium metabisulphite; potassium metabisulphite; calcium sulphite; sulphur dioxide
PROPERTIES AND APPEARANCE:	Yellowish liquid, strong SO_2 odour
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** Soluble **@ 50°C** Soluble **@ 100°C** Soluble
in sucrose solution:	
10%	Soluble
40%	Soluble
60%	Soluble
in sodium chloride solution:	
5%	Soluble
10%	Soluble
15%	Soluble
in ethanol solution:	
5%	Soluble
20%	Soluble
95%	Soluble
100%	Soluble
FUNCTION IN FOODS:	Antimicrobial preservative, antioxidant and bleach

ALTERNATIVES: Combination of antimicrobial preservative, antioxidant and bleach

TECHNOLOGY OF USE IN FOODS: Multifunctional: an antimicrobial preservative, an antioxidant and a bleaching agent

ANTAGONISTS: Sulphur dioxide is very reactive and binds to many substances in foods including oxygen, aldehydes, some ketones, sugars, carbonyls, thiamin, nucleotides, colours, anthocyanins

FOOD SAFETY ISSUES: Normal humans are reasonably tolerant to ingested sulphites, but some individuals are hypersensitive and may be subject to asthma attacks and even life-threatening anaphylaxis.

LEGISLATION:

USA:	**CANADA:**	**UK and EUROPE:**	**AUSTRALIA/PACIFIC RIM:**
Not permitted	Not permitted	Conditionally permitted	Not permitted

REFERENCES:

http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.

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NAME:	Calcium propionate
CATEGORY:	Antimicrobial preservative
FOOD USE:	Baked products/Cheese products
SYNONYMS:	Methylacetic acid/Propanoic acid, calcium salt/Ethylformic acid, calcium salt/E282/CAS 4075-81-4/EINECS 223-795-8
FORMULA:	$(C_2H_5COO)_2Ca$
MOLECULAR MASS IN Daltons:	186.22
PROPERTIES AND APPEARANCE:	Transparent crystals, granules. Powder or monoclinic crystals, hygroscopic
MELTING RANGE IN °C:	>300
PURITY %:	98
WATER CONTENT MAXIMUM IN %:	5
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
FUNCTION IN FOODS:	Antimicrobial preservative; antimycotic; flavouring agent; preservative additive; mould inhibitor
ALTERNATIVES:	Other antimicrobial preservatives depending on the application
TECHNOLOGY OF USE IN FOODS:	1% (foods); limitation 0.32% (flour in white bread/rolls), 0.38% (whole wheat), 0.3% (cheese products)
ANTAGONISTS:	Calcium chloride
LEGISLATION:	**USA:** PRES, GRAS/FS, Part 136 Bakery Pdts; Part 133, Cheeses; Part 150, Art Sw Fruit Jelly and Preserves 184.1221, 184.1784 **UK and EUROPE:** Conditionally permitted **CANADA:** Permitted in selected foods to certain maximum levels of use **AUSTRALIA/NZ:** Permitted in specified food types to maximum permitted levels

REFERENCES:

http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.

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ANY OTHER RELEVANT INFORMATION:

pH of a 1 in 10 solution = 8–10

NAME:	Calcium sorbate
CATEGORY:	Antimicrobial preservative
FOOD USE:	Baked goods/Beverages/Bread, cake batters, cake fillings, cake toppings/Cheese, cottage cheese/Fish (smoked, salted)/Fruit juices (fresh), fruit (dried)/Margarine/Pickled products/Pie crusts, pie fillings/Salad dressings, salads (fresh)/Sausage/Seafood cocktails/Syrups/Wine
SYNONYMS:	Calcium hexadienoate/2,4-Hexadienoic acid calcium salt/Sorbic acid calcium salt/2-Propenylacrylic acid calcium salt/E203/Hexadienic acid, calcium salt/(2-Butenylidene) acetic acid, calcium salt/CAS 7492-55-9
FORMULA:	$(CH_3CH{=}CHCH{=}CHCOO)_2Ca$
MOLECULAR MASS IN Daltons:	262.32
ALTERNATIVE FORMS:	Sorbic acid (potassium and sodium salts)
PROPERTIES AND APPEARANCE:	White or fine crystalline powder, characteristic odour
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	Decomposes >400
MELTING RANGE IN °C:	Decomposes >400
PURITY %:	>98 (anhydrous basis)
WATER CONTENT MAXIMUM IN %:	1.0
HEAVY METAL CONTENT MAXIMUM IN ppm:	10 (as Pb)
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 58.2
in vegetable oil:	**@ 20°C** Practically insoluble **@ 50°C** Practically insoluble **@ 100°C** Practically insoluble

in sucrose solution:	
10%	Sparingly soluble
40%	Sparingly soluble
60%	Sparingly soluble
in sodium chloride solution:	
5%	Sparingly soluble
10%	Sparingly soluble
15%	Sparingly soluble
in ethanol solution:	
5%	Practically insoluble
20%	Practically insoluble
95%	Practically insoluble
100%	6.5
in propylene glycol:	**@ 20°C** Practically insoluble
in glacial acetic acid:	Sparingly soluble

FUNCTION IN FOODS: Antimicrobial preservative: fungi (broad spectrum); bacteria (mostly strict aerobes). Not lactic acid bacteria. Flavouring. Acidulant

ALTERNATIVES: Sodium sorbate; sorbic acid; potassium sorbate; benzoic acid; sodium benzoate; potassium benzoate; calcium benzoate; propionic acid; sodium propionate; potassium propionate; calcium propionate

TECHNOLOGY OF USE IN FOODS: The pK_a is 4.8, so sorbic acid and its salts would normally be used at pH less than 4.8. It can, however, be used at up to neutral pH, but the activity reduces as the pH increases. In wine, it should only be used in conjunction with sulphur dioxide, otherwise a characteristic off-odour may result.

SYNERGISTS: Sulphur dioxide; carbon dioxide; sodium chloride; sucrose; propionic acid; dehydration; nisin with polyphosphates; benzoates

ANTAGONISTS: Non-ionic surfactants

FOOD SAFETY ISSUES: This is not an additive which has been subject to great criticism over safety.

LEGISLATION:

USA	**UK and EUROPE:**
FDA 21 CFR § GRAS 182.3225, 166.110	Conditionally permitted

CANADA:
Permitted in selected foods to certain maximum levels of use

AUSTRALIA/PACIFIC RIM:
Australia: permitted in specified food types to maximum permitted levels
Japan: approved with limitations

REFERENCES:

http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.

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NAME:	Calcium sulphite
CATEGORY:	Antimicrobial preservative
FOOD USE:	Bleaching agent/Antimicrobial/Preservative/Dough modifier/Vitamin C stabiliser. Not for use in meats, sources of vitamin B_1, raw fruits and vegetables, or fresh potatoes
SYNONYMS:	E226
FORMULA:	$CaO_3S(^1/_2H_2O)$
MOLECULAR MASS IN Daltons:	129.15
ALTERNATIVE FORMS:	Sodium sulphite; sodium bisulphite; sodium metabisulphite; potassium metabisulphite; sulphur dioxide; calcium bisulphite
PROPERTIES AND APPEARANCE:	Dihydrate, crystals or powder
MELTING RANGE IN °C:	$^1/_2H_20$ >250
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 0.0043 **@ 100°C** 0.0011
FUNCTION IN FOODS:	Preservative in cider and fruit juices; disinfectant in brewing vats; in sugar manufacture
ALTERNATIVES:	Combination of antimicrobial preservative, antioxidant and bleach
TECHNOLOGY OF USE IN FOODS:	Multifunctional: an antimicrobial preservative, an antioxidant and a bleaching agent
ANTAGONISTS:	Sulphur dioxide is very reactive and binds to many substances in foods including oxygen, aldehydes, some ketones, sugars, carbonyls, thiamin, nucleotides, colours, anthocyanins
FOOD SAFETY ISSUES:	Normal humans are reasonably tolerant to ingested sulphites, but some individuals are hypersensitive and may be subject to asthma attacks and even life-threatening anaphylaxis.
LEGISLATION:	**USA:** Not permitted **CANADA:** Not permitted **UK and EUROPE:** Conditionally permitted **AUSTRALIA/PACIFIC RIM:** Not permitted

REFERENCES:

http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.

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O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

NAME:	Dimethyl dicarbonate
CATEGORY:	Antimicrobial preservative
FOOD USE:	Wine/Beverages
SYNONYMS:	Dimethyl pyrocarbonate/DMDC/INS No. 242/CAS 004-525-33-1
FORMULA:	$C_4H_6O_5$
MOLECULAR MASS IN Daltons:	139.09
ALTERNATIVE FORMS:	None
PROPERTIES AND APPEARANCE:	Colourless liquid. Soluble in water with decomposition
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.25
PURITY %:	99.8
WATER CONTENT MAXIMUM IN %:	Not applicable
HEAVY METAL CONTENT MAXIMUM IN ppm:	Pb - not more than 2
ARSENIC CONTENT MAXIMUM IN ppm:	None
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C**
FUNCTION IN FOODS:	Used as a cold sterilisation agent in beverages when used according to good manufacturing practice up to a maximum concentration of 250 mg/L
ALTERNATIVES:	Sulphur dioxide
TECHNOLOGY OF USE IN FOODS:	Preservative in wine, carbonated and non-carbonated beverages, ready-to-drink teas

SYNERGISTS:	Sulphur dioxide
ANTAGONISTS:	High levels of spoilage yeasts - more than 500 cells/mL
FOOD SAFETY ISSUES:	DMDC breaks down to methanol and carbon dioxide during its action in foods. These levels are deemed to be within safe limits.
LEGISLATION	**USA:** MISC, REG, Microbial control agent in the following beverages under normal circumstances of bottling, canning, or other forms of final packaging, where the viable microbial load has been reduced to 500 microorganisms per millilitre or less by current good manufacturing practices such as heat treatment, filtration, or other technologies prior to the use of dimethyl dicarbonate: (1) In wine, dealcoholised wine, and low alcohol wine in an amount not to exceed 200 parts per million; (2) In ready-to-drink teas in an amount not to exceed 250 parts per million; (3) In carbonated or non-carbonated, non-juice-containing (less than or equal to 1% juice), flavoured or unflavoured beverages containing added electrolytes (5–20 milliequivalents/litre sodium ion (Na^+) and 3–7 milliequivalents/litre potassium ion (K^+)) in an amount not to exceed 250 parts per million; (4) In carbonated, dilute beverages containing juice, fruit flavour, or both, with juice content not to exceed 50 percent, in an amount not to exceed 250 parts per million 172.133 **CANADA:** Permitted in selected foods to certain maximum levels of use **UK and EUROPE:** Conditionally permitted **AUSTRALIA/NZ:** Permitted in specified food types to maximum permitted levels
REFERENCES:	http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010. www.fao.org/ag/agn/jecfa-additives/specs/Monograph1/Additive-158.pdf. www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010.

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NAME:	Ethyl-4-hydroxybenzoate
CATEGORY:	Antimicrobial preservative
FOOD USE:	Bakery products (cakes, crusts, pastries, toppings, fillings)/Soft drinks/Fish (marinated, smoked, jellied)/Flavour extracts/Fruit products/Gelatin, jams, jellies, preserves/Malt extracts/Olives/Pickles/Salad dressings/Syrups/Wines
SYNONYMS:	CAS 120-47-8/EINECS 204-399-4/E214/Ethyl paraben/4-Hydroxybenzoic acid ethyl ester/Ethyl *p*-hydroxybenzoate/Carboxyphenol
FORMULA:	$HOC_6H_4CO_2C_2H_5$
MOLECULAR MASS IN Daltons:	166.18
ALTERNATIVE FORMS:	Methyl, propyl, butyl and heptyl esters
PROPERTIES AND APPEARANCE:	Ivory to white powder
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	297–298
MELTING RANGE IN °C:	114–118
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 10°C** 0.07 **@ 25°C** 0.17 **@ 80°C** 0.86
in vegetable oil:	**@ 25°C** 3.0 (olive oil), 1.0 (peanut oil)
in ethanol solution (100%):	70
in propylene glycol:	**@ 20°C** 25
FUNCTION IN FOODS:	Antimicrobial preservative, especially effective against bacteria and fungi at around neutral pH
ALTERNATIVES:	Other parabens
TECHNOLOGY OF USE IN FOODS:	pH optimum is 3–8. Parabens are often used as blends, e.g. methyl and propyl at a ratio of 2–3 : 1. Dissolve initially in water, ethanol, propylene glycol or the food itself. Hot water is recommended. Parabens can also be dry-blended with other dry ingredients.

LEGISLATION:	USA:	CANADA:	UK and EUROPE:	AUSTRALIA/PACIFIC RIM:
	Not permitted	Not permitted	Conditionally permitted	Australia: not permitted

REFERENCES:

http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010.

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NAME:	Ethyl-4-hydroxybenzoate, sodium salt
CATEGORY:	Antimicrobial preservative
FOOD USE:	Bakery products (cakes, crusts, pastries, toppings, fillings)/Soft drinks/Fish (marinated, smoked, jellied)/Flavour extracts/Fruit products/Gelatin, jams, jellies, preserves/Malt extracts/Olives/Pickles/Salad dressings/Syrups/Wines
SYNONYMS:	E215/Ethyl paraben sodium salt/4-Hydroxybenzoic acid ethyl ester sodium salt/Ethyl *p*-hydroxybenzoate sodium salt/Carboxyphenol sodium salt
FORMULA:	$NaOC_6H_4CO_2C_2H_5$
ALTERNATIVE FORMS:	Other parabens
PROPERTIES AND APPEARANCE:	Ivory to white powder
FUNCTION IN FOODS:	Antimicrobial preservative, especially effective against bacteria and fungi at around neutral pH
TECHNOLOGY OF USE IN FOODS:	pH optimum is 3–8. Parabens are often used as blends, e.g. methyl and propyl at a ratio of 2–3 : 1. Dissolve initially in water, ethanol, propylene glycol or the food itself. Hot water is recommended. Parabens can also be dry-blended with other dry ingredients.
LEGISLATION:	**USA:** Not permitted **CANADA:** Not permitted **UK and EUROPE:** Conditionally permitted **AUSTRALIA/PACIFIC RIM:** Australia: not permitted
REFERENCES:	http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010. www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010. www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010. www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010. Food Standards Australia New Zealand Act 1991 Food Standards Code Schedule 1 'Permitted uses of food additives by food type'. Available at: www.foodstandards.gov.au/_srcfiles/Standard_1_3_1_ Additives_Part_2_v115.pdf. Accessed 4 May 2010. O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

NAME:	Formic acid
CATEGORY:	Antimicrobial preservative
FOOD USE:	Preservative, flavouring agent
SYNONYMS:	Methanoic acid/Hydrogen carboxylic acid/Formylic acid/Aminic acid/INS No. 236/CAS 64-18-6
FORMULA:	CH_2O_2
MOLECULAR MASS IN Daltons:	46.03
ALTERNATIVE FORMS:	Ethyl formate
PROPERTIES AND APPEARANCE:	Colourless fuming liquid. Miscible with water
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	101
MELTING RANGE IN °C:	8.4
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.22 g/mL, liquid
PURITY %:	85
WATER CONTENT MAXIMUM IN %:	None
HEAVY METAL CONTENT MAXIMUM IN ppm:	None
ARSENIC CONTENT MAXIMUM IN ppm:	None
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** Miscible
in ethanol solution (100%):	Soluble
FUNCTION IN FOODS:	Preservative in animal feeds, flavouring in foods
ALTERNATIVES:	Ethyl formate

TECHNOLOGY OF USE IN FOODS:	Used in some beverages, sweets, bakery products, ice cream			
SYNERGISTS:	Other organic acids			
ANTAGONISTS:	Bases			
FOOD SAFETY ISSUES:	Irritant at high concentrations. Formic acid has an odour and taste that limits its use in food.			
LEGISLATION	**USA:**	**CANADA:**	**UK and EUROPE:**	**AUSTRALIA/PACIFIC RIM:**
	Not permitted	Not permitted	Not permitted	Not permitted

REFERENCES:

http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.

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NAME:	Heptyl paraben
CATEGORY:	Antimicrobial preservative
FOOD USE:	Antioxidant/Preservative/Antimicrobial agent for beer, fermented malt beverages/Non-carbonated soft drinks and fruit drinks
SYNONYMS:	*n*-Heptyl *p*-hydroxybenzoate/CAS 1085-12-7
FORMULA:	$C_{14}H_{20}O_3$
MOLECULAR MASS IN Daltons:	236.31
PROPERTIES AND APPEARANCE:	Colourless small crystals or white crystalline powder, odourless or faint charcoal odour, slight burning taste
MELTING RANGE IN °C:	48–51
PURITY %:	>99
WATER CONTENT MAXIMUM IN %:	0.5
HEAVY METAL CONTENT MAXIMUM IN ppm:	10 (as Pb)
ASH MAXIMUM IN %:	0.05
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 1.5
in ethanol solution (100%)	Readily soluble
FUNCTION IN FOODS:	Antioxidant, preservative; antimicrobial agent for beer, fermented malt beverages, non-carbonated soft drinks and fruit drinks
TECHNOLOGY OF USE IN FOODS:	Especially effective against bacteria and fungi at around neutral pH.

LEGISLATION:

USA:
INH, REG, 12 ppm In fermented malt beverages to inhibit microbiological spoilage, 172.145; 20 ppm In non-carbonated soft drinks and fruit based beverages when allowed by established standards of identity 172.145; PRES, REG, <12 ppm In fermented malt beverages 193.285

CANADA:
Not permitted

UK:
Not permitted

AUSTRALIA/NZ:
Not permitted

REFERENCES:

http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.

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NAME:	Hexamethylenetetramine
CATEGORY:	Antimicrobial preservative
FOOD USE:	Provolone cheese/Marinated fish
SYNONYMS:	CAS 100-97-0/EINECS 202-905-8/E239/HMTA/Methenamine/Aminoform/Urotropine/Hexamine
FORMULA:	$(CH_2)_6N_4$
MOLECULAR MASS IN Daltons:	140.22
PROPERTIES AND APPEARANCE:	White crystalline powder or colourless lustrous crystals
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.27
FUNCTION IN FOODS:	Antimicrobial preservative; releases formaldehyde in solution. Setting agent for proteins including casein used in food packaging paper/paperboard
TECHNOLOGY OF USE IN FOODS:	Added to provolone cheese and marinated fish; releases formaldehyde which exerts its broad-spectrum antimicrobial effect
ANTAGONISTS:	High pH (formaldehyde is released in acid solution)
LEGISLATION:	**USA:** Not permitted; **CANADA:** Not permitted; **UK and EUROPE:** Conditionally permitted; **AUSTRALIA/NZ:** Not permitted
REFERENCES:	http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010. www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010. www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010. www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010.

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NAME:	2-Hydroxybiphenyl
CATEGORY:	Antimicrobial preservative
FOOD USE:	Citrus fruit
SYNONYMS:	(1,1′-Biphenyl)-2-ol/*o*-Phenylphenol/2-Phenylphenol/*o*-Xenol/E231/*o*-Hydroxybiphenyl/CAS 90-43-7/EINECS 201-993-5
FORMULA:	$C_{12}H_{10}O$
MOLECULAR MASS IN Daltons:	170.22
PROPERTIES AND APPEARANCE:	Nearly white or light buff crystals, mild charcoal odour
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	760 mmHg 280–284 14 mmHg 145
MELTING RANGE IN °C:	56–58
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.217
FUNCTION IN FOODS:	Fungicide applied to surface of citrus fruit
ALTERNATIVES:	Other surface-applied fungicides, e.g. biphenyl, 2(thiazol-4-yl)-benzimidazole
TECHNOLOGY OF USE IN FOODS:	Fungicide applied to surface of citrus fruit
SYNERGISTS:	Other fungicides
LEGISLATION:	**USA:** Not permitted **CANADA:** Not permitted **UK and EUROPE:** Conditionally permitted **AUSTRALIA/PACIFIC RIM:** Not permitted
REFERENCES:	http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010. www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010.
www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010.
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O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

NAME:	Lactic acid
CATEGORY:	Antimicrobial preservative
FOOD USE:	Bakery products, cheese/Frozen desserts/Preserves, jams and jellies
SYNONYMS:	2-hydroxypropanoic acid/INS No. 270/CAS 50-21-5 (L-: 79-33-4; D-: 10326-41-7; DL-: 598-82-3)
FORMULA:	$C_3H_6O_3$
MOLECULAR MASS IN Daltons:	90.08
ALTERNATIVE FORMS:	Lactates
PROPERTIES AND APPEARANCE:	Obtained by the lactic fermentation of sugars or is prepared synthetically; may contain condensation products such as lactic acid, lactate and dilactide. Common products of commerce are 50–90% solutions. Solid products containing about 100–125% of titratable lactic acid also exist. Lactic acid is hygroscopic and when concentrated by boiling or by distillation it forms condensation products which hydrolyse to lactic acid on dilution and heating in water. Colourless syrupy liquid or white to light yellow solid or powder. Liquid: soluble in water and in ethanol Solid: sparingly soluble in water, soluble in acetone.
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.2
PURITY %:	95
WATER CONTENT MAXIMUM IN %:	None
HEAVY METAL CONTENT MAXIMUM IN ppm:	Pb 2
ARSENIC CONTENT MAXIMUM IN ppm:	None
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** Sparingly soluble
in ethanol solution (100%):	Soluble
FUNCTION IN FOODS:	Preservative

ALTERNATIVES:	Lactates
TECHNOLOGY OF USE IN FOODS:	Lactic acid is found in fermented milk products, such as koumiss, leban, yogurt, kefir, and cottage cheeses. Lactic acid is also responsible for the sour flavour of sourdough breads. This acid is used in beer brewing to lower the pH and increase the body of the beer. In winemaking, a bacterial process, natural or controlled, is often used to convert the naturally present malic acid to lactic acid, to reduce the sharpness and for other flavour-related reasons. This malolactic fermentation is undertaken by the family of lactic acid bacteria.
SYNERGISTS:	Organic acids
ANTAGONISTS:	Bases
FOOD SAFETY ISSUES:	Lactic acid has an odour and taste that limits its use in food.
LEGISLATION	**USA:** B&N, GRAS/FS 184.1061, Part 136, Bakery Pdts; Part 133, Cheese; Part 135, Frozen Desserts; Part 150, Fruit Butters, Jellies and Preserves In animal feed practices 582.1061 **CANADA:** Not permitted **AUSTRALIA/NZ:** Permitted in specified food types to maximum permitted levels **UK and EUROPE:** GMP
REFERENCES:	http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010. www.fao.org/ag/agn/jecfa-additives/specs/Monograph1/Additive-247.pdf. Accessed 4 May 2010. www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010. www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010. www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010. Food Standards Australia New Zealand Act 1991 Food Standards Code Schedule 1 'Permitted uses of food additives by food type'. Available at: www.foodstandards.gov.au/_srcfiles/Standard_1_3_1_ Additives_Part_2_v115.pdf. Accessed 4 May 2010. O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

NAME:	Methyl para-hydroxybenzoate
CATEGORY:	Antimicrobial preservative
FOOD USE:	Bakery products (cakes, crusts, pastries, toppings, fillings)/Soft drinks/Fish (marinated, smoked, jellied)/ Flavour extracts/Fruit products/Gelatin, jams jellies/Preserves/Malt extracts/Olives/Pickles/Salad dressings/ Syrups/Wines
SYNONYMS:	Methyl 4-hydroxybenzoate/4-Hydroxybenzoic acid, methyl ester/Methyl *p*-hydroxybenzoate/E218/FEMA 2710/CAS 99-76-3/EINEC 202-785-7
FORMULA:	$C_6H_4(OH)CO_2CH_3$
MOLECULAR MASS IN Daltons:	152.14
ALTERNATIVE FORMS:	Sodium salt and ethyl, propyl and heptyl parabens and their sodium salts
PROPERTIES AND APPEARANCE:	Colourless crystals or white crystalline powder, odourless or faint charcoal odour, slight burning taste
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	270–280 (decomposes)
MELTING RANGE IN °C:	131
PURITY %:	>99
WATER CONTENT MAXIMUM IN %:	0.5
HEAVY METAL CONTENT MAXIMUM IN ppm:	10 (as Pb)
ASH MAXIMUM IN %:	0.05
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 10°C** 0.20 **@ 25°C** 0.25 **@ 80°C** 2.0
in vegetable oil:	**@ 25°C** 0.5 (peanut), 2.9 (olive)

in ethanol solution:	
10%	0.5
50%	18.0
100%	52.0
in propylene glycol (25°C, aqueous solution):	
10%	0.3
50%	2.7
100%	22.0

FUNCTION IN FOODS: Antimicrobial agent, preservative, flavouring agent; for baked goods, beverages, food colours, milk, wine; antimycotic migrating from food packaging. Usage level: 0.1–1.0%; use in foods restricted to 0.1%; especially effective against bacteria and fungi at around neutral pH

TECHNOLOGY OF USE IN FOODS: Effective against yeasts and moulds. Bacteria: mainly Gram-positive. Heptyl parabens more active than propyl, then ethyl, then methyl. Used in similar foods in which benzoic acid is used, but active to higher pH (pK_a is 8.5). Has a characteristic phenolic taste. pH optimum is 3–8. Parabens are often used as blends, e.g. methyl and propyl at a ratio of 2–3 : 1. Dissolve initially in water, ethanol, propylene glycol or the food itself. Hot water is recommended. Parabens can also be dry-blended with other dry ingredients.

ANTAGONISTS: Proteins; emulsifiers; lipids; polysaccharides

LEGISLATION:

USA:
Fully up-to-date toxicology information has been sought

CANADA:
Permitted in selected foods to certain maximum levels of use

UK and EUROPE:
Conditionally permitted

AUSTRALIA/PACIFIC RIM:
Permitted in specified food types to maximum permitted levels

REFERENCES:

Ash, M. and Ash, I. (1996) *Food Additives*. Gower Publishing, Brookfield, VT.
Davidson, P.M. and Branen, A.L. (1993) *Antimicrobials in Foods*, 2nd edn. Marcel Dekker, New York.

NAME:	Methyl-4-hydroxybenzoate, sodium salt
CATEGORY:	Antimicrobial preservative
FOOD USE:	Bakery products (cakes, crusts, pastries, toppings, fillings)/Soft drinks/Fish (marinated, smoked, jellied)/ Flavour extracts/Fruit products/Gelatin, jams, jellies/Preserves/Malt extracts/Olives/Pickles/Salad dressings/ Syrups/Wines
SYNONYMS:	E219/Sodium methyl *para*-hydroxybenzoate
FORMULA:	$NaOC_6H_4CO_2CH_3$
MOLECULAR MASS IN Daltons:	174
FUNCTION IN FOODS:	Antimicrobial preservative, especially effective against bacteria and fungi at around neutral pH
TECHNOLOGY OF USE IN FOODS:	pH optimum is 3–8. Parabens are often used as blends, e.g. methyl and propyl at a ratio of 2–3 : 1. Dissolve initially in water, ethanol, propylene glycol or the food itself. Hot water is recommended. Parabens can also be dry-blended with other dry ingredients.
LEGISLATION:	**USA:** Not permitted **CANADA:** Permitted in selected foods to certain maximum levels of use **UK and EUROPE:** Conditionally permitted **AUSTRALIA/PACIFIC RIM:** Not permitted
REFERENCES:	http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010. www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010. www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010. www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010.

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Davidson, P.M. and Branen, A.L. (1993) *Antimicrobials in Foods*, 2nd edn. Marcel Dekker, New York.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

NAME:	Natamycin
CATEGORY:	Antimicrobial preservative
FOOD USE:	Cheese
SYNONYMS:	Pimaricin/INS No. 235/CAS 7681-93-8
FORMULA:	$C_{33}H_{47}NO_{13}$
MOLECULAR MASS IN Daltons:	665.74
ALTERNATIVE FORMS:	None
PROPERTIES AND APPEARANCE:	White to creamy-white, almost odourless, crystalline powder Practically insoluble in water, in lipid and in mineral oils; slightly soluble in methanol; soluble in glacial acetic acid and dimethylformamide Not less than 95.0% calculated on the dried basis
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	Not applicable
PURITY %:	95
WATER CONTENT MAXIMUM IN %:	8
HEAVY METAL CONTENT MAXIMUM IN ppm:	Pb 2
ARSENIC CONTENT MAXIMUM IN ppm:	None
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** Practically insoluble in water
in ethanol solution (100%):	Slightly soluble
FUNCTION IN FOODS:	A fungicidal antimycotic of the polyene macrolide group. A preservative for certain cheese and dried sausage products. Used in products such as cottage cheese, sour cream, yogurt and packaged salad mixes
ALTERNATIVES:	Antimycotics

TECHNOLOGY OF USE IN FOODS: Used as a surface treatment for cheese to prevent mould growth

SYNERGISTS: Antimycotics

ANTAGONISTS: Temperature above 50°C

FOOD SAFETY ISSUES: The EU Scientific Committee on Food (SCF) states on the usage of natamycin: '. . .in view of the general principle with regard to the undesirability of using antibiotics in foodstuffs the Committee is strongly opposed to proposals for further food uses of natamycin such as use on ham and wine and other beverages.'

LEGISLATION

USA:
FUNG, REG, applied on cheese as an antimycotic not to exceed 20 milligrams per kilogram (20 ppm) in the finished product 172.155

UK and EUROPE:
Conditionally permitted

CANADA:
Permitted in selected foods to certain maximum levels of use

AUSTRALIA/PACIFIC RIM:
Not permitted

REFERENCES:

http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.

www.fao.org/ag/agn/jecfa-additives/specs/Monograph1/Additive-293.pdf. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010.

www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010.

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NAME:	Nisin
CATEGORY:	Antimicrobial preservative
FOOD USE:	Pasteurised cheese and cheese spreads/Canned fruits and vegetables
SYNONYMS:	E234/CAS 1414-45-5/EINECS 215-807-5/*Streptococcus lactis* (*Lactococcus lactis*) bacteriocin
FORMULA:	$C_{143}H_{230}N_{42}O_{37}S_7$ (contains L-amino acids and the unusual sulphur-containing amino acids lanthionine and β-methyllanthionine). There are five variants of nisin: A, B, C, D and E. The most active antimicrobially is variant A. The commercial product contains mainly variant A
MOLECULAR MASS IN Daltons:	3500 (usually occurs as the dimer, 7000)
ALTERNATIVE FORMS:	Nisaplin® is the trade name for nisin produced by Aplin & Barrett Ltd., Dorset, England
PROPERTIES AND APPEARANCE:	Crystals derived from pure culture fermentation of *Streptococcus lactis* (*Lactococcus lactis*)
PURITY %:	Not less than 900 IU/mg
WATER CONTENT MAXIMUM IN %:	3.0
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ASH MAXIMUM IN %:	Not less than 50% NaCl
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ pH 2.5** 12.0 **@ pH 5.0** 4.0 **@ >pH 7.0** Insoluble
FUNCTION IN FOODS:	As a preservative in cheese and canned fruits and vegetables. Effective against Gram-positive bacteria, lactic acid bacteria, *Streptococcus*, *Bacillus*, *Clostridium*
ALTERNATIVES:	Other anti-botulinal antimicrobial preservative treatments
TECHNOLOGY OF USE IN FOODS:	Cheese (6–12 ppb); dairy products (6–12 ppb); canned foods (stable at low pH and high temperature) (6–12 ppb). Activity in foods is lost gradually upon storage

ANTAGONISTS: High pH, pancreatin, alpha-chymotrypsin, nisinase, penicillinase, high microbial load

LEGISLATION:

USA:
MISC, GRAS 184.1538; <250 ppm Antimicrobial in Cheese pdts, Part 133 (133.175., 133.176, 133.179, 133.180)

UK and EUROPE:
Conditionally permitted

CANADA:
Permitted in selected foods to certain maximum levels of use

AUSTRALIA/NZ:
Permitted in specified food types to maximum permitted levels

REFERENCES:

http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010.

www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010.

Food Standards Australia New Zealand Act 1991 Food Standards Code Schedule 1 'Permitted uses of food additives by food type'. Available at: www.foodstandards.gov.au/_srcfiles/Standard_1_3_1_ Additives_Part_2_v115.pdf. Accessed 4 May 2010.

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NAME:	Potassium acetate
CATEGORY:	Antimicrobial preservative
FOOD USE:	Meat products/Ready-to-eat meals
SYNONYMS:	INS No. 261/CAS 127-08-2
FORMULA:	$C_2H_3KO_2$
MOLECULAR MASS IN Daltons:	98.14
ALTERNATIVE FORMS:	None
PROPERTIES AND APPEARANCE:	Colourless, deliquescent crystals or a white crystalline powder, odourless or with a faint acetic odour
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.57
PURITY %:	99
WATER CONTENT MAXIMUM IN %:	8
HEAVY METAL CONTENT MAXIMUM IN ppm:	Pb 2
ARSENIC CONTENT MAXIMUM IN ppm:	None
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 253 g/100 mL **@ 62°C** 492 g/100 mL
in ethanol solution (100%):	Soluble
FUNCTION IN FOODS:	Preservative and acidity regulator
ALTERNATIVES:	Sodium acetate
TECHNOLOGY OF USE IN FOODS:	Potassium acetate can be used in processed meat products and ready-to-eat meals as low sodium replacement for sodium acetate and sodium chloride

SYNERGISTS:	Other acetates			
ANTAGONISTS:	Bases			
FOOD SAFETY ISSUES:	Potassium acetate has an odour and taste that limits its use in food.			
LEGISLATION	**USA:**	**CANADA:**	**UK and EUROPE:**	**AUSTRALIA/NZ:**
	B&N, FS Unlisted GRAS	Not permitted	GMP	Permitted in specified food types to maximum permitted levels

REFERENCES:

http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010.

www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010.

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O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

NAME:	Potassium benzoate
CATEGORY:	Antimicrobial preservative
FOOD USE:	Beverages/Margarine/Bakery products/Fish products/Fruit juice, fruit pulp/Jam/Liquid egg, whole egg, egg yolk/Mayonnaise, mustard, pickles, sauces, ketchup/Sausage
SYNONYMS:	Benzoic acid, potassium salt/E212/CAS 582-25-2 (anhydrous)/EINECS 209-481-3
FORMULA:	C_6H_5COOH
MOLECULAR MASS IN Daltons:	160.22
ALTERNATIVE FORMS:	Other salts; benzoic acid
PROPERTIES AND APPEARANCE:	Orthorhombic crystals or powder
MELTING RANGE IN °C:	>300
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.44
PURITY %:	>99 (anhydrous basis)
WATER CONTENT MAXIMUM IN %:	1.5
HEAVY METAL CONTENT MAXIMUM IN ppm:	10 (as Pb)
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 50
in ethanol solution:	
90%	2.0
100%	1.33
FUNCTION IN FOODS:	Antimicrobial preservative for margarine, oleomargarine, wine

TECHNOLOGY OF USE IN FOODS: Effective versus yeasts and moulds, food-poisoning bacteria, spore-forming bacteria. Not effective against many spoilage bacteria. pK_a is 4.2, so should be used in foods with pH less than 4.2. Levels for general use: carbonated beverages, 0.03–0.05%; non-carbonated beverages, 0.1%; beverage syrups, 0.1%; fruit drinks, 0.1%; fruit juices, 0.1%; purées and concentrates, 0.1%; cider, 0.05–0.1%; salted margarine, 0.1%; pie and pastry fillings, 0.1%; icings, 0.1%; soy sauce, 0.1%; mincemeat, 0.1%; salads, 0.1%; salad dressings, 0.1%; fruit salads, 0.1%; pickles, 0.1%; relishes, 0.1%; fruit cocktails, 0.1%; olives, 0.1%; sauerkraut, 0.1%; preserves, 0.1%; dried fruits, 0.1%; jams, 0.1%; jellies, 0.1%; fish, 0.15–0.35; dipping solutions, 0.15–0.35%; ice glaze, 0.15–0.30%

SYNERGISTS: Sulphur dioxide; carbon dioxide; sodium chloride; sucrose; sorbates; thermal processing; refrigeration; boric acid

ANTAGONISTS: Lipids (partitioning); ferric salts; anionic surfactants

LEGISLATION:

USA:
Fully up-to-date toxicology information has been sought FDA 21 CFR §166.110, 177.1210

CANADA:
Permitted in selected foods to certain maximum levels of use

UK and EUROPE:
Conditionally permitted

AUSTRALIA/PACIFIC RIM:
Australia: permitted in specified food types to maximum permitted levels

REFERENCES:

http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010.

www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010.

Food Standards Australia New Zealand Act 1991 Food Standards Code Schedule 1 'Permitted uses of food additives by food type'. Available at: www.foodstandards.gov.au/_srcfiles/Standard_1_3_1_Additives_Part_2_v115.pdf. Accessed 4 May 2010.

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ANY OTHER RELEVANT INFORMATION:

Effect of pH on the dissociation of benzoic acid:

pH	*% Undissociated acid*
3	93.5
4	59.3
5	12.8
6	1.44
7	0.144
p*K*	4.19

NAME:	Potassium metabisulphite
CATEGORY:	Antimicrobial preservative
FOOD USE:	Food preservative/Antioxidant/Steriliser/Brewing, wine making. Not for use in meats, sources of vitamin B_1, raw fruits and vegetables, or fresh potatoes
SYNONYMS:	CAS 16731-55-8/EINECS 240-795-3/E224/Disulfurous acid dipotassium salt/Potassium pyrosulfite/ Potassium disulfite/Dipotassium disulfite
FORMULA:	$K_2S_2O_5$
MOLECULAR MASS IN Daltons:	222.32
ALTERNATIVE FORMS:	Sodium sulphite; sodium bisulphite; sodium metabisulphite; sulphur dioxide; calcium sulphite; calcium bisulphite
PROPERTIES AND APPEARANCE:	White granules or powder, pungent sharp odour
MELTING RANGE IN °C:	>300, decomposes at 150–190
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	2.34
PURITY %:	57.6 as SO_2
HEAVY METAL CONTENT MAXIMUM IN ppm:	10 (as Pb)
ARSENIC CONTENT MAXIMUM IN ppm:	3
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 25 **@ 50°C** Slightly soluble **@ 100°C** Slightly soluble
in ethanol solution:	
5%	Slightly soluble
20%	Slightly soluble
95%	Slightly soluble
100%	Slightly soluble

FUNCTION IN FOODS:	Antimicrobial preservative, antioxidant and bleach
ALTERNATIVES:	Combination of antimicrobial preservative, antioxidant and bleach
TECHNOLOGY OF USE IN FOODS:	Multifunctional: an antimicrobial preservative, an antioxidant and a bleaching agent
ANTAGONISTS:	Sulphur dioxide is very reactive and binds to many substances in foods including oxygen, aldehydes, some ketones, sugars, carbonyls, thiamin, nucleotides, colours, anthocyanins
FOOD SAFETY ISSUES:	Normal humans are reasonably tolerant to ingested sulphites, but some individuals are hypersensitive and may be subject to asthma attacks and even life-threatening anaphylaxis.
LEGISLATION:	**USA:** GRAS/FS, GMP, Restrictions: not in meats, foods recognised as source of vitamin B_1, raw fruit and veg (including fresh potatoes, i.e., not frozen, canned or dehydrated), served fresh, 182.3617 **UK and EUROPE** Conditionally permitted **CANADA:** Permitted in selected foods to certain maximum levels of use **AUSTRALIA/PACIFIC RIM:** Permitted in specified food types to maximum permitted levels Japan: approved (0.03–5 g/kg max. residual as sulphur dioxide)
REFERENCES:	http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010. www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010. www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010. www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010. Food Standards Australia New Zealand Act 1991 Food Standards Code Schedule 1 'Permitted uses of food additives by food type'. Available at: www.foodstandards.gov.au/_srcfiles/Standard_1_3_1_ Additives_Part_2_v115.pdf. Accessed 4 May 2010. O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

NAME:	Potassium nitrate
CATEGORY:	Antimicrobial preservative
SYNONYMS:	E252/Nitre/Niter/Saltpetre/CAS 7757-79-l/EINECS 231-818-8
FORMULA:	KNO_3
MOLECULAR MASS IN Daltons:	101.11
PROPERTIES AND APPEARANCE:	Transparent colourless or white crystals or crystal powder, odourless, cooling pungent salty taste
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	Decomposes at 320
MELTING RANGE IN °C:	334
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	2.109
PURITY %:	99
WATER CONTENT MAXIMUM IN %:	1
HEAVY METAL CONTENT MAXIMUM IN ppm:	2
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 33 **@ 100°C** 200
in ethanol solution (100%):	0.13
FUNCTION IN FOODS:	Formerly used as a curing agent, now superseded by nitrite
ALTERNATIVES:	Nitrite
TECHNOLOGY OF USE IN FOODS:	200 ppm cod roe; 7 g/L pickles; 2.2 g/kg meat; 1.72 g/kg chopped meat

LEGISLATION:

USA:
MISC, REG, <200 ppm of finished roe. Used as a curing agent in the processing of cod roe 172.160; PRES, PS, source of nitrite used in production of cured red meat and poultry products 181.33

UK and EUROPE:
Conditionally permitted

CANADA:
Permitted in selected foods to certain maximum levels of use

AUSTRALIA/NZ:
Permitted in specified food types to maximum permitted levels

REFERENCES:

http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010.

www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010.

Food Standards Australia New Zealand Act 1991 Food Standards Code Schedule 1 'Permitted uses of food additives by food type'. Available at: www.foodstandards.gov.au/_srcfiles/Standard_1_3_1_ Additives_Part_2_v115.pdf. Accessed 4 May 2010.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

NAME:	Potassium nitrite
CATEGORY:	Antimicrobial preservative
FOOD USE:	Cured meats/Meat products/Fish products
SYNONYMS:	Nitrous acid potassium salt/E249/CAS 7758-09-0/EINECS 231-832-4
FORMULA:	KNO_2
MOLECULAR MASS IN Daltons:	85.10
ALTERNATIVE FORMS:	Sodium nitrite
PROPERTIES AND APPEARANCE:	White or slightly yellow deliquescent granules or rods
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	Decomposes at 320
MELTING RANGE IN °C:	441 (decomposition starts at 350)
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.915
PURITY %:	90
HEAVY METAL CONTENT MAXIMUM IN ppm:	0.002%, not more than 10 ppm Pb
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 0°C** 281 **@ 100°C** 413
in ethanol solution:	
5%	Soluble
20%	Soluble
95%	Soluble
100%	Soluble

FUNCTION IN FOODS:	Antimicrobial preservative; colour fixative; flavour enhancer
ALTERNATIVES:	Multifunctional, so requires a blend of additives
TECHNOLOGY OF USE IN FOODS:	2 g/L pickle, 0.625 g/kg meat, 0.156 g/kg chopped meat
LEGISLATION:	**USA:** PRES, PS, source of nitrite used in production of cured red meat and poultry products 181.34 **CANADA:** Permitted in selected foods to certain maximum levels of use **UK and EUROPE:** Conditionally permitted **AUSTRALIA/NZ:** Permitted in specified food types to maximum permitted levels
REFERENCES:	http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010. www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010. www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010. www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010. Food Standards Australia New Zealand Act 1991 Food Standards Code Schedule 1 'Permitted uses of food additives by food type'. Available at: www.foodstandards.gov.au/_srcfiles/Standard_1_3_1_ Additives_Part_2_v115.pdf. Accessed 4 May 2010. O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

NAME:	Potassium propionate
CATEGORY:	Antimicrobial preservative
FOOD USE:	Baked products/Cheese products
SYNONYMS:	E283
FORMULA:	KC_2H_5COO
ALTERNATIVE FORMS:	Other salts
FUNCTION IN FOODS:	Antimicrobial preservative; antimycotic; flavouring agent; preservative additive; mould inhibitor
ALTERNATIVES:	Other antimicrobial preservatives, depending on the application
TECHNOLOGY OF USE IN FOODS:	1% (foods); limitation 0.32% (flour in white bread/rolls), 0.38% (whole wheat), 0.3% (cheese products)
ANTAGONISTS:	Calcium chloride
LEGISLATION	**USA:** Not permitted **CANADA:** Not permitted **UK and EUROPE:** Conditionally permitted **AUSTRALIA/NZ:** Permitted in specified food types to maximum permitted levels
REFERENCES:	http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010. www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010. www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010. www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010. Food Standards Australia New Zealand Act 1991 Food Standards Code Schedule 1 'Permitted uses of food additives by food type'. Available at: www.foodstandards.gov.au/_srcfiles/Standard_1_3_1_ Additives_Part_2_v115.pdf. Accessed 4 May 2010. O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

NAME:	Potassium sorbate
CATEGORY:	Antimicrobial preservative
FOOD USE:	Baked goods/Beverages/Bread, cake batters, cake fillings, cake toppings/Cheese, cottage cheese/Fish (smoked, salted)/Fruit juices (fresh), fruit (dried)/Margarine/Pickled products/Pie crusts, pie fillings/Salad dressings, salads (fresh)/Sausage/Seafood cocktails/Syrups/Wine
SYNONYMS:	Potassium hexadienoate/2,4-Hexadienoic acid potassium salt/Sorbic acid potassium salt/2-Propenylacrylic acid potassium salt/E202/CAS 590-00-1/24634-61-5/246-376-1/EINECS 203-768-7/Hexadienic acid, potassium salt/(2-Butenylidene) acetic acid, potassium salt
FORMULA:	$CH_3CH{=}CHCH{=}CHCOOH$
MOLECULAR MASS IN Daltons:	150.22
ALTERNATIVE FORMS:	Sorbic acid (sodium, and calcium salts)
PROPERTIES AND APPEARANCE:	White or off-white powder, characteristic odour
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	Decomposes above 270
MELTING RANGE IN °C:	Decomposes above 270
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.36
PURITY %:	>98 (anhydrous basis)
WATER CONTENT MAXIMUM IN %:	1.0
HEAVY METAL CONTENT MAXIMUM IN ppm:	10 (as Pb)
ARSENIC CONTENT MAXIMUM IN ppm:	3

SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:						
in water:	**@ 20°C**	58.2 (pH 3.1)	**@ 50°C**	61	**@ 100°C**	64
in vegetable oil:	**@ 20°C**	0.01	**@ 50°C**	0.03		
in sucrose solution:						
10%	58					
40%	45					
60%	28					
in sodium chloride solution:						
5%	47					
10%	34					
15%	12–15					
in ethanol solution:						
5%	57.4					
20%	54.6					
50%	45.3					
95%	6.5					
100%	2.0					
in propylene glycol:	**@ 20°C**	55	**@ 50°C**	48	**@ 100°C**	20

FUNCTION IN FOODS: Antimicrobial preservative: fungi (broad spectrum); bacteria (mostly strict aerobes). Not lactic acid bacteria Flavouring. Acidulant

ALTERNATIVES: Sodium sorbate; sorbic acid; calcium sorbate; benzoic acid; sodium benzoate; potassium benzoate; calcium benzoate; propionic acid; sodium propionate; potassium propionate; calcium propionate

TECHNOLOGY OF USE IN FOODS: The pK_a is 4.8, so sorbic acid and its salts would normally be used at pH less than 4.8. It can, however, be used at up to neutral pH, but the activity reduces as the pH increases. In wine, it should only be used in conjunction with sulphur dioxide, otherwise a characteristic off-odour may result.

SYNERGISTS: Sulphur dioxide; carbon dioxide; sodium chloride; sucrose; propionic acid; dehydration; nisin with polyphosphates; benzoates

ANTAGONISTS: Non-ionic surfactants

FOOD SAFETY ISSUES: This is not an additive which has been subject to great criticism over safety

LEGISLATION

USA:
GRAS if used in accordance with GMP, 182.3640; <0.3% as sorbic acid, Part 133 (133.123, 133.173, 133.179, 133.180, 133.188) Cheeses; FS, <0.1% by weight, Part 150 (150.141, 150.161), Fruit Butter and Art Sw Jelly and Preserves; <0.1% or 0.2% total in combination w/other pres, Margarine and Oleomargarine, 166.110; GRAS, substance migrating to food from paper and paperboard pdts, 182.90 FDA 21 CFR § 133.118, 133.123, 133.124, 133.169, 133.173, 133.179, 133.187, 133.188, 150.141, 150.161, 166.110, 182.3640, 182.90

CANADA:
Permitted in selected foods to certain maximum levels of use

UK and EUROPE:
Conditionally permitted

AUSTRALIA/PACIFIC RIM:
Australia: permitted in specified food types to maximum permitted levels
Japan: approved with limitations

REFERENCES:

http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010.

www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010.

Food Standards Australia New Zealand Act 1991 Food Standards Code Schedule 1 'Permitted uses of food additives by food type'. Available at: www.foodstandards.gov.au/_srcfiles/Standard_1_3_1_ Additives_Part_2_v115.pdf. Accessed 4 May 2010.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

ANY OTHER RELEVANT INFORMATION:

Occurs naturally in the berries of the mountain ash *Sorbus aucuparia* L., Rosaceae

NAME:	Propionic acid
CATEGORY:	Antimicrobial preservative
FOOD USE:	Baked products/Cheese products
SYNONYMS:	Methylacetic acid/Propanoic acid/Ethylformic acid/E280/CAS 79-09-4/EINECS 201-176-3
FORMULA:	C_2H_5COOH
MOLECULAR MASS IN Daltons:	74.09
PROPERTIES AND APPEARANCE:	Oily liquid, pungent, rancid odour
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	760 mmHg 141.1 400 mmHg 122.0 100 mmHg 85.8 10 mmHg 41.6 1 mmHg 4.6
MELTING RANGE IN °C:	−21.5
FLASH POINT IN °C:	58
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	0.993
PURITY %:	99.5
WATER CONTENT MAXIMUM IN %:	0.15
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ASH MAXIMUM IN %:	0.01
FUNCTION IN FOODS:	Antimicrobial preservative; antimycotic; flavouring agent; preservative additive; mould inhibitor
ALTERNATIVES:	Other antimicrobial preservatives depending on the application
TECHNOLOGY OF USE IN FOODS:	1% (foods); limitation 0.32% (flour in white bread/rolls), 0.38% (whole wheat), 0.3% (cheese products)
ANTAGONISTS:	Calcium chloride

LEGISLATION:

USA:
PRES, GRAS/FS, GMP 184.1081; Part 133 (133.149, 133.195)
Propionic acid produced by bacteria, Swiss and Gruyere Cheese

UK and EUROPE:
Conditionally permitted

CANADA:
Permitted in selected foods to certain maximum levels of use

AUSTRALIA/NZ:
Permitted in specified food types to maximum permitted levels

REFERENCES:

http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010.

www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010.

Food Standards Australia New Zealand Act 1991 Food Standards Code Schedule 1 'Permitted uses of food additives by food type'. Available at: www.foodstandards.gov.au/_srcfiles/Standard_1_3_1_ Additives_Part_2_v115.pdf. Accessed 4 May 2010.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

ANY OTHER RELEVANT INFORMATION:

Refractive index: 1.3862
Surface tension 27.21 mN/m (15°C)
Viscosity 1.020 mPa·s (15°C)
p*K* 4.87
Swiss cheese contains up to 1% propionic acid as a result of growth and metabolism of propionibacteria, and this limits mould growth

NAME:	Propyl-4-hydroxybenzoate
CATEGORY:	Antimicrobial preservative
FOOD USE:	Bakery products (cakes, crusts, pastries, toppings, fillings)/Soft drinks/Fish (marinated, smoked, jellied)/ Flavour extracts/Fruit products/Gelatin, jams, jellies/Preserves/Malt extracts/Olives/Pickles/Salad dressings/ Syrups/Wines
SYNONYMS:	Propyl-*para*-hydroxybenzoate/Benzoic acid/4-Hydroxy propyl ester/4-Hydroxybenzoic acid propyl ester/CAS 94-13-3/EINECS 202-307-7/E216
FORMULA:	$HOC_6H_4CO_2C_3H_7$
MOLECULAR MASS IN Daltons:	180.20
ALTERNATIVE FORMS:	Salt or other parabens
PROPERTIES AND APPEARANCE:	Colourless crystals or white powder
MELTING RANGE IN °C:	95–98
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.0630
PURITY %	>99
WATER CONTENT MAXIMUM IN %:	0.5
HEAVY METAL CONTENT MAXIMUM IN ppm:	10 (as Pb)
ASH MAXIMUM IN %:	0.05
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 10°C** 0.025 **@ 20°C** 0.05 **@ 80°C** 0.30
in vegetable oil:	**@ 25°C** 1.4 (peanut), 5.2 (olive)

in ethanol solution:	
10%	0.1
50%	18
100%	95
in propylene glycol (25°C, aqueous solution):	
10%	0.06
50%	0.9
100%	26.0

FUNCTION IN FOODS: Antimicrobial preservative, especially effective against bacteria and fungi at around neutral pH

TECHNOLOGY OF USE IN FOODS: pH optimum is 3–8. Parabens are often used as blends, e.g. methyl and propyl at a ratio of 2–3 : 1. Dissolve initially in water, ethanol, propylene glycol or the food itself. Hot water is recommended. Parabens can also be dry-blended with other dry ingredients.

LEGISLATION:

USA:
Fully up-to-date toxicology information has been sought

CANADA:
Permitted in selected foods to certain maximum levels of use

UK and EUROPE:
Conditionally permitted

AUSTRALIA/PACIFIC RIM:
Permitted in specified food types to maximum permitted levels

REFERENCES:

http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010.

www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010.

Food Standards Australia New Zealand Act 1991 Food Standards Code Schedule 1 'Permitted uses of food additives by food type'. Available at: www.foodstandards.gov.au/_srcfiles/Standard_1_3_1_ Additives_Part_2_v115.pdf. Accessed 4 May 2010.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

NAME:	Propyl-4-hydroxybenzoate, sodium salt
CATEGORY:	Antimicrobial preservative
FOOD USE:	Bakery products (cakes, crusts, pastries, topping, fillings)/Soft drinks/Fish (marinated, smoked, jellied)/Flavour extracts/Fruit products/Gelatin, jams, jellies/Preserves/Malt extracts/Olives/Pickles/Salad dressings/Syrups/Wines
SYNONYMS:	E217/Propyl-*para*-hydroxybenzoate sodium salt/Benzoic acid sodium salt/4-Hydroxy propyl ester sodium salt/4-Hydroxybenzoic acid propyl ester sodium salt
FORMULA:	$NaOC_6H_4CO_2C_3H_7$
FUNCTION IN FOODS:	Antimicrobial preservative, especially effective against bacteria and fungi at around neutral pH
TECHNOLOGY OF USE IN FOODS:	pH optimum is 3–8. Parabens are often used as blends, e.g. methyl and propyl at a ratio of 2–3 : 1. Dissolve initially in water, ethanol, propylene glycol or the food itself. Hot water is recommended. Parabens can also be dry-blended with other dry ingredients.
LEGISLATION:	**USA:** Not permitted **CANADA:** Permitted in selected foods to certain maximum levels of use **UK and EUROPE:** Conditionally permitted **AUSTRALIA/PACIFIC RIM:** Not permitted
REFERENCES:	http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010. www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010. www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010. www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010.

Food Standards Australia New Zealand Act 1991 Food Standards Code Schedule 1 'Permitted uses of food additives by food type'. Available at: www.foodstandards.gov.au/_srcfiles/Standard_1_3_1_ Additives_Part_2_v115.pdf. Accessed 4 May 2010.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

NAME:	Sodium acetate
CATEGORY:	Antimicrobial preservative
FOOD USE:	Jams, jellies, preserves
SYNONYMS:	INS No. 262(i)/CAS 127-09-3
FORMULA:	$C_2H_3NaO_2 \cdot nH_2O$ ($n = 0$ or 3)
MOLECULAR MASS IN Daltons:	Anhydrous 82.03; Trihydrate 136.08
ALTERNATIVE FORMS:	Acetic acid
PROPERTIES AND APPEARANCE:	Anhydrous: white, odourless, granular, hygroscopic powder Trihydrate: colourless transparent crystals or a granular crystalline powder, odourless or with a faint acetic odour. Effloresces in warm dry air Very soluble in water; soluble in ethanol
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.5
PURITY %:	98.5
WATER CONTENT MAXIMUM IN %:	1.5
HEAVY METAL CONTENT MAXIMUM IN ppm:	Pb 2
ARSENIC CONTENT MAXIMUM IN ppm:	None
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 0°C** 36.2 g/100 mL **@ 20°C** 46.4 g/100mL **@ 60°C** 139 g/100mL **@ 100°C** 170.15 g/100mL
in ethanol solution (100%):	Soluble
FUNCTION IN FOODS:	Preservative, flavouring

ALTERNATIVES:	Sodium diacetate; acetic acid
TECHNOLOGY OF USE IN FOODS:	Seasoning in snack products with salt and vinegar flavour
SYNERGISTS:	Organic acids
ANTAGONISTS:	Bases
FOOD SAFETY ISSUES:	Sodium acetate has an odour and taste that limits its use in food.

LEGISLATION

USA:
B&N, GRAS/FS, Art Sw Fruit Jelly 150.141, Art Sw Fruit
Pres and Jams 150.161; BC, REG, Comp of boiler water additive 173.310; GRAS, GMP -184.1721; GRAS, Migr from cotton and cotton fabrics used in dry food pkg 182.70;
In animal feeds 582.121

CANADA:
Not permitted

AUSTRALIA/NZ:
Permitted in specified food types to maximum permitted levels

UK and EUROPE:
GMP

REFERENCES:

http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.

www.fao.org/ag/agn/jecfa-additives/specs/Monograph1/Additive-387.pdf. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010.

www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010.

Food Standards Australia New Zealand Act 1991 Food Standards Code Schedule 1 'Permitted uses of food additives by food type'. Available at: www.foodstandards.gov.au/_srcfiles/Standard_1_3_1_Additives_Part_2_v115.pdf. Accessed 4 May 2010.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

NAME:	Sodium benzoate
CATEGORY:	Antimicrobial preservative
FOOD USE:	Beverages/Margarine/Bakery products/Fish products/Fruit juice, fruit pulp/Jam/Liquid egg, whole egg, egg yolk/Mayonnaise, mustard, pickles, sauces, ketchup/Sausage
SYNONYMS:	Benzoic acid, sodium salt/CAS 532-32-1/EINECS 208-534-8/E211/Benzoate of soda; benzoate sodium
FORMULA:	C_6H_5COONa
MOLECULAR MASS IN Daltons:	144.11
ALTERNATIVE FORMS:	Other salts; benzoic acid
PROPERTIES AND APPEARANCE:	White granular or crystalline powder, odourless, sweetish astringent taste
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.44
PURITY %:	>99 (anhydrous basis)
WATER CONTENT MAXIMUM IN %:	1.5
HEAVY METAL CONTENT MAXIMUM IN ppm:	10 (as Pb)
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 0°C** 62.8 **@ 20°C** 66.0 **@ 100°C** 74.2
in ethanol solution:	
90%	2.0
100%	1.33
FUNCTION IN FOODS:	Preservative, antimocrobial agent, flavouring agent, adjuvant; antimycotic migrating from food packaging
TECHNOLOGY OF USE IN FOODS:	Usage level: 0.5% max.; 0.1% max. in food; 0.1% (in distilling materials). Most effective in acid foods. Effective versus yeasts and moulds, food-poisoning bacteria, spore-forming bacteria. Not effective against many spoilage bacteria. pK_a is 4.2, so should be used in foods with pH less than 4.2. Levels for general use: carbonated

beverages, 0.03–0.05%; non-carbonated beverages, 0.1%; beverage syrups, 0.1%; fruit drinks, 0.1%; fruit juices, 0.1%; purées and concentrates, 0.1%; cider, 0.05–0.1%; salted margarine, 0.1%; pie and pastry fillings, 0.1%; icings, 0.1%; soy sauce, 0.1%; mincemeat, 0.1%; salads, 0.1%; salad dressings, 0.1%; fruit salads, 0.1%; pickles, 0.1%; relishes, 0.1%; fruit cocktails, 0.1%; olives, 0.1%; sauerkraut, 0.1%; preserves, 0.1%; dried fruits, 0.1%; jams, 0.1%; jellies, 0.1%; fish, 0.15–0.35%; dipping solutions, 0.15–0.35%; ice glaze, 0.15–0.30%

SYNERGISTS: Sulphur dioxide; carbon dioxide; sodium chloride; sucrose; sorbates; thermal processing; refrigeration; boric acid

ANTAGONISTS: Lipids (partitioning); ferric salts; anionic surfactants

LEGISLATION:

USA:
GRAS/FS, <0.1%, Fruit Pres and Art Sw Fruit Jelly and Pres, 150.141, 150.161; <0.1%, Margarine,166.110; Conc. Orange Juice, 146.152, 146.154; GRAS, GMP 184.1733
FDA 21 CFR §150.141, 150.161, 166.110, 181.23, 184.1733

CANADA:
Permitted in selected foods to certain maximum levels of use

AUSTRALIA/PACIFIC RIM:
Australia: permitted in specified food types to maximum permitted levels
Japan: approved with limitations

UK and EUROPE:
Conditionally permitted

REFERENCES:

http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010.

www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010.

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O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

ANY OTHER RELEVANT INFORMATION:

Effect of pH on the dissociation of benzoic acid:

pH	*% Undissociated acid*
3	93.5
4	59.3
5	12.8
6	1.44
7	0.144
p*K*	4.19

NAME:	Sodium bisulphite
CATEGORY:	Antimicrobial preservative
FOOD USE:	Preservative. Not for use on meats, sources of vitamin B_1, raw fruits and vegetables, or fresh potatoes
SYNONYMS:	CAS 7631-90-5/EINECS 231-548-0/E222 sodium acid sulfite/Acid sodium sulfite/Sodium bisulfite (1 : 1)/ Sulfurous acid monosodium salt/Sodium hydrogen sulfite/Sodium sulfhydrate
FORMULA:	$NaHSO_3$ (commercially sodium bisulphite consists mainly of sodium metabisulphite $Na_2S_2O_5$ with sodium bisulphite)
MOLECULAR MASS IN Daltons:	104.06
ALTERNATIVE FORMS:	Sodium sulphite; sulphur dioxide; sodium metabisulphite; potassium metabisulphite; calcium sulphite; calcium bisulphite
PROPERTIES AND APPEARANCE:	White crystalline powder, SO_2 odour, disagreeable taste
MELTING RANGE IN °C:	315
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.48
PURITY %:	61.6 (as sulphur dioxide)
HEAVY METAL CONTENT MAXIMUM IN ppm:	10 (as Pb)
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 300 **@ 50°C** Very soluble **@ 100°C** Very soluble
FUNCTION IN FOODS:	Antimicrobial preservative, antioxidant and bleach
ALTERNATIVES:	Combination of antimicrobial preservative, antioxidant and bleach
TECHNOLOGY OF USE IN FOODS:	Multifunctional: an antimicrobial preservative, an antioxidant and a bleaching agent
SYNERGISTS:	Combination of antimicrobial preservative, antioxidant and bleach

ANTAGONISTS:

Sulphur dioxide is very reactive and binds to many substances in foods including oxygen, aldehydes, some ketones, sugars, carbonyls, thiamin, nucleotides, colours, anthocyanins

FOOD SAFETY ISSUES:

Normal humans are reasonably tolerant to ingested sulphites but some individuals are hypersensitive and may be subject to asthma attacks and even life-threatening anaphylaxis.

LEGISLATION:

USA:
GRAS, Not in meats or foods recognised as source of vitamin B1, etc. See REG 182.3739; GRAS, FS, Cnd Shrimp 161.173

UK and EUROPE:
Conditionally permitted

CANADA:
Permitted in selected foods to certain maximum levels of use

AUSTRALIA/PACIFIC RIM:
Permitted in specified food types to maximum permitted levels
Japan: approved (0.03–5 g/kg max. residual as sulphur dioxide)

REFERENCES:

http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010.

www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010.

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O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

NAME:	Sodium diacetate
CATEGORY:	Antimicrobial preservative
FOOD USE:	Bread/Meat, fish, poultry and their by-products
SYNONYMS:	Sodium hydrogen diacetate/INS No. 262(ii)/CAS: sodium acetate 127-09-3; acetic acid 64-19-7
FORMULA:	$C_4H_7NaO_4 \cdot xH_2O$
MOLECULAR MASS IN Daltons:	142.09 (anhydrous)
ALTERNATIVE FORMS:	Acetic acid
PROPERTIES AND APPEARANCE:	A molecular compound of sodium acetate and acetic acid. White hygroscopic crystalline solid with an acetic odour. Freely soluble in water
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	Not applicable
PURITY %:	98
WATER CONTENT MAXIMUM IN %:	Anhydrous form 2
HEAVY METAL CONTENT MAXIMUM IN ppm:	Pb 2
ARSENIC CONTENT MAXIMUM IN ppm:	None
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** Very soluble
in ethanol solution (100%):	Soluble
FUNCTION IN FOODS:	Anti-mould and anti-rope agent
ALTERNATIVES:	Acetic acid

TECHNOLOGY OF USE IN FOODS: Used in salt and vinegar flavour snacks, and instant soups, bakery products; flavours and seasonings, sauces, dips. Sodium diacetate (E262) provides a solid source of acetic acid for use in dry products. Sodium diacetate has some specific uses as a source of acetic acid, for example in bread production, where it is used to protect against ropiness and against some moulds. Sodium diacetate can be used as an antimycotic for feed, grains and food extending their shelf-life. Sodium diacetate can act as a buffer to maintain relatively constant pH. Sodium diacetate provides a solid source of acetic acid for use in dry products.

SYNERGISTS: Other organic acids

ANTAGONISTS: Bases

FOOD SAFETY ISSUES: Sodium diacetate has an odour and taste that limits its use in food.

LEGISLATION

USA:	**CANADA:**	**UK and EUROPE:**	**AUSTRALIA/NZ:**
MISC, GRAS, GMP 184.1754	Not permitted	GMP	Permitted in specified food types to maximum permitted levels

REFERENCES:

http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.

www.fao.org/ag/agn/jecfa-additives/specs/Monograph1/Additive-400.pdf. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010.

www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010.

Food Standards Australia New Zealand Act 1991 Food Standards Code Schedule 1 'Permitted uses of food additives by food type'. Available at: www.foodstandards.gov.au/_srcfiles/Standard_1_3_1_Additives_Part_2_v115.pdf. Accessed 4 May 2010.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

NAME:	Sodium metabisulphite
CATEGORY:	Antimicrobial preservative
FOOD USE:	Preservative/Antioxidant/Flavouring in cherries and shrimp/Boiler water additive for food contact/Bleaching agent. Not for use on meats, sources of vitamin B_1, raw fruits and vegetables, or fresh potatoes
SYNONYMS:	CAS 7681-57-4/EINECS 231-673-0/E223/Disulfurous acid disodium salt/Sodium pyrosulfite/Disodium pyrosulfite/Sodium bisulfite
FORMULA:	$Na_2S_2O_5$
MOLECULAR MASS IN Daltons:	190.10
ALTERNATIVE FORMS:	Sodium sulphite; sodium bisulphite; sulphur dioxid; potassium metabisulphite; calcium sulphite; calcium bisulphite
PROPERTIES AND APPEARANCE:	Colourless crystalline or white to yellowish powder, SO_2 odour
MELTING RANGE IN °C:	Decomposes >150
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.4
PURITY %:	67.4 as SO_2
HEAVY METAL CONTENT MAXIMUM IN ppm:	10 (as Pb)
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 54 **@ 100°C** 81.7
FUNCTION IN FOODS:	Antimicrobial preservative, antioxidant and bleach
ALTERNATIVES:	Combination of antimicrobial preservative, antioxidant and bleach
TECHNOLOGY OF USE IN FOODS:	Multifunctional: an antimicrobial preservative, an antioxidant and a bleaching agent

ANTAGONISTS:

Sulphur dioxide is very reactive and binds to many substances in foods including oxygen, aldehydes, some ketones, sugars, carbonyls, thiamin, nucleotides, colours, anthocyanins.

FOOD SAFETY ISSUES:

Normal humans are reasonably tolerant to ingested sulphites, but some individuals are hypersensitive and may be subject to asthma attacks and even life-threatening anaphylaxis.

LEGISLATION:

USA:
GRAS, GMP, Not in meats or foods recognised as a source of vitamin B_1, etc. See REG 182.3766; GRAS/FS, Fruit Jellies Part 150

UK and EUROPE:
Conditionally permitted

CANADA:
Permitted in selected foods to certain maximum levels of use

AUSTRALIA/PACIFIC RIM:
Permitted in specified food types to maximum permitted levels

Japan: approved (0.03–5 g/kg max. residual as sulphur dioxide)

REFERENCES:

http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010.

www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010.

Food Standards Australia New Zealand Act 1991 Food Standards Code Schedule 1 'Permitted uses of food additives by food type'. Available at: www.foodstandards.gov.au/_srcfiles/Standard_1_3_1_Additives_Part_2_v115.pdf. Accessed 4 May 2010.

O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

NAME:	Sodium nitrate
CATEGORY:	Antimicrobial preservative
SYNONYMS:	CAS 7631-99-4/EINECS 231-554-3/E251/Soda niter/Cubic niter/Chile saltpeter
FORMULA:	$NaNO_3$
MOLECULAR MASS IN Daltons:	84.99
PROPERTIES AND APPEARANCE:	Colourless transparent crystals, odourless
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	Decomposes at 380
MELTING RANGE IN °C:	308
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	2.267
PURITY %:	99
HEAVY METAL CONTENT MAXIMUM IN ppm:	10 as Pb
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 25°C** 92.1 **@ 100°C** 180
in ethanol solution:	
5%	Soluble
20%	Soluble
95%	Soluble
100%	Soluble
FUNCTION IN FOODS:	Antimicrobial agent, preservative. Source of nitrite, colour fixative in cured meats, fish, poultry; boiler water additive; curing salt

TECHNOLOGY OF USE IN FOODS:

Used in cured meats and fish as an anti-botulinum agent as well as an antimicrobial preservative, colour fixative, flavour enhancer

LEGISLATION:

USA:
PRES, REG, <500 ppm Alone or w/sodium nitrite as a preservative and colour fixative in smoked, cured salmon, shad, and sablefish, or in meat-curing preparations for home curing of meat and meat products (including poultry and wild game) 172.170; BC, REG, GMP, Boiler water additive 173.310; PS (by USDA) As a source of nitrite, w/or w/o sodium or potassium nitrite, in the production of cured red meats and poultry 181.33

CANADA:
Permitted in selected foods to certain maximum levels of use

AUSTRALIA/NZ:
Permitted in specified food types to maximum permitted levels

UK and EUROPE:
Conditionally permitted

REFERENCES:

http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010.

www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010.

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O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

NAME:	Sodium nitrite
CATEGORY:	Antimicrobial preservative
FOOD USE:	Cured meats/Meat products/Fish products
SYNONYMS:	Nitrous acid sodium salt/E250/CAS 7632-00-0/EINECS 231-555-9
FORMULA:	$NaNO_2$
MOLECULAR MASS IN Daltons:	69.00
ALTERNATIVE FORMS:	Potassium nitrite
PROPERTIES AND APPEARANCE:	White or slightly yellow hygroscopic granules rods or powder
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	Decomposes at 320
MELTING RANGE IN °C:	271
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	2.168
PURITY %	97
WATER CONTENT MAXIMUM IN %:	0.25
HEAVY METAL CONTENT MAXIMUM IN ppm:	0.002%, not more than 10 ppm Pb
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 15°C** 81.5 **@ 100°C** 163
in ethanol solution:	
20%	0.3
100%	3.0
FUNCTION IN FOODS:	Antimicrobial preservative; colour fixative; flavour enhancer

ALTERNATIVES: Multifunctional, so requires a blend of additives

TECHNOLOGY OF USE IN FOODS: Used in cured meats and fish as an anti-botulinum agent as well as an antimicrobial preservative, colour fixative; flavour enhancer

LEGISLATION:

USA:
PRES, PS, source of nitrite used in production of cured red meat and poultry products 181.34

CANADA:
Permitted in selected foods to certain maximum levels of use

UK and EUROPE:
Conditionally permitted

AUSTRALIA/NZ:
Permitted in specified food types to maximum permitted levels

REFERENCES:

http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.

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www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010.

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O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

NAME:	Sodium *o*-phenylphenate
CATEGORY:	Antimicrobial preservative
FOOD USE:	Fruit
SYNONYMS:	CAS 132-27-4/EINECS 205-055-6/E232/*o*-Phenylphenol sodium salt/Sodium *o*-phenylphenol/Sodium biphenyl-2-yl oxide/(1,1′-Biphenyl)-2-ol, sodium salt/Sodium *o*-phenylphenolate
FORMULA:	$C_6H_4(C_6H_5)ONa{\cdot}4H_2O$
MOLECULAR MASS IN Daltons:	192.20
PROPERTIES AND APPEARANCE:	White flakes
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 122
in propylene glycol:	**@ 20°C** 28
FUNCTION IN FOODS:	Preservative, antimicrobial, mould inhibitor for apples, etc.
TECHNOLOGY OF USE IN FOODS:	Surface application on fruit to prevent mould growth

LEGISLATION:	USA:	CANADA:	UK and EUROPE:	AUSTRALIA/PACIFIC RIM:
	Not permitted	Not permitted	Conditionally permitted	Japan: approved (0.01 g/kg residual)

REFERENCES:

http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.

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www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010.

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NAME:	Sodium propionate
CATEGORY:	Antimicrobial preservative
FOOD USE:	Baked products/Cheese products
SYNONYMS:	Methylacetic acid/Propanoic acid sodium salt/Ethylformic acid sodium salt/E281/CAS 137-40-6/EINECS 205-290-4
FORMULA:	C_2H_5COONa
MOLECULAR MASS IN Daltons:	96.07
ALTERNATIVE FORMS:	Other salts
PROPERTIES AND APPEARANCE:	Transparent crystals, granules. Deliquescent in moist air
MELTING RANGE IN °C:	287–289
PURITY %:	99
WATER CONTENT MAXIMUM IN %:	1
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
FUNCTION IN FOODS:	Antimicrobial preservative; antimycotic; flavouring agent; preservative additive; mould inhibitor
ALTERNATIVES:	Other antimicrobial preservatives, depending on the application
TECHNOLOGY OF USE IN FOODS:	1% (foods); limitation 0.32% (flour in white bread/rolls), 0.38% (whole wheat), 0.3% (cheese products)
ANTAGONISTS:	Calcium chloride
LEGISLATION:	**USA:** PRES, GRAS/FS, GMP, Cheeses and Rel Cheese Prods Part 133; Art Sw Fruit Jellies, Pres, and Jams 150.141, 150.161; Bakery Prods Part 136; MISC, GRAS, GMP 184.1784 **CANADA:** Permitted in selected foods to certain maximum levels of use

UK and EUROPE:
Conditionally permitted

AUSTRALIA/NZ:
Permitted in specified food types to maximum permitted levels

REFERENCES:

http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.

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www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010.

www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010.

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NAME:	Sodium sorbate
CATEGORY:	Antimicrobial preservative
FOOD USE:	Baked goods/Beverages/Bread, cake batters, cake fillings, cake toppings/Cheese, cottage cheese/Fish (smoked, salted)/Fruit juices (fresh), fruit (dried)/Margarine/Pickled products/Pie crusts, pie fillings/Salad dressings, salads (fresh)/Sausage/Seafood cocktails/Syrups/Wine
SYNONYMS:	Sodium hexadienoate/2,4-Hexadienoic acid sodium salt/Sorbic acid sodium salt/2-Propenylacrylic acid sodium salt/E201/CAS 7757-81-5/Hexadienic acid/(2-Butenylidene) acetic acid, sodium salt
FORMULA:	$CH_3CH{=}CHCH{=}CHCOOHNa$
MOLECULAR MASS IN Daltons:	134.12
ALTERNATIVE FORMS:	Sorbic acid (potassium and calcium salts)
PROPERTIES AND APPEARANCE:	White or fine crystalline powder, characteristic odour
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.36
PURITY %:	>98
WATER CONTENT MAXIMUM IN %:	1.0
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ARSENIC CONTENT MAXIMUM IN ppm:	3
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 58.2
in ethanol solution (100%):	6.5
FUNCTION IN FOODS:	Antimicrobial preservative: fungi (broad spectrum); bacteria (mostly strict aerobes). Not lactic acid bacteria Flavouring. Acidulant

ALTERNATIVES: Potassium sorbate; sorbic acid; calcium sorbate; benzoic acid; sodium benzoate; potassium benzoate; calcium benzoate; propionic acid; sodium propionate; potassium propionate; calcium propionate

TECHNOLOGY OF USE IN FOODS: The pK_a is 4.8, so sorbic acid and its salts would normally be used at pH less than 4.8. It can, however, be used at up to neutral pH, but the activity reduces as the pH increases. In wine, it should only be used in conjunction with sulphur dioxide, otherwise a characteristic off-odour may result.

SYNERGISTS: Sulphur dioxide; carbon dioxide; sodium chloride; sucrose; propionic acid; dehydration; nisin with polyphosphates; benzoates

ANTAGONISTS: Non-ionic surfactants

FOOD SAFETY ISSUES: This is not an additive which has been subject to great criticism over safety

LEGISLATION

USA:
GRAS if used in accordance with GMP, <0.3% by weight as sorbic acid, Cheeses and Rel Cheese Prods, alone or combined with potassium sorbate or sorbic acid, Part 133; 0.1% by weight, Fruit Butter, Art Sw Fruit Jelly, Pres, and Jams, 150.110, 150.141, 150.161; <0.2% in comb or <0.1%, Margarine, 160.110; GRAS Migr to food from paper and paperboard prods; 182.90 FDA 21 CFR § 133.118, 133.121, 133.123, 133.124, 133.169, 133.173, 133.179, 133.187, 133.188, 150.141, 150.161, 166.110, 182.3795, 182.90

CANADA:
Permitted in selected foods to certain maximum levels of use

UK and EUROPE:
Conditionally permitted

AUSTRALIA/PACIFIC RIM:
Australia: Permitted in specified food types to maximum permitted levels
Japan: approved with limitations

REFERENCES:

http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.
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www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010.
www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010.

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O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

NAME:	Sodium sulphite
CATEGORY:	Antimicrobial preservative
FOOD USE:	Food preservative and antioxidant/Boiler water additive. Not for use on meats, sources of vitamin B_1, raw fruits and vegetables, or fresh potatoes. Bleaching agent
SYNONYMS:	CAS 7757-83-7/EINECS 231-821-4/E221/Sulfurous acid sodium salt (1:2)/Sulfurous acid disodium salt/ Sodium sulfite (2 : 1)/Sodium sulfite anhydrous
FORMULA:	Na_2SO_3
MOLECULAR MASS IN Daltons:	126.04
ALTERNATIVE FORMS:	Sulphur dioxide; sodium bisulphite; sodium metabisulphite; potassium metabisulphite; calcium sulphite; calcium bisulphite
PROPERTIES AND APPEARANCE:	White powder or small hexagonal crystals, odourless, salty sulphurous taste
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	Decomposes
MELTING RANGE IN °C:	Decomposes
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	2.633 (15.4°C)
PURITY %:	95 (as Na_2SO_3) (or 48% SO_2)
HEAVY METAL CONTENT MAXIMUM IN ppm:	10 (as Pb)
ARSENIC CONTENT MAXIMUM IN ppm:	3
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 0°C** 12.54 **@ 40°C** 28 **@ 80°C** 28.3

FUNCTION IN FOODS: Antimicrobial preservative, antioxidant and bleach

ALTERNATIVES: Combination of antimicrobial preservative, antioxidant and bleach

TECHNOLOGY OF USE IN FOODS: Multifunctional: an antimicrobial preservative, an antioxidant and a bleaching agent

ANTAGONISTS: Sulphur dioxide is very reactive and binds to many substances in foods including oxygen, aldehydes, some ketones, sugars, carbonyls, thiamin, nucleotides, colours, anthocyanins

FOOD SAFETY ISSUES: Normal humans are reasonably tolerant to ingested sulphites, but some individuals are hypersensitive and may be subject to asthma attacks and even life-threatening anaphylaxis.

LEGISLATION:

USA:
GRAS, GMP, Not in meats or foods recognised as source of vitamin B_1, etc.
See REG 182.3798

UK and EUROPE:
Conditionally permitted

CANADA:
Permitted in selected foods to certain maximum levels of use

AUSTRALIA/PACIFIC RIM:
Permitted in specified food types to maximum permitted levels
Japan: approved (0.03–5 g/kg max. residual as sulphur dioxide)

REFERENCES:

http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.

www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010.

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O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

NAME:	Sorbic acid
CATEGORY:	Antimicrobial preservative
FOOD USE:	Baked goods/Beverages/Bread, cake batters, cake fillings, cake toppings/Cheese, cottage cheese/Fish (smoked, salted)/Fruit juices (fresh), fruit (dried)/Margarine/Pickled products/Pie crusts, pie fillings/Salad dressings, salads (fresh)/Sausage/Seafood cocktails/Syrups/Wine
SYNONYMS:	Hexadienoic acid/Sorbistat/2,4-Hexadienoic acid/2-Propenylacrylic acid/E200/CAS 110-44-1/22500-92-1/ EINECS 203-768-7/Hexadienic acid/(2-Butenylidene) acetic acid
FORMULA:	CH_3-CH=CHCH=CH-COOH
MOLECULAR MASS IN Daltons:	112.13
ALTERNATIVE FORMS:	Sodium, potassium, calcium salts
PROPERTIES AND APPEARANCE:	White or off-white powder, characteristic odour
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	At 760 mmHg decomposes at 228°C, at 50 mmHg = 143°C, at 10 mmHg = 119°C
MELTING RANGE IN °C:	134.5 (range 132–135)
FLASH POINT IN °C:	127
IONISATION CONSTANT AT 25°C:	1.73×10^{-5}
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.36
HEAT OF COMBUSTION AT 25°C IN J/kg:	27718 kJ/kg
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	**@ 20°C** <0.01 **@ 120°C** 10 **@ 140°C** 43

PURITY %:	>99 (anhydrous basis)
WATER CONTENT MAXIMUM IN %:	0.5
HEAVY METAL CONTENT MAXIMUM IN ppm:	10 (as Pb)
ARSENIC CONTENT MAXIMUM IN ppm:	3
ASH MAXIMUM IN %:	0.2
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 0.15 (pH 3.1) 0.22 (pH 4.4) 1.02 (pH 5.9) **@ 30°C** 0.25 **@ 50°C** 0.55 **@ 100°C** 4.00
in vegetable oil:	**@ 20°C** 0.80 **@ 50°C** 2.00
in sucrose solution:	
10%	0.15
40%	0.10
60%	0.08
in sodium chloride solution:	
5%	0.11
10%	0.07
15%	0.04
in ethanol solution:	
5%	0.16
20%	0.29
95%	12.6–14.5
100%	12.9–14.8
in propylene glycol:	**@ 20°C** 5.5
in glacial acetic acid:	11.5

FUNCTION IN FOODS: Antimicrobial preservative: fungi (broad spectrum); bacteria (mostly strict aerobes). Not lactic acid bacteria. Flavouring. Acidulant

ALTERNATIVES: Sodium sorbate; potassium sorbate; calcium sorbate; benzoic acid; sodium benzoate; potassium benzoate; calcium benzoate; propionic acid; sodium propionate; potassium propionate; calcium propionate

TECHNOLOGY OF USE IN FOODS: The pK_a is 4.8, so sorbic acid and its salts would normally be used at pH less than 4.8. It can, however, be used at up to neutral pH, but the activity reduces as the pH increases. In wine, it should only be used in conjunction with sulphur dioxide, otherwise a characteristic off-odour may result.

SYNERGISTS: Sulphur dioxide; carbon dioxide; sodium chloride; sucrose; propionic acid; dehydration; nisin with polyphosphates; benzoates

ANTAGONISTS: Non-ionic surfactants

FOOD SAFETY ISSUES: This is not an additive which has been subject to great criticism over safety

LEGISLATION:

USA:
GRAS if used in accordance with GMP, <0.2%, Cheeses and Cheese Rel Prods, Part 133; PRES, GRAS/FS, <0.3% by weight as sorbic acid, alone or comb with potassium or sodium sorbate, Cheeses and Rel Cheese Prods, Part 133; <0.1% Art Sw Fruit Jellies, Pres, and Jams, 150.141, 150.161; <0.2% by wt Concentrated Orange Juice, 146.154; <0.1% alone or <0.2% in comb with other preservatives, Margarine, 166.110; GRAS, GMP 182.3089 FDA 21CFR § 133.118, 133.123, 133.124, 133.169, 133.173, 133.179, 133.187, 133.188, 150.141, 150.161, 166.110, 172.872, 177.2260, 181.23, 182.3089

CANADA:
Permitted in selected foods to certain maximum levels of use

UK and EUROPE:
Conditionally permitted

AUSTRALIA/PACIFIC RIM:
Australia: Permitted in specified food types to maximum permitted levels
Japan: approved with limitations

REFERENCES:

http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.
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NAME:	Sulphur dioxide
CATEGORY:	Antimicrobial preservative
FOOD USE:	Bleaching agent/Antimicrobial/Preservative/Dough modifier/Vitamin C stabiliser. Not for use in meats, sources of vitamin B_1, raw fruits and vegetables, or fresh potatoes
SYNONYMS:	Sulphurous oxide/Sulphurous anhydride/CAS 7446-09-5/EINECS 231-195-2/E220
FORMULA:	SO_2
MOLECULAR MASS IN Daltons:	64.06
ALTERNATIVE FORMS:	Sodium sulphite; sodium bisulphite; sodium metabisulphite; potassium metabisulphite; calcium sulphite; calcium bisulphite
PROPERTIES AND APPEARANCE:	Colourless gas condenses at −10°C to colourless liquid
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	−10
MELTING RANGE IN °C:	−72
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.5 (liquid), 2.26 (vapour)
PURITY %:	>99 (by weight)
WATER CONTENT MAXIMUM IN %:	0.05
HEAVY METAL CONTENT MAXIMUM IN ppm:	30 (as Pb)
ARSENIC CONTENT MAXIMUM IN ppm:	3
ASH MAXIMUM IN %:	0.05

SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:

in water:	**@ 20°C** 11
in ethanol solution (100%):	25

FUNCTION IN FOODS: Bleaching agent, antimicrobial preservative, dough modifier

ALTERNATIVES: Multifunctional, so need a blend of additives to provide each of the functions

TECHNOLOGY OF USE IN FOODS: Multifunctional: an antimicrobial preservative, an antioxidant and a bleaching agent

ANTAGONISTS: Sulphur dioxide is very reactive and binds to many substances in foods including oxygen, aldehydes, some ketones, sugars, carbonyls, thiamin, nucleotides, colours, anthocyanins

FOOD SAFETY ISSUES: Normal humans are reasonably tolerant to ingested sulphites, but some individuals are hypersensitive and may be subject to asthma attacks and even life-threatening anaphylaxis.

LEGISLATION:

USA:
GRAS/FS, Not in meats or in foods recognised as a source of vitamin B_1, etc.
(See REG) 182.3862; BL, REG, <0.05%
Food starch modifier 172.892; FUNG, REG, 10.0 ppm as residues in/on grapes 40 CFR 180.444
FDA 21 CFR 172.892, 182.3862, 73.170

CANADA:
Permitted in specified foods

AUSTRALIA/PACIFIC RIM:
Japan: approved 0.03–5 g/kg

UK and EUROPE:
Permitted in specified foods

REFERENCES:

http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010.

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O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

NAME:	Thiabendazole
CATEGORY:	Antimicrobial preservative
FOOD USE:	Citrus, banana fruit
SYNONYMS:	CAS 148-79-8/E233/Thiaben/2-(Thiazol-4-yl) benzimidazole/2-(4-Thiazolyl)-1*H*-benzimidazole/4-(2-benzimidazolyl)thiazole/MK-360/Omnizole/Thibenzole/Bovizole/Eprofil/Equizole/Mintezol/Top Form Wormer/Mertect/Lombristop/Minzolum/Nemapan/Polival/TBZ/Tecto
FORMULA:	$C_{10}H_7N_3S$
MOLECULAR MASS IN Daltons:	201.25
PROPERTIES AND APPEARANCE:	Colourless crystals
MELTING RANGE IN °C:	300 (sublimes)
FUNCTION IN FOODS:	Anthelmintic, fungicide
TECHNOLOGY OF USE IN FOODS:	Citrus surface application (3 ppm); banana surface application (1 ppm)
LEGISLATION:	**USA:** FEED/VET, REG, 0.1 ppm neg residue, Residue in edible tissues of cattle, goats, sheep and swine 556.730; 0.05 ppm neg residue, Residue in milk 556.730; Use: As dosage forms/block 520.2380; As feed for cattle, goats, sheep, swine and pheasants 558.615; FUNG, REG, Tolerances for Residues 40 CFR 180.242 **CANADA:** Permitted in selected foods to certain maximum levels **UK and EUROPE:** Conditionally permitted **AUSTRALIA/NZ:** Not permitted
REFERENCES:	http://laws.justice.gc.ca/PDF/Regulation/C/C.R.C.,_c._870.pdf. Canada Food and Drugs Regulations C.R.C., c. 870 current to April 21, 2010. Accessed 4 May 2010. www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. US Food and Drug Administration Listing of Food Additive Status Part I. Accessed 4 May 2010. www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/ucm191033.htm. US Food and Drug Administration Listing of Food Additive Status Part II. Accessed 4 May 2010.

www.opsi.gov.uk/si/si1995/Uksi_19953187_en_4.htm. Statutory Instrument 1995 No. 3187, Miscellaneous Food Additives Regulations 1995. Accessed 4 May 2010.
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Part 12

Sequestrants

Stephanie Moriartey

This Part is based upon the First Edition contribution of Jean Chaw-Kant

Food Additives Data Book, Second Edition. Edited by Jim Smith and Lily Hong-Shum.

NAME:	Calcium acetate
CATEGORY:	Sequestrant
FOOD USE:	Edible caseinates/Instant puddings/Sweet sauces/Baked goods/Gelatins/Syrups/Cake mixes/Fillings/Toppings
SYNONYMS:	Brown acetate of lime/Lime acetate/Sorbocalcion/Vinegar salts/Gray acetate of lime/INS 263/E263/FEMA 2228/EINECS/ELINCS 200-540-9
FORMULA:	$C_4H_6CaO_4$ or $C_4H_6CaO_4 \cdot H_2O$
MOLECULAR MASS IN Daltons:	158.18 anhydrous or 176.17 monohydrate
ALTERNATIVES FORMS:	Calcium diacetate
PROPERTIES AND APPEARANCE:	White hygroscopic bulky crystalline solid with slight bitter taste Monohydrates: needles, granules or powder
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	160, decomposes to acetone and $CaCO_3$
MELTING RANGE IN °C:	160
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.5
PURITY %:	98–99
WATER CONTENT MAXIMUM IN %:	7–11
HEAVY METAL CONTENT MAXIMUM IN ppm:	25–30
ARSENIC CONTENT MAXIMUM IN ppm:	3

SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:

in water: **@ 20°C** Slightly soluble in water

in ethanol solution (5%): Insoluble in ethanol

FUNCTION IN FOODS: Corrosion inhibitor in metal containers. Medically, as a source of calcium. Used in the manufacture of acetic acid and acetone; also used as an emulsifier and firming agent. Functions as a mould-control agent

ALTERNATIVES: Sodium acetate; potassium acetate; sodium diacetate

TECHNOLOGY OF USE IN FOODS: pH 6.9 in a 1 in 10 solution. Store in well-closed containers. Avoid excessive heat, sparks or open flame >160°C

FOOD SAFETY ISSUES: Low oral toxicity

LEGISLATION:

USA:
FDA generally recognised as safe (GRAS) if used in accordance with GMP: 0.2% in baked goods; 0.2% in gelatins/puddings and fillings; 0.15% in sweet sauces, toppings and syrups; 1 ppm in beverages

UK and EUROPE:
Authorised without limitation

CANADA:
GMP in alcoholic beverages

AUSTRALIA/PACIFIC RIM:
Japan: GMP

NAME:	Calcium chloride
CATEGORY:	Sequestrant
FOOD USE:	Sliced apples/Canned fruit/Coffee and tea/Apple pie mix/Canned milks/Processed fruit/Jams and jellies/Milk powders/Fruit juice/Canned tomatoes and vegetables/Baked goods/Cheeses/Beverages
SYNONYMS:	Superflake anhydrous/Peladow/Dowflake/INS 509/Snomelt/Calpus/Caltac/E509/Liquidow/EINECS/ELINCS **233-140-8/**Calcium Chloride anhydrous
FORMULA:	Anhydrous: $CaCl_2$
MOLECULAR MASS IN Daltons:	110.99 (dihydrate 147.01; hexahydrate 219.08)
ALTERNATIVE FORMS:	Dihydrate/Hexahydrate
PROPERTIES AND APPEARANCE:	Anhydrous: white or greyish white deliquescent lumps Dihydrate: white hard deliquescent fragments Hexahydrate: colourless, very deliquescent crystals
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	>1600; hexahydrate decomposes at 200
MELTING RANGE IN °C:	Anhydrous 772; dihydrate 176; hexahydrate 30
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	Anhydrous 2.16; dihydrate 1.83; hexahydrate 1.68
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	15 mmHg at 25°C (30% calcium chloride solution)
PURITY %:	Anhydrous >93; dihydrate 99; hexahydrate 98
HEAVY METAL CONTENT MAXIMUM IN ppm:	20–40
ARSENIC CONTENT MAXIMUM IN ppm:	3

SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:

in water: **@ 20°C** 74.5 g/100 mL
Freely dissolves in water and alcohol

FUNCTION IN FOODS: General-purpose food additive. Used as a firming agent in canned fruit and vegetables. In evaporated milk: adjust salt balance to prevent clotting. Flavour protectant in pickles. Gelling enhancer

TECHNOLOGY OF USE IN FOODS: Store in airtight containers to avoid moisture

SYNERGISTS: Calcium gluconate/calcium lactate/disodium EDTA

ANTAGONISTS: Methyl vinyl ether/strong acids

LEGISLATION:

USA:
FDA GRAS if used in accordance with GMP
Miscellaneous general-purpose food additive: 0.3% in baked goods; in evaporated milk up to 0.1% by weight of finished product; in canned vegetables up to 260–360 ppm; 0.22% in non-alcoholic beverages; 0.2% in cheese and processed fruits/fruit juice; 0.32% in coffee/tea; 0.2% in gravies

UK and EUROPE:
GMP. 2000 ppm in canned milk products/creams
Denmark: 5000 ppm in canned milk products

CANADA:
260 ppm in deep-frozen apples, 350 ppm canned grapefruit, $\leq$0.2% in dairy

AUSTRALIA/PACIFIC RIM:
Japan: 2% as calcium as dietary supplement

NAME:	Calcium citrate
CATEGORY:	Sequestrant
FOOD USE:	Confections/Flour/Milk powders/Jams and jellies/Canned vegetables/Processed cheese/Saccharin/Evaporated milk/Cream/Condensed milk/Edible ices/Frozen apples
SYNONYMS:	Tricalcium citrate/Tricalcium salt of 2-hydroxy-1,2,3 propanetricarboxylic acid/INS 333/E333
FORMULA:	$Ca_3(C_6H_5O_7)_2 \cdot 4H_2O$
MOLECULAR MASS IN Daltons:	498.44–570.5
PROPERTIES AND APPEARANCE:	Fine white powder; odourless
MELTING RANGE IN °C:	120
PURITY %:	97.5
WATER CONTENT MAXIMUM IN %:	10–14
HEAVY METAL CONTENT MAXIMUM IN ppm:	20
ARSENIC CONTENT MAXIMUM IN ppm:	3
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 85 g/100 mL
in ethanol solution (5%):	Insoluble in ethanol
FUNCTION IN FOODS:	Used in the production of citric acid and other citrates. Used to improve baking properties of flours. Soluble in fats: good stabiliser
TECHNOLOGY OF USE IN FOODS:	Store in well-closed containers. When heated to decomposition, emits acrid smoke and irritating fumes

FOOD SAFETY ISSUES:

Citrates may interfere with laboratory tests, including those measuring pancreatic function, liver function and blood alkalinity–acidity. Citrate esters showed no adverse effects on rats in a 2-year feeding study. Poses no hazard to consumers

LEGISLATION:

USA:
FDA GRAS with no limitations if used in accordance with GMP

CANADA:
260 ppm in deep-frozen apples (sliced or not sliced), tomatoes and canned vegetables, unstandardised foods in accordance with GMP

UK and EUROPE:
Authorised without limitation
Finland: 2000 ppm in frozen fruit

AUSTRALIA/PACIFIC RIM:
Japan: GMP

REFERENCES:

Ash, M. and Ash, I. (2008) *Handbook of Food Additives*. Synapse Information Resources Inc., New York.

NAME:	Calcium disodium ethylenediaminetetraacetate
CATEGORY:	Sequestrant
FOOD USE:	Salad dressings/Fats and oils/Canned legumes/Sauces/Nut meat and roasted nuts/Prepeeled potatoes/Spreads/Fried and baked goods/Soft drinks/Cheeses/Fruit juices/Canned seafood/Vinegar and cider/Milks/Beer and wine/Margarine/Canned mushrooms/Oleomargarine
SYNONYMS:	Calcium disodium EDTA/Calcium disodium edetate/Calcium disodium(ethylene-dinitrilo)-tetraacetate/*N*,*N*′, 1,2-ethanedi(*bis*[*N*-(carboxymethyl)-glycinate (4)- *N*,*N*′,*O*,*O*′,*ON*,*ON*] calciate (2) disodium/INS 385/E385
FORMULA:	$C_{10}H_{12}CaN_2Na_2O_8{\cdot}2H_2O$
MOLECULAR MASS IN Daltons:	374.28–410.31
PROPERTIES AND APPEARANCE:	White odourless, crystalline granules or white powder
PURITY %:	97
WATER CONTENT MAXIMUM IN %:	13
HEAVY METAL CONTENT MAXIMUM IN ppm:	20
ARSENIC CONTENT MAXIMUM IN ppm:	3
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 80 g/100 mL water
FUNCTION IN FOODS:	Stabilises fats and oils. As a preservative, extends shelf-life of salad oils dressing, spreads Prevents rancid odour in fried and baked products. Retention of colour/flavour in meat. Stabilisation of vitamins in aqueous systems. Promotes texture retention in cucumbers. Decreases poor flavour in milk
ALTERNATIVES:	Citrates; pyrophosphates; antioxidants; phosphates; disodium EDTA

TECHNOLOGY OF USE IN FOODS:	pH 6.5–7.5 (1 in 100 solution). Store in well-closed containers. Does not contribute any flavours. Effectiveness as stabilisers increases with decreasing pH (<3.6). Prevents moulds on peeled potatoes; decreases astringent taste in beer and prevents 'chill haze'. Also decreases turbidity in wine, vinegar and cider	
SYNERGISTS:	BHT, BHA, nordihydroguaiaretic acid (NDGA)/propyl gallate (e.g. antioxidants)/citrates, phosphates, tocopherols, ascorbates	
FOOD SAFETY ISSUES:	Used medically as a chelating agent to detoxify poisoning by lead and other heavy metals. May cause intestinal upset, muscle cramps; also kidney damage, blood in urine	
LEGISLATION:	**USA:** 25 ppm fermented malt beverages; 60 ppm spice extracts in soluble carriers, 100 ppm pecan pie filling; 340 ppm in clams (cooked/canned); 800 ppm dry pinto beans; beverages; 75 ppm in standardised dressings; 200 ppm crabmeat (cooked/canned); 250 ppm shrimp (cooked/canned); 33 ppm in soft drinks; 110 ppm in pickled cucumbers or cabbage; 100 ppm in artificially coloured lemon or orange-flavoured spreads; 100 ppm in potato salad; 75 ppm French dressings, mayo, and salad dressings, non-standardised dressings and sauces; 100 ppm sandwich spread; 200 ppm by wt egg yolk portion in egg product that is hard-cooked and consists in a cylindrical shape of egg white with an inner core of yolk; 25 ppm in distilled alcoholic bev; 75 ppm oleomargarine; 365 ppm legume (all cooked, canned, other than dried lima beans, pink beans and red beans)	**CANADA:** Up to 25 ppm in ale, beer, malt liquor, porter, stout; 75 ppm max. in dressings, mayo, and sauces; 100 ppm max. in potato salad, unstandardised sandwich spreads; 250 ppm max in canned shrimp or tuna; 275 ppm max. in canned crabmeat, lobster or salmon; 75 ppm max. n margarine; 340 ppm max in canned clams; 130 ppm max. in canned ripe lima beans and canned pinto beans; 300 ppm in canned snails and canned sea snails; 365 ppm max. in canned fava beans, 33 ppm max. in soft drinks and ready to drink teas; 100 ppm max. in pasteurised sous-vide potatoes

NAME:	Calcium gluconate
CATEGORY:	Sequestrant
FOOD USE:	Pickled cucumbers/Cured meats/Sugar substitute/Coffee powders/Gelatin and puddings/Dairy product analogues/Canned fruit and vegetables/Baked goods/Jams and jellies
SYNONYMS:	D-Gluconic acid calcium salt/Calciofon/Caglucon/Calcium di-gluconate/Calcium di-D-gluconate monohydrate/INS 578/E578
FORMULA:	$Ca(C_6H_{11}O_7)_2 \cdot H_2O$
MOLECULAR MASS IN Daltons:	430.38–448.39
PROPERTIES AND APPEARANCE:	White crystalline granules
MELTING RANGE IN °C:	120, loses H_2O
PURITY %:	98
WATER CONTENT MAXIMUM IN %:	3
HEAVY METAL CONTENT MAXIMUM IN ppm:	10–20
ARSENIC CONTENT MAXIMUM IN ppm:	3
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 3.3
FUNCTION IN FOODS:	Used in fruits and vegetables as a firming agent
TECHNOLOGY OF USE IN FOODS:	Store in well-closed containers. pH 6–7 aqueous solution
FOOD SAFETY ISSUES:	May cause gastrointestinal and cardiac disturbances

LEGISLATION:

USA:
FDA GRAS in accordance with GMP
Used at 1.75% in baked goods; 0.4% in dairy analogues; 4.5% in gelatins and puddings; 0.01% in sugar substitutes

CANADA:
Unstandardised foods in accordance with GMP

UK and EUROPE:
GMP in canned fruit and vegetables

AUSTRALIA/PACIFIC RIM:
Japan: 1% as calcium in cured meat products

NAME:	Calcium phosphate monobasic
CATEGORY:	Sequestrant
FOOD USE:	Ice cream/Ice milk mix/Sherbert/Dough conditioner/leavening agent/Firming agent/Supplement/Yeast foods
SYNONYMS:	Calcium phosphate monobasic anhydrous/Acid calcium phosphate/Monocalcium orthophosphate/Phosphoric acid calcium salt (2:1)/Calcium biphosphate/Calcium dihydrogen phosphate/EINECS/ELINCS 231-837-1/ Monocalcium phosphate
FORMULA:	$Ca(H_2PO_4)_2$
MOLECULAR MASS IN Daltons:	234.05
PROPERTIES AND APPEARANCE:	White powder
DECOMPOSITION:	$>200°C$
DENSITY AT 16°C IN kg/L	2.22
PURITY %:	≥ 95
HEAVY METAL CONTENT MAXIMUM	$<0.003\%$
ARSENIC CONTENT MAXIMUM IN ppm:	3
FLUORIDE:	$\leq 0.0025\%$
FUNCTION IN FOODS:	Slightly soluble in water, insoluble in alcohol, strong acidic taste
FOOD SAFETY ISSUES:	Avoid contact with eyes and respiratory tract as it may cause irritation. Store in a tightly closed container in a cool, dry ventilated area

LEGISLATION:	USA:	CANADA:	AUSTRALIA/PACIFIC RIM:
	FDA, GRAS used in accordance with GMP	GRAS used in accordance with GMP	Japan: approved

REFERENCES:

Ash, M. and Ash, I. (2008) *Handbook of Food Additives*. Synapse Information Resources Inc., New York.
National Academy of Sciences (1981) *Food Chemicals Codex*, 3rd edn. National Academy Press, Washington, DC.

NAME:	Calcium phosphate tribasic		
CATEGORY:	Sequestrant		
FOOD USE:	Ice cream/Ice milk mix		
SYNONYMS:	Calcium orthophosphate/Calcium phosphate tertiary/Phosphoric acid calcium salt (2:3)/Tertiary calcium phosphate/Tricalcium phosphate/EINECS/ELINCS 231-840-8		
FORMULA:	$Ca_3(PO_4)_2$		
MOLECULAR MASS IN Daltons:	310.18		
PROPERTIES AND APPEARANCE:	White crystalline powder, odourless, tasteless		
MELTING POINT IN °C:	1670		
DENSITY AT 25°C:	3.18		
PURITY %:	$\geq$95		
FUNCTION IN FOODS:	Very low solubility in water and alcohol, leavening agent, texturiser, yeast food, dough conditioner, mineral supplement, water retention agent in foods, soluble in dilute HCl or HNO_3		
FOOD SAFETY ISSUES:	Incompatible with strong oxidising agents; avoid contact with eyes, skin and respiratory tract (may cause irritation). Hazardous decomposition products: phosphine, PO_x, calcium oxide; may emit toxic fumes under fire conditions. Store in a tightly closed container at room temperature in a dry area		
LEGISLATION:	**USA:** FDA, GRAS used in accordance with GMP	**CANADA:** GMP	**AUSTRALIA/PACIFIC RIM:** Japan: approved (1% max. calcium)
REFERENCE:	Ash, M. and Ash, I. (2008) *Handbook of Food Additives*. Synapse Information Resources Inc., New York.		

NAME:	Calcium phytate
CATEGORY:	Sequestrant
FOOD USE:	Wine/Vinegar/Glazed fruit/Calcium source for nutrition
SYNONYMS:	Hexacalcium phytate/Phytocalcium
FORMULA:	$C_6H_6(CaPO_4)_6$
MOLECULAR MASS IN Daltons:	888.42
PROPERTIES AND APPEARANCE:	White powder
BOILING/MELTING POINT:	Not available
PURITY %:	$\geq$96
HEAVY METAL CONTENT MAXIMUM IN ppm:	10–20
ARSENIC CONTENT MAXIMUM IN ppm:	3
FUNCTION IN FOODS:	Removes excess metals in wine and vinegar products, slightly soluble in water, source of calcium
FOOD SAFETY ISSUES:	Reactive with oxidising agents; avoid contact with eyes, skin and respiratory tract (may cause irritation). Store in a tightly closed container at room temperature in a dry area
LEGISLATION:	**USA:** FDA, GRAS used in accordance with GMP **CANADA:** GMP
REFERENCES:	Ash, M. and Ash, I. (2008) *Handbook of Food Additives*. Synapse Information Resources Inc., New York.

NAME:	Calcium sulphate
CATEGORY:	Sequestrant
FOOD USE:	Yeast food/Brewing, sherry and wine/Artificially sweetened fruit/Cottage cheese/Bread (rolls and buns)/Jelly/Canned tomatoes/Cheese/Cereal flours/Canned potatoes/Canned sweet peppers/Soft ice-cream/Frozen apples/Confections/Puddings
SYNONYMS:	INS 516/E516
FORMULA:	$CaSO_4$
MOLECULAR MASS IN Daltons:	136.14
ALTERNATIVE FORMS:	Calcium sulphate dihydrate
PROPERTIES AND APPEARANCE:	Crystals are orthorhombic, yellow to white powder
BOILING POINT AT VARIOUS PRESSURES (INCLUDING 760 mm Hg):	N/A
MELTING RANGE IN °C:	>120
FLASH POINT IN °C:	Non-flammable
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	2.964
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg	Unknown
PURITY %:	98
WATER CONTENT MAXIMUM IN %:	<1.5: dihydrate 19–23
HEAVY METAL CONTENT MAXIMUM IN ppm:	10–20

ARSENIC CONTENT MAXIMUM IN ppm:	3
FUNCTION IN FOODS:	Used as a carrier in bleaching, bleaching agent in flour. Used in cottage cheese as an alkali. Used as a firming agent in canned vegetables. Used as a dough conditioner/strengthener in breadmaking, and as a calcium source for reaction with alginates to form dessert gels. Also used as a nutritional supplement
TECHNOLOGY OF USE IN FOODS:	Store in well-closed containers. Reacts violently with aluminium when heated. Mixtures with phosphorus ignite at high temperatures. When heated to decomposition, it emits toxic fumes of SO_x
SYNERGISTS:	Alginates/ammonium chloride/benzoyl peroxide/dicalcium phosphate
LEGISLATION:	**USA:** FDA GRAS if used in accordance with GMP Used in cottage cheese (5 g/kg); canned tomatoes (800 mg/kg); in specific vegetables GMP up to 700 ppm. Also used in bakery products (0.25% w/w flour), in confections and frostings (3%), 1.3% in baked goods, in preserved seafood (up to 700 ppm) and 0.35% in processed vegetables. Used in canned milks and chocolate drinks (up to 700 ppm) and in beverages (700 ppm) **UK and EUROPE:** Authorised without limitation **CANADA:** GMP in alcoholic beverages Used in deep-frozen apples, tomatoes, canned vegetables (260 ppm) and dairy desserts (5000 ppm) **AUSTRALIA/PACIFIC RIM:** Japan: GMP

NAME:	Citric acid
CATEGORY:	Sequestrant
FOOD USE:	Fruit juice drinks and beverages/Frozen dairy products/Preserves/Wines and cider/Evaporated milks/Curing meats/Jams and jellies/Cheese and cheese spreads/Pie fillings/Jelly candies/Sherbet and ice-cream/Canned apples/Canned fruit/Confections/Canned sardines/Carbonated beverages/Canned figs/Canned crab and shrimp/Frozen fruit and dried fruit/Mayonnaise/Cocoa powder/Canned vegetables/Salad dressing/Table olives/Fats and oils/Canned chilli/Instant potatoes/Pickled cucumbers/Bouillons and consommés/Canned baby food/Infant formula/Cereal-based foods for infants
SYNONYMS:	Citric acid anhydrous/2-Hydroxy-1,2,3 propane tricarboxylic acid/Citric acid monohydrate/β-hydroxytricarballytic acid/Citro/INS 330/E330
FORMULA:	$C_6H_8O_7$
MOLECULAR MASS IN Daltons:	192.12
ALTERNATIVE FORMS:	Ammonium citrate/Isopropyl citrate/Stearyl citrate/Calcium citrate/Potassium citrate/Sodium citrate/Triethyl citrate
PROPERTIES AND APPEARANCE:	White or colourless crystalline solid; strongly acid taste
MELTING RANGE IN °C:	153
FLASH POINT IN °C:	100
IONISATION CONSTANT AT 25°C:	$K_1 = 8.2 \times 10^{-4}$, $K_2 = 1.8 \times 10^{-5}$, $K_3 = 3.9 \times 10^{-6}$
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L	1.665
HEAT OF COMBUSTION AT 25°C:	474.5 kcal/mole
PURITY %:	99.5
WATER CONTENT MAXIMUM IN %:	0.5
HEAVY METAL CONTENT MAXIMUM IN ppm:	10

ARSENIC CONTENT MAXIMUM IN ppm:	3
ASH MAXIMUM IN %:	0.05
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 60% w/w; very soluble **@ 50°C** 70% **@ 100°C** 84%
in ethanol solution:	
5%	Freely soluble
95%	**@** 22°C >100 mg/mL
FUNCTION IN FOODS:	Collects and deactivates metal contaminants, increases the effect of preservatives. Used to maintain freshness and prevent rancidity. Soluble in fats: good stabilisers. Also used as a sequestrant to adjust acid–alkali balance. Mixed with erythorbic acid to prevent browning. 1% solution used in the canning of crabmeat. Used to decrease turbidity in wines, ciders, vinegars. Mixed with ascorbic acid in seafood dip to prevent discoloration. Prevents colour and flavour changes in canned fruit and vegetables and fish
ALTERNATIVES:	L-Tartaric acid; phosphoric acid; EDTA; acetic acid
TECHNOLOGY OF USE IN FOODS:	Dissolve to makes solution first, e.g. 1% solutions to prevent black spot formation in seafood The dilute aqueous solution may ferment on standing Combustible liquid; potentially explosive reaction to metal nitrates
SYNERGISTS:	With amino acids: serves to increase water retention of products With erythorbic acid: retards browning of bananas With gelatin, salt, vitamin C, glucose, carageenates With antioxidants: inhibits rancidity of foods containing fats and oils
ANTAGONISTS:	Potassium tartrate/alkali and alkaline earth carbonates and bicarbonates/acetates and sulphides/strong bases
FOOD SAFETY ISSUES:	Very low levels of toxicity. Digested and metabolised normally by the body. Citrates are normal constituents of many foods; they are present in far higher amounts in the body than amounts added to processed foods. May cause severe eye and moderate skin irritation

LEGISLATION:

USA:
FDA GRAS with no limitations if used in accordance with GMP
Citric acid: single or mixed with antioxidants (100 ppm)
Meat Inspection Division: 0.01% in shortening/lard; 0.01% in fats and oils; 0.003% in dry sausage/dried meat

CANADA:
Citric acid: GMP, frozen fish (0.1%)
Stearyl citrate: margarine
0.01% of the fat content

UK and EUROPE:
Authorised without limitation, GMP
Finland: 1000 ppm quick-frozen fruit
3 g/L in fruit juices

AUSTRALIA/PACIFIC RIM:
Japan: GMP

REFERENCES:

Bouchard, E.F. and Merrit, E.G. (1979) *Kirk-Othmer Encyclopedia of Chemical Toxicology*, Vol. 6. John Wiley & Sons, New York, pp. 150–179.
Food and Drugs Act (2009) Food and Drug Regulations. Accessed at http://laws.justice.gc.ca/en/showdoc/cr/C.R.C.-c.870/bo-ga:l_B-gb:l_16/20090831/en#anchorbo-ga:l_B-gb:l_16.

NAME:	Disodium ethylenediaminetetraacetate (disodium EDTA)
CATEGORY:	Sequestrant
FOOD USE:	Lard/Canned legumes/Creamed turkey/Fats and oils/Potatoes and French fries/Dried banana/Fruit juices/Canned seafood/Cereal/Ham/Bacon/Frankfurters/Milks/Strawberry pie filling/Canned corn/Egg custards/Mayonnaise/Canned apples/Cheese/Frozen ground beef/Processed vegetables and fruit
SYNONYMS:	Edate disodium/*N*,*N*′-1,2-ethanediyl-*bis*[*N*(carboxymethyl)glycine]disodium salt/EDTA disodium salt/Disodium hydrogen EDTA/Ethylenedinitrolo-tetraacetic acid disodium salt/INS 386
FORMULA:	$C_{10}H_{14}N_2Na_2O_8$
MOLECULAR MASS IN Daltons:	336.21–372.24
ALTERNATIVE FORMS:	Sodium EDTA
PROPERTIES AND APPEARANCE:	White dihydrate crystals
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	Decomposes at 250
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	Negligible
PURITY %:	99
HEAVY METAL CONTENT MAXIMUM IN ppm:	20
ARSENIC CONTENT MAXIMUM IN ppm:	3
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 10 g/100 mL water

FUNCTION IN FOODS:	Stabilises lard and also vitamins in food systems. Prevents undesirable colour changes. Decreases the poor flavour in milk; decreases the grey discoloration on meat surfaces. Acts as a preservative; promotes colour and flavour retention in foods. Decreases crystal formation	
ALTERNATIVES:	Citrates; BHT; phosphates and pyrophosphates; calcium disodium EDTA	
TECHNOLOGY OF USE IN FOODS:	Does not contribute any flavour. pH 4.5 in a 1% solution. Store in well-closed containers	
SYNERGISTS:	Ascorbates	
LEGISLATION:	**USA:** FDA - 145 ppm maximum in canned black eye peas; 165 ppm cooked chickpeas/kidney beans; 315 ppm in dried banana; 500 ppm in strawberry pie filling; 100 ppm in frozen potatoes; 36 ppm in coated sausage; 25 ppm in alcoholic beverages; 75 ppm in standardised dressing/mayonnaise	**CANADA:** Dressing 70 ppm, sandwich spreads 90 ppm, canned chickpeas, black-eye peas, kidney beans Dried banana products 265 ppm

NAME:	Disodium pyrophosphate
CATEGORY:	Sequestrant
FOOD USE:	Evaporated milk/Cheese/Biscuits/Pasta products/Cured meats/Bologna/Flour/Cake mixes/Doughnuts/Poultry products/Processed potato/Canned fish products
SYNONYMS:	Disodium dihydrogen diphosphate/Disodium dihydrogen pyrophosphate/Acid sodium pyrophosphate/Sodium pyrophosphate/INS 450 (i)/E450a/Disodium salt diphosphoric acid
FORMULA:	$Na_2H_2P_2O_7$
MOLECULAR MASS IN Daltons:	221.94
PROPERTIES AND APPEARANCE:	White crystalline powder or granules
MELTING RANGE IN °C:	220, decomposition
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.862
WATER CONTENT MAXIMUM IN %:	0.5
HEAVY METAL CONTENT MAXIMUM IN ppm:	20
ARSENIC CONTENT MAXIMUM IN ppm:	3
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 15 g/100 mL water
FUNCTION IN FOODS:	Increases water-holding capacity in meat. Emulsifier in cheese. Decreases cooked-out juices. Buffering agent
TECHNOLOGY OF USE IN FOODS:	1 in 100 solution is pH 8

LEGISLATION:

USA:
FDA GRAS sequestrant 5% phosphate in pickle; 0.1% in evaporated milk; emulsifier in cheese 3% by weight; macaroni/noodles 0.5–1%; 0.5% final meat product and total poultry product

UK and EUROPE:
Authorised without limitations. 2000 ppm in canned milk

AUSTRALIA/PACIFIC RIM:
Japan: GMP

NAME:	Glucono-delta-lactone
CATEGORY:	Sequestrant
FOOD USE:	Jelly powder/Dessert mixes/Fish/Sausages/Luncheon meat/Frankfurters/Cooked chopped meat
SYNONYMS:	δ-D-Gluconolactone/Gluconolactone/D-Gluconic acid, δ-lactone/D-Glucono-1,5-lactone/GDL/INS 575/E575
FORMULA:	$C_6H_{10}O_6$
MOLECULAR MASS IN Daltons:	178.14
PROPERTIES AND APPEARANCE:	Fine, white, odourless powder
BOILING POINT:	4351 (decomposes at 153°C)
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	61.7
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	Negligible
PURITY %:	99
WATER CONTENT MAXIMUM IN %:	1
HEAVY METAL CONTENT MAXIMUM IN ppm:	20
ARSENIC CONTENT MAXIMUM IN ppm:	3
FUNCTION IN FOODS:	Leavening agent in jelly powder and soft drink powder. Used in the dairy industry to prevent milk stone. Used in breweries to prevent milk stone. Speeds up colour fixing process in smoked meats. Acidulant in dessert mixes
TECHNOLOGY OF USE IN FOODS:	1% solution has pH of 3.6 which decreases to 2.5 within 2 hours Store in well-closed containers

ANTAGONISTS: Strong oxidisers

LEGISLATION:

USA:
FDA, GRAS in accordance with GMP
Cleared by the USDA Meat Inspection Division; 3 g/kg in cooked meat and luncheon meat; limit of 8 oz/100 lb meat

CANADA:
GMP in cooked sausage, 5000 ppm
Unstandardised foods (GMP)

UK and EUROPE:
GMP
Finland: 9000 ppm in preserved sausage; 3000 ppm in boiled sausage
Denmark: 5000 ppm in smoked herring
Germany: 1% in semi-preserved anchovy and fish

AUSTRALIA/PACIFIC RIM:
Japan: authorised without limitation in meat products and fish products

NAME:	Glycine
CATEGORY:	Sequestrant
FOOD USE:	Nutrient/Dietary supplement/Flavour enhancer/Stabiliser/Sweetener
SYNONYMS:	Aminoacetic Acid/Glycocoll/Glycolixir
FORMULA:	H_2NCH_2COOH
MOLECULAR MASS IN Daltons:	75.07
PROPERTIES AND APPEARANCE:	White crystalline powder, odourless, slightly sweet
MELTING POINT IN °C:	232–236
PURITY (%)	98.5
HEAVY METAL CONTENT MAXIMUM IN %	0.02
ARSENIC CONTENT MAXIMUM IN ppm:	3
LEAD MAXIMUM IN ppm:	5
FUNCTION IN FOODS:	Slightly soluble in alcohol, 1 g dissolves in ~4 mL water
FOOD SAFETY ISSUES:	Emits toxic fumes when heated to decomposition. Store in well-closed containers
LEGISLATION:	**USA:** 0.2% of finished beverage or beverage base Masking agent for saccharin in beverages and bases, 0.02% In mono- and diglycerides **CANADA:** Mono- and diglycerides 0.02% **AUSTRALIA/PACIFIC RIM:** Japan: approved

REFERENCES:

Food and Drug Administration (2009) Listing of Food Additives. Accessed at www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm#abb

Food and Drugs Act (2009) Food and Drug Regulations. Accessed at http://laws.justice.gc.ca/en/showdoc/cr/C.R.C.-c.870/bo-ga:l_B-gb:l_16/20090831/en#anchorbo-ga:l_B-gb:l_16

National Academy of Sciences (1981) *Food Chemicals Codex*, 3rd edn. National Academy Press, Washington, DC.

NAME:	Isopropyl citrate
CATEGORY:	Sequestrant
FOOD USE:	Oleomargarine/Fats and oils/Premier jus
SYNONYMS:	Citric acid mixture of 2-propanol/Isopropyl citrate mixture
ALTERNATIVE FORMS:	Monoisopropyl citrate 27 parts by weight/Diisopropyl citrate 9 parts by weight/Triisopropyl citrate 2 parts by weight
HEAVY METAL CONTENT MAXIMUM IN ppm:	30
ARSENIC CONTENT MAXIMUM IN ppm:	10
ASH MAXIMUM IN %:	3
FUNCTION IN FOODS:	Added to margarine to protect flavour. Chelates ions in fats/oils to prevent rancidity
ALTERNATIVES:	Citric acid; phosphoric acid
TECHNOLOGY OF USE IN FOODS:	When heated to decomposition, emits acrid smoke and irritating fumes
SYNERGISTS:	Phosphoric acid/monoglyceride citrate
LEGISLATION:	**USA:** FDA, GRAS with no limitations if used in accordance with GMP Meat Inspection Division: up to 0.02% in oleomargarine; 100 ppm in fats and oils; 100 ppm in margarine **CANADA:** Fats and oils, unstandardised foods in accordance with GMP

NAME:	Manganese citrate
CATEGORY:	Sequestrant
FOOD USE:	Baked goods/Fish products/Milk products/Beverages/Infant formula/Poultry products/Dairy product analogues/Meat products
FORMULA:	$Mn_3(C_6H_5O_7)_2$
MOLECULAR MASS IN Daltons:	543.02
PROPERTIES AND APPEARANCE:	Pale orange or pinkish white powder
MELTING RANGE IN °C:	160
FUNCTION IN FOODS:	Serves as a nutritional supplement and sequestrant in foods
TECHNOLOGY OF USE IN FOODS:	When heated to decomposition emits acrid smoke and irritating fumes pH of 2% solution is 6.3 Avoid heat, flames and moisture; store in an airtight container
LEGISLATION:	**USA:** FDA, GRAS if used in accordance with GMP

NAME:	Oxystearin
CATEGORY:	Sequestrant
FOOD USE:	Canola oil/Sunflower seed oil/Sesame seed oil/Soyabean oils/Maize oil/Safflower oil/Cottonseed oil/Rapeseed oil/Mustard seed oil/Beet sugar/Yeast
SYNONYMS:	INS 387
PROPERTIES AND APPEARANCE:	Tan to light brown, fatty wax-like substance. Mixture of glycerides of partially oxidised stearic acid and other fatty acids
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ARSENIC CONTENT MAXIMUM IN ppm:	3
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** Insoluble
in ethanol solution (5%):	Soluble
FUNCTION IN FOODS:	Crystallisation inhibitor in vegetable oils and salad oils. Defoaming agent in beet sugar and yeast processing
TECHNOLOGY OF USE IN FOODS:	Oxystearin is a mixture of partially oxidised stearic acid and other fatty acids. Store in well-closed containers. Refractive index 1.465–1.467 at 48-°C. Soluble in ether, hexane and chloroform
FOOD SAFETY ISSUES:	Limited information available, but may represent a hazard to the public when used at current levels. Uncertainty exists requiring additional studies
LEGISLATION:	**USA:** FDA, GRAS in edible fats and oils at 1250 ppm

NAME:	Phosphoric acid
CATEGORY:	Sequestrant
FOOD USE:	Colas and root beer/Jams and jellies/Frozen dairy products/Carbonated beverages/Caramel candies/Candies/Canned seafood/Cocoa powder/Chocolate/Processed cheeses/Rendered fat, fats and oils, vegetable oils/Brewing industry
SYNONYMS:	Orthophosphoric acid/INS 338/*o*-Phosphoric acid/E338
FORMULA:	H_3PO_4
MOLECULAR MASS IN Daltons:	98
ALTERNATIVE FORMS:	Monocalcium phosphate/Dicalcium phosphate/Sodium aluminium phosphate/Sodium tripolyphosphate/Sodium acid pyrophosphate/Ammonium phosphate/Sodium phosphate mono, di, tribasic
PROPERTIES AND APPEARANCE:	Clear, syrupy liquid
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	158
MELTING RANGE IN °C:	21
FLASH POINT IN °C:	42.4
IONISATION CONSTANT AT 25°C:	$K_1 = 7.107 \times 10^{-3}$
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.874 (100%); 1.68 (85%); 1.33 (50%); 1.05 (10%)
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	0.0285 mmHg @ 20°C 0.03–2.16
PURITY %:	>75
HEAVY METAL CONTENT MAXIMUM IN ppm:	10

ARSENIC CONTENT MAXIMUM IN ppm:	2–3
FUNCTION IN FOODS:	Used as an acidulant in processed cheese. Used to clarify/acidity collagen in the production of gelatin/fats and oils. pH of 0.1 N aqueous solution is 1.5. Antioxidant and sequestrant in vegetable and animal fats; synergist with antioxidants
ALTERNATIVES:	Disodium phosphate; citric acid; L-tartaric acid
TECHNOLOGY OF USE IN FOODS:	Food-grade phosphoric acid is supplied at 75, 80 and 85% aqueous solutions. An acid containing about 88% H_3PO_4 will frequently crystallise on prolonged cooling. Store in suitable stainless steel containers. Do not mix with nitromethane as the mixture becomes explosive. Do not store in stainless steel containers in contact with chlorides, as forms H_2 gas. Do not mix with sodium tetrahydroborate. Avoid excessive heat
SYNERGISTS:	Antioxidants/monoglyceride citrate, isopropyl citrate in fats and oils
ANTAGONISTS:	Chlorides/strong alkalis/metals, sulphides and sulphites
FOOD SAFETY ISSUES:	Concentrated solutions are irritating to skin and mucous membranes LD_{50} 3500–4400 mg/kg
LEGISLATION:	**USA:** FDA, GRAS in accordance with GMP. Miscellaneous all-purpose additive. Used at 0.01% to increase effectiveness of antioxidants in lard/shortening. 10.9 ppm total phosphorus in cheese; 2000–5000 ppm in jams and jellies **CANADA:** GMP, mono- and diglycerides 0.02%, sodium tripolyphosphate and sodium phosphate, monobasic: 0.5% total added phosphate, calculated as sodium phosphate, dibasic in meat products **UK and EUROPE:** GMP
REFERENCE:	Food and Drugs Act (2009) Food and Drug Regulations. Accessed at: http://laws.justice.gc.ca/en/showdoc/cr/C.R.C.-c.870/bo-ga:l_B-gb:l_16/20090831/en#anchorbo-ga:l_B-gb:l_16.

NAME:	Potassium dihydrogen citrate
CATEGORY:	Sequestrant
FOOD USE:	Bouillons and consommés/Minarine/Processed cheese/Evaporated milk/Margarine/Edible ices and ice mix/Condensed milk/Jams and jellies/Edible caseinates/Milk powders/citrus marmalade
SYNONYMS:	Monopotassium citrate/Potassium citrate monobasic/Monopotassium salt of 2-hydroxypropan-1,2,3-tricarboxylic acid/INS 332(i)/E332
FORMULA:	$C_6H_7KO_7$
MOLECULAR MASS IN Daltons:	230.21
PROPERTIES AND APPEARANCE:	Transparent crystals/white powder, slight acid taste
PURITY %:	99
WATER CONTENT MAXIMUM IN %:	0.5
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ARSENIC CONTENT MAXIMUM IN ppm:	3
FUNCTION IN FOODS:	Chelates and deactivates metal contaminants. Increases the effect of preservatives. Soluble in fats: good stabilisers
TECHNOLOGY OF USE IN FOODS:	pH of 0.05 molal solution: pH scale standard at 25°C = 3.776 Store in airtight containers
LEGISLATION:	**USA:** FDA, GRAS miscellaneous or general-purpose ingredient **UK and EUROPE:** Authorised without limitation **CANADA:** GMP **AUSTRALIA/PACIFIC RIM:** Japan: GMP Used in accordance with GMP

NAME:	Potassium phosphate dibasic
CATEGORY:	Sequestrant
FOOD USE:	Bouillons and consommés/Cured ham and chopped meat/Milk powder and cream powder/Luncheon meat/Evaporated milks/Processed cheese/Edible ices and ice mixes/Low-sodium products/Caramels/Sparkling wines/Yeast food/Cream/Cured pork shoulder/Condensed milk
SYNONYMS:	Dipotassium hydrogen phosphate/Dipotassium orthophosphate/Dipotassium monophosphate/Dibasic potassium phosphate/Dipotassium phosphate/DKP/Dipotassium phosphate/Dipotassium acid phosphate
FORMULA:	K_2HPO_4
MOLECULAR MASS IN Daltons:	174.18
ALTERNATIVE FORMS:	Monobasic/Pyrophosphate/Tribasic forms
PROPERTIES AND APPEARANCE:	Colourless or white granular powder, crystals or masses. Deliquescent
PURITY %:	>98
WATER CONTENT MAXIMUM IN %:	2–5
HEAVY METAL CONTENT MAXIMUM IN ppm:	20–30
ARSENIC CONTENT MAXIMUM IN ppm:	3
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 6 g/100 mL water
FUNCTION IN FOODS:	Used as a yeast food in the brewing industry. Excellent acidifying agent. Able to form soluble complexes with alkali and alkali earth metal ions; these ions interfere with food processing reactions, e.g. beverage industry. Decreases amount of cooked-out juices. Increases hydration in freeze-thaw products. Stabilises meat emulsions
ALTERNATIVES:	Sodium phosphates

TECHNOLOGY OF USE IN FOODS: Strongly alkaline with a pH of 12 (pH 8.7–9.3 for 1 in 100 solution). Less astringent than their sodium counterparts. Must adjust the formulation to account for water of hydration in the phosphate. Store in airtight containers; avoid moisture, heat and strong oxidisers, sparks and flames

FOOD SAFETY ISSUES: No known toxicity

LEGISLATION:

USA:
FDA, GRAS with no limitations except GMP Consommes/bouillons 1000 ppm; luncheon meat 3 g/kg; 5% phosphate in pickles; 0.5% in products, 0.5% in total poultry product

UK and EUROPE:
2000 ppm in canned milks

CANADA:
GMP, 0.5% total added phosphate, calculated as sodium phosphate, dibasic: solid cut meat; prepared meat by-product, solid cut poultry meat; prepared poultry meat; prepared poultry meat by-product

AUSTRALIA/PACIFIC RIM:
Japan: GMP

REFERENCE:

Food and Drugs Act (2009) Food and Drug Regulations. Accessed at http://laws.justice.gc.ca/en/showdoc/cr/C.R.C.-c.870/bo-ga:l_B-gb:l_16/20090831/en#anchorbo-ga:l_B-gb:l_16.

NAME:	Potassium phosphate monobasic
CATEGORY:	Sequestrant
FOOD USE:	Milk/Whole eggs/Caramels/Meat products/Yeast food/Poultry food products/Low-sodium products/ Sparkling wine
SYNONYMS:	Potassium dihydrogen orthophosphate/Monopotassium monophosphate/Potassium acid phosphate/ Potassium biphosphate
FORMULA:	KH_2PO_4
MOLECULAR MASS IN Daltons:	136.09
ALTERNATIVE FORMS:	Monobasic/Tribasic/Metaphosphates
PROPERTIES AND APPEARANCE:	Colourless white granular salt
MELTING RANGE IN °C:	253; at 400 loses water
FLASH POINT IN °C:	None
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	2.34
PURITY %:	>98
WATER CONTENT MAXIMUM IN %:	1
HEAVY METAL CONTENT MAXIMUM IN ppm:	20
ARSENIC CONTENT MAXIMUM IN ppm:	3
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 20 g/100 mL water **@ 25°C 33**

FUNCTION IN FOODS: Preserves colour in whole eggs. Low-sodium products typical usage range 0.1–0.5%. Used as a yeast food in brewing industry. Excellent acidifying agent. Complexes metal ions and precipitates them out in beverage industry. Decreases amount of cooked-out juices in meat products; increases hydration in freeze-thaw products; stabilises meat emulsions

ALTERNATIVES: Sodium phosphate

TECHNOLOGY OF USE IN FOODS: pH mild acid 4–5. Usually less astringent than their sodium counterparts. Before use, must adjust formulation to account for amount of water of hydration in the phosphate. Deliquescent when exposed to moist air. Store in airtight containers; avoid excessive heat; avoid aluminium and steel (may corrode these); avoid strong bases as may react violently

FOOD SAFETY ISSUES: No known toxicity

LEGISLATION:

USA:
FDA - GRAS food additive with no limitations except GMP
0.5% phosphate in product; 0.5% in total poultry product; 5000 ppm in frozen whole eggs

UK and EUROPE:
2000 ppm in canned milks

CANADA:
Ice cream/milk mix, sherbert: GMP
Unstandardised foods: GMP
Meat/poultry products: 0.5% total added phosphate, calculated as sodium phosphate monobasic

AUSTRALIA/PACIFIC RIM:
Japan: GMP

REFERENCE:

Food and Drugs Act (2009) Food and Drug Regulations. Accessed at http://laws.justice.gc.ca/en/showdoc/cr/C.R.C.-c.870/bo-ga:l_B-gb:l_16/20090831/en#anchorbo-ga:l_B-gb:l_16.

NAME:	Potassium sodium tartrate
CATEGORY:	Sequestrant
FOOD USE:	Cheese products/Citrus marmalade/Margarines/Minced meat/Jams and jellies/Edible ices and ice mixes/Sausage casings/Bouillons and consommés
SYNONYMS:	Rochelle salt/Seignette salt/Potassium sodium dextro-tartrate/Potassium sodium D-tartrate/Potassium sodium dextro-tartrate/INS 337/E337
FORMULA:	$C_4H_4KNaO_6 \cdot 4H_2O$
MOLECULAR MASS IN Daltons:	210.16–282.23
ALTERNATIVE FORMS:	Cream of tartar (acid monopotassium salt)/Tartaric acid/Diacetyl glyceryl tartrate
PROPERTIES AND APPEARANCE:	Translucent crystals or white crystal powder
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	760 mmHg 220°C, decomposes 225°C
MELTING RANGE IN °C:	70–80 (at 100°C, loses $3H_2O$; at 130–140°C, becomes anhydrous)
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.79
PURITY %:	99
WATER CONTENT MAXIMUM IN %:	21–26
HEAVY METAL CONTENT MAXIMUM IN ppm:	20
ARSENIC CONTENT MAXIMUM IN ppm:	3
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 100 g/100 mL water

FUNCTION IN FOODS:	Sequestrant, pH control agent and a buffering agent. Prevents rancidity with antioxidants. Stabiliser in minced meat	
TECHNOLOGY OF USE IN FOODS:	pH 6.5–7.5 for a 1 in 10 solution. Avoid excessive heat: 1% solution has a pH of 10	
SYNERGISTS:	Fumaric acid and their salts/With antioxidants	
ANTAGONISTS:	Acid lead salts/calcium, magnesium sulphate/silver nitrate	
LEGISLATION:	**USA:** FDA, GRAS if used in accordance with GMP Jams/jellies up to 0.19%	**UK and EUROPE:** Authorised without limitation GMP in fruits and vegetables
	CANADA: GMP	**AUSTRALIA/PACIFIC RIM:** Japan: GMP

NAME:	Sodium monohydrogen phosphate 2 : 1 : 1
CATEGORY:	Sequestrant
FOOD USE:	Coffee whitener/Meat food products/Puddings/Cream sauce/Evaporated milks/Whipped products/Broths/Poultry/Macaroni/Hog carcasses
SYNONYMS:	Dibasic sodium phosphate/Disodium hydrogen phosphate/Disodium monohydrogen phosphate/Sodium phosphate dibasic anhydrous/DSP/INS 399(ii)/Disodium orthophosphate/Disodium phosphate/Disodium phosphoric acid/Phosphate of soda/E399/Sodium hydrophosphate
FORMULA:	Na_2HPO_4
MOLECULAR MASS IN Daltons:	141.96
ALTERNATIVE FORMS:	Dihydrate: $Na_2HPO_4 \cdot 2H_2O$/Heptahydrate
PROPERTIES AND APPEARANCE:	Hygroscopic white powder or crystalline granules
MELTING RANGE IN °C:	240
PURITY %:	>98
WATER CONTENT MAXIMUM IN %:	<5 (dihydrate 18–22)
HEAVY METAL CONTENT MAXIMUM IN ppm:	10–30
ARSENIC CONTENT MAXIMUM IN ppm:	3
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 25°C** 12 g/100 mL
in ethanol solution (5%):	Insoluble

FUNCTION IN FOODS: Used as a buffer, emulsifier and sequestrant in food. Decreases cooked-out juices in meat products. Used as a dietary supplement. Used to increase the pH of food products and stabilise the optimum pH in a food system. Used in evaporated milks as a buffer, and also prevents gelation. Decreases setting time in instant puddings. Used as a dispersant in producing a swelling of protein

TECHNOLOGY OF USE IN FOODS: pH of 1% aqueous solution at 25°C is 9.1. Store in airtight containers, as extremely hygroscopic; store in cool, dry vented areas. Avoid acids. When heated to decomposition, emits highly toxic fumes of oxides of phosphorus and sodium

FOOD SAFETY ISSUES: Mildly toxic by ingestion. Skin and eye irritant, or on mucous membranes

LEGISLATION:

USA:
FDA, GRAS if used in accordance with GMP 5% phosphate in pickle; 0.5% phosphate in product; 0.5% in poultry products

CANADA:
Sodium phosphate, dibasic: GMP in ice cream/milk mix, sherbert, unstandardised foods 0.5% total added phosphate, calculated as sodium phosphate, dibasic for meat products

NAME:	Sodium polyphosphate
CATEGORY:	Sequestrant
FOOD USE:	Processed cheeses/Cream powders and cream/Bouillons and consommés/Sweetened condensed milk/Luncheon meat and cured ham/Cured pork/Milk powders/Frozen seafood/Edible ices and ice mixes/Dried eggs/Evaporated milk/Canned fruit and vegetables/Carbonated beverages/Alcoholic beverages
SYNONYMS:	Sodium hexametaphosphate/Sodium tetraphosphate/Graham salt/Sodium metaphosphate/INS 452/Insoluble sodium metaphosphate/Sodium polyphosphate, glassy/Sodium polyphosphate/Sodium phymetaphosphate/E450c
FORMULA:	$(NaPO_3)x$ $x > 2$ terminated by Na_2PO_4
MOLECULAR MASS IN Daltons:	101.96–611.2
PROPERTIES AND APPEARANCE:	Colourless, glassy transparent platelets or powders
MELTING RANGE IN °C:	628
FLASH POINT IN °C:	Non-combustible
PURITY %:	60–71
HEAVY METAL CONTENT MAXIMUM IN ppm:	20
ARSENIC CONTENT MAXIMUM IN ppm:	3
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** Very soluble
FUNCTION IN FOODS:	Decreases amount of cooked-out juice. Prevents staining on exterior of canned goods. Inactivates metallic ions; sequestering in canning of fruits and vegetables. Retards oxidation of unsaturated fats in aqueous food systems. Decreases growth of microbes; softens water for preparation of alcoholic beverages; decreases loss of carbonation in beverages; precipitates casein β-lactoglobulin in milk (stabiliser effect); decreases turbidity in wines/ciders/vinegars

ALTERNATIVES: EDTA (ethylenediaminetetraacetate); citrates; phosphates

TECHNOLOGY OF USE IN FOODS: Store in airtight containers; extremely hygroscopic, protect from moisture. Avoid strong oxidising agents; avoid high heat. 1% solution = pH 10

FOOD SAFETY ISSUES: Dust may be irritating to skin and eyes and mucous membranes

LEGISLATION:

USA:
FDA, GRAS sequestrant, miscellaneous food additive 5% of phosphate in pickles; in food starches, 0.4% of calculated phosphates; 0.5% in total poultry product

UK and EUROPE:
2000 ppm in canned milk

CANADA:
2000 ppm in raw meat products; 5000 ppm in frozen fish

Sodium hexametaphosphate: 0.5% total added phosphate alculated as sodium phosphate, dibasic in meat products

AUSTRALIA/PACIFIC RIM:
Japan: GMP

REFERENCE:

VanWaser, J.R. (1958) *Phosphorus and its Components*, Vol. 1. Interscience, New York, pp. 601–800.

NAME:	Sodium tartrate
CATEGORY:	Sequestrant
FOOD USE:	Meat products/Sausage casings/Cheeses
SYNONYMS:	Disodium tartrate/Disodium D-tartrate/Sodium dextrotartrate/Disodium (+)-2,3-dihydroxybutanedioic acid/ Disodium L-tartrate/INS 335/E335
FORMULA:	$C_4H_4Na_2O_6 \cdot 2H_2O$
MOLECULAR MASS IN Daltons:	194.05–230.08
PROPERTIES AND APPEARANCE:	Translucent, colourless, odourless crystals
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.82
PURITY %:	99
WATER CONTENT MAXIMUM IN %:	14–17
HEAVY METAL CONTENT MAXIMUM IN ppm:	10–20
ARSENIC CONTENT MAXIMUM IN ppm:	3
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 33 g/100 mL water
FUNCTION IN FOODS:	Used in laxatives. Stabiliser in cheese. Used in artificially sweetened jelly. Used as a chemical reactant
TECHNOLOGY OF USE IN FOODS:	Store in airtight containers. pH 7–7.5; 1% solution pH 10

LEGISLATION:

USA:
FDA, GRAS sequestrant
Emulsifier up to 3% by weight in specific cheeses; jams/jellies up to 0.19%

CANADA:
GMP

UK and EUROPE:
Authorised without limitations
GMP in fruits and vegetables

AUSTRALIA/PACIFIC RIM:
Japan: GMP

NAME:	Tartaric acid
CATEGORY:	Sequestrant
FOOD USE:	Firming agent/Flavouring agent/Baked goods/Gelatin desserts/Wines/Jams/Cream of tartar
SYNONYMS:	Butanedioic acid, 2,3-dihydroxy-/2,3-Dihydrosuccinic acid/Dihydroxybutanedioic acid/L-Tartaric acid
FORMULA:	$C_4H_6O_6$
MOLECULAR MASS IN Daltons:	150.09
PROPERTIES AND APPEARANCE:	White crystalline powder, colourless translucent crystals, odourless, acid taste, soluble in water and alcohol
MELTING POINT IN °C:	168–170
FLASH POINT IN °C:	210
PURITY %:	≥99.5
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ARSENIC CONTENT MAXIMUM IN ppm:	3
FUNCTION IN FOODS:	Synergist for antioxidants, acid, emulsifier, sequestrant
FOOD SAFETY ISSUES:	Strong organic acid, when heated to decomposition emits irritating fumes and acrid smoke, stable in air. Store in a tightly closed container at room temperature in a dry area
LEGISLATION:	**USA:** FDA, GRAS used in accordance with GMP **CANADA:** GRAS when used in accordance with GMP
REFERENCES:	Ash, M. and Ash, I. (2008) *Handbook of Food Additives*. Synapse Information Resources Inc., New York.

Part 13

Solvents

Stephanie Moriartey

This Part is based upon the First Edition contribution of Lynn M. McMullen

Food Additives Data Book, Second Edition. Edited by Jim Smith and Lily Hong-Shum.

NAME:	Acetic acid
CATEGORY:	Solvent
FOOD USE:	Baked goods/Chewing gum/Resins/Volatile oils/Fats and oils/Condiments: catsup, pickles, relish, mayonnaise/Salad dressings/Sauces, gravies/Dairy products: cheese/Meat products
SYNONYMS:	Ethanoic acid/E260/CAS 64-19-7
FORMULA:	CH_3COOH
MOLECULAR MASS IN Daltons:	60.05
PROPERTIES AND APPEARANCE:	Clear, colourless liquid, pungent vinegar odour
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	118
MELTING RANGE IN °C:	16.7
FLASH POINT IN °C:	39
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.053
PURITY %:	99 as glacial acetic acid
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ARSENIC CONTENT MAXIMUM IN ppm:	3
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** Completely soluble in water
in vegetable oil:	**@ 20°C** Immiscible
in sucrose solution (10%):	Miscible
in sodium chloride solution (5%):	Miscible

in ethanol solution (5%):	Miscible
in propylene glycol:	**@ 20°C** Miscible
FUNCTION IN FOODS:	Normally used to acidify foods and as a flavouring agent. Used as a solvent for gums, resins, baked goods, fats and oils to carry flavourings and colouring agents
TECHNOLOGY OF USE IN FOODS:	Used as a pH-adjusting agent in amounts consistent with GMP. $pK_a = 4.74$, therefore would normally be used at pH less than 4.7. pH of aqueous solutions 1.0 M = 2.4; 0.1 M = 2.9; 0.01 M = 3.4
FOOD SAFETY ISSUES:	Acetic acid is not an additive that has been subject to great criticism over safety. FAO/WHO recognises that acetic acid is a normal constituent of foods and has set no limit on the daily acceptable intake for humans. As a concentrated solution it is caustic and can cause burns and is a severe eye and skin irritant
LEGISLATION:	**USA:** GRAS when used at levels in accordance with GMP (21CFR 182.1005) Current GMP results in the following: 0.8% for cheese and dairy products 0.5% in chewing gum 9.0% in condiments and relishes 3% in gravies and sauces 0.5% in fats and oils 0.25% for baked goods 0.6% in meat products 0.15% for all other foods **CANADA:** Listed as a pH-adjusting agent for use in cream cheese spread, processed cheese, processed cheese food, processed cheese spread, cold-pack cheese, cold-pack cheese food, whey cheese; canned asparagus, gelatin and unstandardised foods according to GMP Listed as a class I preservative for use in preserved fish, preserved meat; preserved meat by-product, preserved poultry meat, preserved poultry meat by-product, pumping pickle, cover pickle and dry cure employed in the curing of preserved meat or preserved meat by-product according to GMP
REFERENCES:	Doores, S. (1990) pH Control agents and acidulants. In: Branen, A.P., Davidson, P.M.and Salminen, S. (eds) *Food Additives*. Marcel Dekker, New York, pp. 477–510. Lewis, R.J. (1989) *Food Additives Handbook*. Van Nostrand Reinhold, New York.

NAME:	Acetone
CATEGORY:	Solvent
FOOD USE:	Fruits/Spice oleoresins/Vegetables/Essential oils
SYNONYMS:	DMK/Acetone oils/Dimethylketone/Dimethylketal/Dimethyl formaldehyde/Ketone dimethyl/Ketone propane/β-Ketopropane/Methyl ketone/Propanone/2-Propanone/Pyroacetic acid/Pyroacetic ether/CAS 67-64-1
FORMULA:	CH_3COCH_3
MOLECULAR MASS IN Daltons:	58.09
PROPERTIES AND APPEARANCE:	Colourless, volatile liquid, sweetish taste, and odour, soluble in water and alcohol
BOILING POINT IN °C:	56.2
MELTING POINT IN °C:	−94.3
FLASH POINT IN °C:	−18
PURITY %	99.5
HEAVY METAL CONTENT MAXIMUM IN ppm:	1
FUNCTION IN FOODS:	Colour diluents, flavouring agent, extraction solvent for foods
FOOD SAFETY ISSUES:	Flammable liquid, reacts violently with oxidising agents, chlorinated solvent/alkali mixtures, reacts with sulphur dichloride, potassium *t*-butoxide, hexachloromelamine; incomplete combustion can produce CO. Store out of direct sunlight and in a cool, dry, ventilated area
LEGISLATION:	**USA:** 30 ppm As residual solvent in spice oleoresins **CANADA:** Spice and natural extracts: 30 ppm Meat and egg marking inks: GMP **AUSTRALIA/PACIFIC RIM:** Japan approved with restrictions

REFERENCES:

Ash, M. and Ash, I. (2008) *Handbook of Food Additives*. Synapse Information Resources, Inc. New York.
Food and Drug Administration (2009) Listing of Food Additives. Accessed at www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm#abb.
Food and Drugs Act (2009) Food and Drug Regulations. Accessed at http://laws.justice.gc.ca/en/showdoc/cr/C.R.C.-c.870/bo-ga:l_B-gb:l_16/20090831/en#anchorbo-ga:l_B-gb:l_16.
National Academy of Sciences (1981) *Food Chemicals Codex*, 3rd edn. National Academy Press, Washington, DC.

NAME:	Acetylated monoglycerides
CATEGORY:	Solvent
FOOD USE:	Soft drinks/Baked goods/Chewing gums, caramels/Frozen desserts, ice-cream/Meat products/Margarine, oleomargarine, shortening, cake shortening/Nuts, peanut butter/Puddings/Whipped toppings
FORMULA:	Varies
MOLECULAR MASS IN Daltons:	Varies, esters of glycerin with acetic acid and edible fat-forming fatty acids
PROPERTIES AND APPEARANCE:	May be white to pale yellow liquids or solids with a bland taste
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** Insoluble
in vegetable oil:	**@ 20°C** Soluble
in sucrose solution (10%):	Insoluble
in sodium chloride solution (5%):	Insoluble
in ethanol solution (5%):	Soluble
FUNCTION IN FOODS:	Solvent for antioxidants and spices. Also used as coating agent, emulsifier, lubricant or texture-modifying agent
TECHNOLOGY OF USE IN FOODS:	Emits an acrid smoke and irritating fumes when heated to decomposition
FOOD SAFETY ISSUES:	Not a food additive that has been subject to concern
LEGISLATION:	**USA:** Used at a level not in excess of the amount reasonably required to produce its intended effect in food (21 CFR 172.828) USDA regulation permits 0.5% in oleomargarine or margarine (9 CFR 318.7) **UK and EUROPE:** UK: GMP in soft drinks
REFERENCES:	FAO/WHO (1992) *Compendium of Food Additive Specifications*, Vol. I, II. Joint Expert Committee on Food Additives. FAO Food and Nutrition Paper 52/1. FAO, Rome. Lewis, R.J. (1989) *Food Additives Handbook*. Van Nostrand Reinhold, New York.

NAME:	Amyl acetate
CATEGORY:	Solvent
FOOD USE:	Information available was very limited. Is listed as a solvent for flavourings, but food uses not clarified
SYNONYMS:	Isoamyl acetate/Acetic acid esters of amyl alcohol/3-Methylbutyl acetate/Isopentyl alcohol acetate/CAS 123-92-2/Amylacetic ester/Banana oil/Pear oil
FORMULA:	$CH_3COOCH_2CH_2CH(CH_3)_2$
MOLECULAR MASS IN Daltons:	130.19
PROPERTIES AND APPEARANCE:	Colourless, clear liquid with fruit-like odour
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	120–142
FLASH POINT IN °C:	33
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	0.868–0.878
PURITY %:	98
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ARSENIC CONTENT MAXIMUM IN ppm:	3

SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:

in water:	**@ 20°C**	0.25	**@ 50°C**	Slightly soluble	**@ 100°C**	Slightly soluble
in vegetable oil:	**@ 20°C**	Miscible	**@ 50°C**	Miscible	**@ 100°C**	Miscible
in sucrose solution:						
10%	Slightly soluble					
40%	Slightly soluble					
60%	Slightly soluble					

in sodium chloride solution:	
5%	Slightly soluble
10%	Slightly soluble
15%	Slightly soluble
in ethanol solution:	
5%	Miscible
20%	Miscible
95%	Miscible
in propylene glycol:	**@ 20°C** Insoluble **@ 50°C** Insoluble **@ 100°C** Insoluble
FUNCTION IN FOODS:	Flavouring agent and carrier solvent in foods
TECHNOLOGY OF USE IN FOODS:	Miscible with ether, ethyl acetate, amyl alcohol and most oils. Insoluble in 1,2-propanediol and glycerin
FOOD SAFETY ISSUES:	Exposure to concentrations greater than 1000 ppm for 1 hour can cause headaches, fatigue, pulmonary irritation and toxic effects. Mildly toxic by ingestion
LEGISLATION:	**USA:** Used in minimum quantity required to produce intended effect (21 CFR 172.515) **CANADA:** Not listed as a solvent for food use. Flavouring agent only
REFERENCES:	FAO/WHO (1992) *Compendium of Food Additive Specifications*, Vol. I, II. Joint Expert Committee on Food Additives. FAO Food and Nutrition Paper 52/1. FAO, Rome. Lewis, R.J. (1989) *Food Additives Handbook*. Van Nostrand Reinhold, New York.

NAME:	Benzyl alcohol
CATEGORY:	Solvent
FOOD USE:	Various
SYNONYMS:	Benzenemethanol/Phenylcarbinol/Phenylmethyl alcohol/α-Hydroxy toluene/CAS 100-51-6
FORMULA:	$C_6H_5CH_2OH$
MOLECULAR MASS IN Daltons:	108.14
PROPERTIES AND APPEARANCE:	Colourless clear liquid with faint aromatic odour
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	at 760 mmHg 204.7 at 400 mmHg 183.0 at 200 mmHg 160.0 at 100 mmHg 141.7 at 60 mmHg 129.3 at 40 mmHg 119.8 at 20 mmHg 105.8 at 10 mmHg 92.6 at 5 mmHg 58.0
MELTING RANGE IN °C:	−15.19
FLASH POINT IN °C:	100.5–104.4
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	@ 20°C: 1.04535 @ 25°C: 1.0456
PURITY %:	98
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ARSENIC CONTENT MAXIMUM IN ppm:	3

SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:

in water:	**@ 20°C** 4	**@ 50°C** Soluble	**@ 100°C** Soluble
in ethanol solution (50%):	67		

FUNCTION IN FOODS: A carrying solvent for flavouring agents

TECHNOLOGY OF USE IN FOODS: Miscible with chloroform and ether. Water-white liquid with faint aromatic odour and sharp burning taste

FOOD SAFETY ISSUES: Poisonous if ingested. Moderately toxic by inhalation, skin contact and subcutaneous routes

LEGISLATION:

USA:
Use at a level not in excess of the amount reasonably required to accomplish the intended effect. (21 CFR 172.515)

CANADA:
GMP for flavours and flavouring preparations

REFERENCES:

FAO/WHO (1992) *Compendium of Food Additive Specifications*, Vol. I, II. Joint Expert Committee on Food Additives. FAO Food and Nutrition Paper 52/1. FAO, Rome.
Lewis, R.J. (1989) *Food Additives Handbook*. Van Nostrand Reinhold, New York.

NAME:	1,3-Butanediol
CATEGORY:	Solvent
FOOD USE:	Bread/Flour/Mixes/Ices
SYNONYMS:	1,3-Butylene glycol/1,3-Dihydroxybutane/β-Butyleneglycol/Methyltrimethylene glycol/Butane-1,3-diol/ CAS 107-88-0
FORMULA:	$CH_3CHOHCH_2CH_2OH$
MOLECULAR MASS IN Daltons:	90.12
PROPERTIES AND APPEARANCE:	Colourless, viscous liquid
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	207.5
MELTING RANGE IN °C:	Melts below 50
FLASH POINT IN °C:	121
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.006
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg	0.06 mmHg at 20°C
PURITY %:	99
WATER CONTENT MAXIMUM IN %:	0.5
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ARSENIC CONTENT MAXIMUM IN ppm:	3

SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:

in water:	**@ 20°C**	Miscible	**@ 50°C**	Miscible	**@ 100°C**	Miscible
in vegetable oil:	**@ 20°C**	Soluble	**@ 50°C**	Soluble	**@ 100°C**	Soluble

in sucrose solution:	
10%	Miscible
40%	Miscible
60%	Miscible
in sodium chloride solution:	
5%	Miscible
10%	Miscible
15%	Miscible
in ethanol solution:	
5%	Soluble
20%	Soluble
95%	Soluble
100%	Soluble

FUNCTION IN FOODS: Used as a solvent for colours, flavours and flavour enhancers

ALTERNATIVES: Glycerol; propylene glycol; sorbitol

TECHNOLOGY OF USE IN FOODS: Very hygroscopic; keep sealed. Miscible with ether and acetone. Soluble in ether

FOOD SAFETY ISSUES: Not a food additive that has been subject to criticism

LEGISLATION:

USA:
May by used as a solvent for natural and synthetic flavourings if the substance is used in the minimum amount required to perform its intended effect

CANADA:
GMP in flavours

NAME:	Carbon dioxide
CATEGORY:	Solvent
FOOD USE:	Carbonated beverages
SYNONYMS:	Carbonic acid anhydride/Carbonic acid gas/Carbonic anhydride/Dry ice/CAS 124-38-9
FORMULA:	CO_2
MOLECULAR MASS IN Daltons:	44.01
PURITY %	>99.5
PROPERTIES AND APPEARANCE	Colourless gas, odourless, soluble in 1 : 1 ratio of water
BOILING/SUBLIMATION POINT IN °C:	−78.5
FREEZING POINT IN °C:	−56.6
CRITICAL PROPERTIES FOR SUPERCRITICAL FLUID EXTRACTION	31.2°C, 72.9 atm, 0.470 g/mL
FUNCTION IN FOODS:	Direct food additive, preservative, carbonation agent, aerating agent, cooling/freezing agent, leavening agent, extraction solvent in supercritical fluid extraction
FOOD SAFETY ISSUES:	Non-flammable, incompatible with acrylaldehyde, aziridine, metal acetylides, sodium peroxide, reacts vigorously with various chemicals and several metals will burn in presence
LEGISLATION:	**USA:** GRAS **CANADA:** GMP: Green coffee beans and tea leaves for decaffeination purposes, spice extracts, natural extracts, hop extracts, egg products, cocoa powder **UK and EUROPE:** UK: approved **AUSTRALIA/PACIFIC RIM:** Japan: approved

REFERENCES:

Ash, M. and Ash, I. (2008) *Handbook of Food Additives*. Synapse Information Resources Inc., New York.

Food and Drug Administration (2009) Listing of Food Additives. Accessed at www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm#abb.

Food and Drugs Act (2009) Food and Drug Regulations. Accessed at http://laws.justice.gc.ca/en/showdoc/cr/C.R.C.-c.870/bo-ga:l_B-gb:l_16/20090831/en#anchorbo-ga:l_B-gb:l_16.

Herrero, M., Cifuentes, A. and Ibanez, E. (2006) Sub- and supercritical fluid extraction of functional ingredients from different natural sources: Plant, food by-products, algae and microalgae. A review. *Food Chemistry* **98**, 136–148.

National Academy of Sciences (1981) *Food Chemicals Codex*, 3rd edn. National Academy Press, Washington, DC.

NAME:	Castor oil
CATEGORY:	Solvent, release agent
FOOD USE:	Butter/Margarine/Hard candy/Vitamin and mineral tablets
SYNONYMS:	Ricinus oil/Oil of Palma Christi/Tangantangan oil/Neoloid/INS 1503/CAS 8001-79-4/Phorbyol/Aromatic castor oil
FORMULA:	N/A
PROPERTIES AND APPEARANCE:	Pale yellow or almost colourless clear liquid
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	156
MELTING RANGE IN °C:	−12
FLASH POINT IN °C:	230
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	0.952–0.966
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ARSENIC CONTENT MAXIMUM IN ppm:	3
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in vegetable oil:	**@ 20°C** Soluble in fixed oils
in ethanol solution (95%):	100
in propylene glycol:	Slightly soluble in light petroleum, miscible in glacial acetic acid, chloroform and ether
FUNCTION IN FOODS:	Carrier solvent for colouring agents: oil-soluble annatto butter colour, annatto butter colour, annatto margarine colour. Also used as a release agent and anti-sticking agent in the manufacture of confections
TECHNOLOGY OF USE IN FOODS:	Excellent stability; does not turn rancid unless exposed to excessive heat

FOOD SAFETY ISSUES:	Not subject to concerns. Moderately toxic by ingestion. Also an allergen	
LEGISLATION:	**USA:** Max. 500 ppm in hard candy	**CANADA:** GMP as solvent for annatto colourings
ANY OTHER RELEVANT INFORMATION:	Composed of 87% ricinoleic, 7% oleic, 3% linoleic, 2% palmitic and 1% stearic fatty acids	

NAME:	Diethyl tartrate
CATEGORY:	Solvent
FOOD USE:	Unspecified
SYNONYMS:	2,3-Dihydroxy butanedioic acid diethyl ester/CAS 87-91-2/Ethyl tartrate
FORMULA:	C_2H_5-COO-CHOH-CHOH-COO-C_2H_5
MOLECULAR MASS IN Daltons:	206.18
PROPERTIES AND APPEARANCE:	Colourless, thick oily liquid with wine-like odour
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	280 (at 11 mmHg: 150°C)
MELTING RANGE IN °C:	17
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.204–1.207
PURITY %:	99
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ARSENIC CONTENT MAXIMUM IN ppm:	1
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** Slightly soluble
in ethanol solution (5%):	Miscible with alcohol
in propylene glycol:	**@ 100°C** Soluble in fixed oils, ether
FUNCTION IN FOODS:	Carrier solvent for flavouring agents
TECHNOLOGY OF USE IN FOODS:	Slightly soluble in water. Miscible with alcohol or ether

FOOD SAFETY ISSUES: Not subject to concern

LEGISLATION:

CANADA:
Not listed as solvent

NAME:	Ethanol
CATEGORY:	Solvent
FOOD USE:	Baked goods/Beverages/Confections/Ice-cream/Liquors/Sauces/Sprayable vegetable oils/Pizza crust
SYNONYMS:	Ethyl alcohol/Ethyl hydroxide/Absolute ethanol/Alcohol/CAS 64-17-5/Grain alcohol/Ethyl hydrate/Spirits of wine, spirit
FORMULA:	CH_3CH_2OH
MOLECULAR MASS IN Daltons:	46.07
PROPERTIES AND APPEARANCE:	Clear colourless liquid
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	78.5
FLASH POINT IN °C:	13
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	0.789
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	40 mmHg at 20°C
PURITY %:	94.9 for 95% ethanol
HEAVY METAL CONTENT MAXIMUM IN ppm:	1
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** Miscible
in sucrose solution (10%):	Miscible
in sodium chloride solution (5%)	Miscible
in propylene glycol:	**@ 20°C** Miscible

FUNCTION IN FOODS:	Carrier solvent for additives. Also used as extraction solvent. Antimicrobial agent		
ALTERNATIVES:	Isopropanol; methanol; *n*-octyl alcohol		
TECHNOLOGY OF USE IN FOODS:	Available in different concentrations: 99.9%, 95%, etc. Absorbs water rapidly from air. Keep tightly closed in cool dark place. Flammable when exposed to flame, can react vigorously with oxidisers		
FOOD SAFETY ISSUES:	Not subject to safety concerns		
LEGISLATION:	**USA:** GRAS: Limit of 2% in pizza crusts Used in accordance with GMP	**UK and EUROPE:** Finland and UK: GMP in soft drinks Belgium and Sweden: GMP for biscuits	**CANADA:** GMP in spice extracts, natural extracts, unstandardised flavouring preparations, colour mixtures and preparations, meat- and egg-marking inks, food additive preparations and hop extracts. Ethyl alcohol denatured with methanol: 10 ppm methanol in vegetable oil seed meals

NAME:	Ethyl acetate
CATEGORY:	Solvent
FOOD USE:	Breads/Confections/Flour/Ices/Mixes/Powders/Decaffeination of coffee, tea/Fruits/Vegetables
SYNONYMS:	Acetic acid ethyl ester/Acetic ether/Vinegar naphtha/CAS 141-78-6/Ethyl ethanoate/Acetoxyethane
FORMULA:	$CH_3COOC_2H_5$
MOLECULAR MASS IN Daltons:	88.11
PROPERTIES AND APPEARANCE:	Clear volatile liquid with fruity odour
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	77
MELTING RANGE IN °C:	−83
FLASH POINT IN °C:	7.2
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	0.897–0.907 at 20°C 0.894–0.901 at 25°C
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg:	100 mmHg at 27°C
PURITY %:	97
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 10% (less soluble at higher temperatures) **@ 50°C** Miscible in water at 54°C
in ethanol solution (5%):	Miscible in alcohol
FUNCTION IN FOODS:	Carrier solvent for spice extracts and flavouring agents. Used for decaffeination of coffee beans and tea
TECHNOLOGY OF USE IN FOODS:	Keep tightly closed in a cool place. Absorbs water. Highly flammable liquids, do not expose to heat and flame
FOOD SAFETY ISSUES:	Not an additive that has been subject to criticism. Mildly toxic if ingested

LEGISLATION:	USA:	UK and EUROPE:	CANADA:
	GMP in coffee as a solvent FDA in decaffeination of coffee/tea	UK: GMP in soft drinks Sweden: GMP in biscuits 10 ppm; decaffeinated tea: 50 ppm	GMP in flavour, spice and natural extracts Roasted decaffeinated coffee beans

NAME:	Glycerin
CATEGORY:	Solvent
FOOD USE:	Alcoholic beverages/Baked goods/Cured meats/Egg products/Ices/Soft drinks/Candy/Marshmallows
SYNONYMS:	Glycerol/1,2,3-Propanetriol/Glycerine/Trihydroxypropane/CAS 56-81-5/E422/INS 422/Glycylalcohol
FORMULA:	CH_2-OH-CHOH-CH_2OH
MOLECULAR MASS IN Daltons:	92.09
PROPERTIES AND APPEARANCE:	Clear, or yellowish hygroscopic viscous liquid with slight odour and slightly sweet taste
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	at 760 mmHg 290.0 at 400 mmHg 263 at 200 mmHg 240 at 60 mmHg 208 at 20 mmHg 182.2 at 10 mmHg 167.2 at 5 mmHg 153.8 at 1 mmHg 125.5
MELTING RANGE IN °C:	17.8
FLASH POINT IN °C:	176
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	
95% aqueous solution:	**@ 15°C** 1.2570 **@ 20°C** 1.26362 **@ 25°C** 1.26201
90% aqueous solution:	**@ 15°C** 1.23950 **@ 20°C** 1.23755 **@ 25°C** 1.23585
80%:	1.213
50%:	1.129
WATER CONTENT MAXIMUM IN %:	5

HEAVY METAL CONTENT MAXIMUM IN ppm:	5
ARSENIC CONTENT MAXIMUM IN ppm:	3
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** Miscible
in ethanol solution (5%)	Miscible
FUNCTION IN FOODS:	Carrier solvent for flavour extracts, colour mixes. Also used as a humectant in meats (sausage casings), as a glaze for preserved meats and as a sweetener
ALTERNATIVES:	Butylene glycol; sorbitol; propylene glycol
TECHNOLOGY OF USE IN FOODS:	Miscible with water and alcohol. 0.6 times sweeter than sucrose
FOOD SAFETY ISSUES:	This is not an additive that has been subject to concerns regarding safety
LEGISLATION:	**UK and EUROPE:** Italy: 7000 ppm in alcoholic beverages: prohibited in egg products, ices, soft drinks, flour and bread UK: allowed without limit in flour and baked goods but is prohibited in breads. GMP in cured meats, ices, soft drinks Denmark: GMP in flour; prohibited in bread, cured meats, egg products and alcoholic beverages; 5% in baked goods; 2% in ices; 5 g/L in soft drinks Finland: 5% in flour and baked goods; prohibited in breads, alcoholic beverages; GMP in cured meats France: 5% in baked goods; prohibited in alcoholic beverages, cured meats, ices, soft drinks, bread and flour Ireland: GMP in bread, baked goods, cake mixes; prohibited in flour. GMP in cured meats Germany: allowed without limit in flour, bread and baked goods. Prohibited in alcoholic beverages, cured meats, ices. GMP in soft drinks Spain: allowed without limit with special permission in baked goods. Prohibited in ices, soft drinks Belgium, Luxembourg, the Netherlands: 1.5% in ices Sweden: 100 ppm in ices; GMP in soft drinks, cured meat casings. Prohibited in egg products, flour and bread

	USA: GMP in alcoholic beverages, cured meats, and soft drinks. Allowed without limit in flour and baked goods but prohi bited in bread GRAS when used in accordance with GMP	**CANADA:** GMP in baked goods, cured meats, flavouring, colouring and additive mixtures, prohibited in alcoholic beverages, ices, soft drinks, flour and bread	**AUSTRALIA/PACIFIC RIM:** Japan: GMP in alcoholic beverages, egg products, ices, bread and baked goods. Allowed without limit in soft drinks, tea, coffee and chocolate drinks Australia: Prohibited in flour and bread; in egg products, ices and soft drinks

NAME:	Glyceryl diacetate
CATEGORY:	Solvent
FOOD USE:	Butter
SYNONYMS:	Diacetin/1,2,3-Propanetriol/Diacetate/Diacetylglycerol/Glycerin diacetate/Glycerine Diacetate/Glycerol Diacetate/Glycerol 1,3-diacetate/2-(Acetyloxy)-1-(hydroxymethyl)ethyl acetate
FORMULA:	$C_3H_5OH(CH_3COO)_2$
MOLECULAR MASS IN Daltons:	176.17
PROPERTIES AND APPEARANCE:	Colourless, oily liquid, bitter taste, soluble in alcohol and water
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	259–261
MELTING RANGE IN °C:	−30
FLASH POINT IN °C:	146
DENSITY AT 25°C (AND OTHER TEMPERATURES) IN g/L:	1.164–1.184
PURITY %:	≥94
HEAVY METAL CONTENT MAXIMUM IN ppm:	5
ARSENIC CONTENT MAXIMUM IN ppm:	3
FUNCTION IN FOODS:	Solvent for flavourings
FOOD SAFETY ISSUES:	Strong oxidising agent, toxic fumes released upon combustion
LEGISLATION:	CANADA: GMP in flavours and unstandardised flavouring preparations
REFERENCE:	Food and Drugs Act (2009) Food and Drug Regulations. Accessed at: http://laws.justice.gc.ca/en/showdoc/cr/C.R.C.-c.870/bo-ga:l_B-gb:l_16/20090831/en#anchorbo-ga:l_B-gb:l_16.

NAME:	Glyceryl tributyrate	
CATEGORY:	Solvent	
FOOD USE:	Ice cream/Candy/Baked goods/Margarine/Pudding/Alcoholic beverages/Fats, oils, fillings	
SYNONYMS:	Tributyrin/CAS 60-01-5/EINECS/ELINCS 200-451-5/FEMA 2223/Butanoic acid 1,2,3-propanetriyl ester/ Butyric acid trimester with glycerine/Butyrin/Butyryl triglyceride/Glycerol tributyrate/Trybutyroin	
FORMULA:	$(C_3H_7COO)_3C_3H_5$	
MOLECULAR MASS IN Daltons:	302.36	
PROPERTIES AND APPEARANCE:	Colourless, oily liquid; bitter taste, very soluble in alcohol, insoluble in water	
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	305–310	
MELTING RANGE IN °C:	−75	
FLASH POINT IN °C:	174	
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.032	
PURITY %:	≥96.5	
HEAVY METAL CONTENT MAXIMUM IN ppm:	10	
ARSENIC CONTENT MAXIMUM IN ppm:	3	
FUNCTION IN FOODS:	Solvent for additives, synthetic flavouring agent, adjuvant in foods	
FOOD SAFETY ISSUES:	Combustible, can react with oxidisers; when heated to decomposition emits acrid smoke and irritating fumes	
LEGISLATION:	**USA:** GMP as flavouring agent and adjuvant, synthetic flavouring GRAS	**CANADA:** GMP in flavours and unstandardised flavouring preparations

REFERENCES:

Ash, M. and Ash, I. (2008) *Handbook of Food Additives*. Synapse Information Resources Inc., New York.
Food and Drug Administration (2009) Listing of Food Additives. Accessed at www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm.
Food and Drugs Act (2009) Food and Drug Regulations. Accessed at http://laws.justice.gc.ca/en/showdoc/cr/C.R.C.-c.870/bo-ga:l_B-gb:l_16/20090831/en#anchorbo-ga:l_B-gb:l_16.

NAME:	Hexane
CATEGORY:	Solvent
FOOD USE:	Extraction solvent for hops, spices, vegetables
SYNONYMS:	Alkane C-6/*n*-Hexane/Hexyl hydride/Normal hexane/CAS 110-54-3
FORMULA:	$CH_3(CH_2)_4CH_3$
MOLECULAR MASS IN Daltons:	86.2
PROPERTIES AND APPEARANCE:	Colourless, volatile liquid, soluble in alcohol and acetone, insoluble in water
BOILING POINT IN °C:	67–70
MELTING RANGE IN °C:	−95
FLASH POINT IN °C:	−21.7
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	0.0659
PURITY %:	98.5
HEAVY METAL CONTENT MAXIMUM IN ppm:	5
STORAGE:	Cool, dry ventilated area, out of direct sunlight; limit large quantities to avoid creating mist
FOOD SAFETY ISSUES:	Dangerous fire/explosive hazard, may react vigorously with oxidising agents, emits acrid smoke and fumes when heated to decomposition
LEGISLATION:	**USA:** 25 ppm as residue in spice oleoresins 2.2% by weight as residue in hops extract, extract added before or during cooking of beer **CANADA:** Spice extracts, natural extractives: 25 ppm Hop extract: 2.2% Vegetable fats, oils and seed meals: 10 ppm

	25 ppm in modified hop extract for beer 5 ppm as residue in fish protein isolate	Pre-isomerised hop extract: 1.5 ppm per percent iso-alpha acid content of the pre-isomerised hop extract
	JAPAN: Approved with restrictions (extraction solvent for hops and spices; processing aid)	

REFERENCES:

Ash, M. and Ash, I. (2008) *Handbook of Food Additives*. Synapse Information Resources Inc., New York.

Food and Drug Administration (2009) Listing of Food Additives. Accessed at www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm.

Food and Drugs Act (2009) Food and Drug Regulations. Accessed at http://laws.justice.gc.ca/en/showdoc/cr/C.R.C.-c.870/bo-ga:l_B-gb:l_16/20090831/en#anchorbo-ga:l_B-gb:l_16.

NAME:	Isopropanol
CATEGORY:	Solvent
FOOD USE:	Baked goods/Beverages/Spices/Beet sugar/Confectionery/Food supplements in tablet form/Gum/Hops extract/Lemon oil/Yeast
SYNONYMS:	Isopropyl alcohol/2-Propanol/Dimethylcarbinol
FORMULA:	$CH_3CHOHCH_3$
MOLECULAR MASS IN Daltons:	60.10
PROPERTIES AND APPEARANCE:	Clear, colourless liquid
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	at 760 mmHg 82.5 at 400 mmHg 67.8 at 200 mmHg 53.0 at 100 mmHg 39.5 at 60 mmHg 30.5 at 40 mmHg 23.8 at 20 mmHg 12.7 at 10 mmHg 2.4
MELTING RANGE IN °C:	−88.5 to −89.5
FLASH POINT IN °C:	11.7
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	0.78505 at 20°C 0.78084 at 25°C 0.728 at 83°C
PURITY %:	99.5
WATER CONTENT MAXIMUM IN %:	<0.2
HEAVY METAL CONTENT MAXIMUM IN ppm:	1

ARSENIC CONTENT MAXIMUM IN ppm: 3

SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:

in water: **@ 20°C** Miscible

in sodium chloride solution (5%): Insoluble

in ethanol solution (5%): Miscible

FUNCTION IN FOODS: Carrier solvent for additives and inks

ALTERNATIVES: Ethanol; methanol; *n*-octyl alcohol

TECHNOLOGY OF USE IN FOODS: Miscible with water, alcohol, ether. Insoluble in salt solutions. Very flammable liquid, reacts with air to form dangerous peroxides

FOOD SAFETY ISSUES: Not subject to concern

LEGISLATION:

USA:
50 ppm residue in spice oleoresins
Maximum of 2.2% residue in hop extracts
Prohibited in bread
6 ppm in lemon oil

CANADA:
50 ppm in spice extracts and natural extractives
GMP in flavour and meat and egg marking inks
0.15% residue in fish protein
GMP in cured meats

UK and EUROPE:
UK: GMP in soft drinks
Norway: GMP in tea, coffee and chocolate drinks
Ireland: GMP in bread

AUSTRALIA/PACIFIC RIM:
Japan: GMP in bread

NAME:	Lactic acid (D, DL or L)
CATEGORY:	Solvent
FOOD USE:	Cheese and cheese products/Ice-cream mix/Baking powder/Olives/Bread/Egg white, egg/powder/Sherbert/Salad dressing/Poultry/Margarine/Mayonnaise/Canned fruit/Pickles/Wine/Alcoholic beverages
SYNONYMS:	2-Hydroxypropanoic acid/α-Hydroxypropanoic acid (DL mixture)/Paralactic acid (L form only)/Sarcolactic acid (L form only)/E270/INS 270/CAS No. 50-21-5/L: 79-33-4; D: 10326-41-7; DL: 598-82-3/Acetonic acid
FORMULA:	CH_3-CHOH-COOH
MOLECULAR MASS IN Daltons:	90.08
PROPERTIES AND APPEARANCE:	Viscous, non-volatile, colourless hygroscopic liquid
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	122 at 14–15 mmHg; 82–85 at 0.5–1 mmHg
MELTING RANGE IN °C:	16.8
IONISATION CONSTANT AT 25°C:	0.000137
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.249 at 15°C
HEAT OF COMBUSTION AT 25°C:	3615 cal/kg
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ARSENIC CONTENT MAXIMUM IN ppm:	3
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	@ 20°C Miscible
in ethanol solution (5%):	Miscible

FUNCTION IN FOODS:	Primarily used as an acidifying agent. Also used as curing agent, flavour enhancer, flavouring agent, and pickling agent. Can be used as a solvent and carrier
TECHNOLOGY OF USE IN FOODS:	Sold as 80% lactic acid in water
FOOD SAFETY ISSUES:	Concern expressed regarding lethality for infants if D or DL forms used. L form is recommended for infant food use
LEGISLATION:	**USA:** GRAS, GMP, Cannot be used in infant foods or formulas
ANY OTHER RELEVANT INFORMATION:	FAO/WHO acceptable daily intake for D(−) isomer is 100 mg/kg body weight

NAME:	Methanol
CATEGORY:	Solvent
FOOD USE:	Spices oleoresins/Hop extracts
SYNONYMS:	Methyl alcohol/Carbinol/Wood alcohol/CAS 67-56-1/Methyl hydroxide
FORMULA:	CH_3OH
MOLECULAR MASS IN Daltons:	32.04
PROPERTIES AND APPEARANCE:	Clear, colourless liquid
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	at 760 mmHg 64.7 at 400 mmHg 49.9 at 200 mmHg 34.8 at 100 mmHg 21.2 at 60 mmHg 12.1 at 50 mmHg 5.0 at 20 mmHg −6.0 at 10 mmHg −16.2 at 5 mmHg −25.3 at 1 mmHg −44
MELTING RANGE IN °C:	64.8
FLASH POINT IN °C:	12
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	**@ 25°C** 0.7866 **@ 20°C** 0.7915 **@ 15°C** 0.7960 **@ 0°C** 0.8100
VAPOUR PRESSURE AT VARIOUS TEMPERATURES IN mmHg	100 mmHg at 20°C
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** Miscible
in sucrose solution (10%):	Miscible

in sodium chloride solution (5%):	Miscible
in ethanol solution (5%):	Miscible
in propylene glycol:	**@ 100°C** Miscible in most organic solvents
FUNCTION IN FOODS:	Carrier solvent for additives, labelling inks
ALTERNATIVES:	Ethanol; propanol; *n*-octyl alcohol
TECHNOLOGY OF USE IN FOODS:	Miscible with water, ethanol, ether. Unlike ethanol, it will dissolve many organic salts. Flammable liquid, can react vigorously with oxidising materials
FOOD SAFETY ISSUES:	Poisoning can occur from ingestion of excess
LEGISLATION:	**USA:** 50 ppm maximum residue in spice oleoresins. 2.2% residue in hop extracts **CANADA:** 50 ppm in spice extracts; 2.2% in hop extracts for use in malt liquors. GMP in meat and egg marking inks

NAME:	Methyl ethyl ketone	
CATEGORY:	Solvent	
FOOD USE:	Ice cream/Candy/Baked goods/Beverages	
SYNONYMS:	MEK/Butanone/2-Butanone/3-Butanone/Ethyl methyl ketone/Methyl acetone/Methyl-2-propanone/ 2-Oxobutane/CAS 78-93-3	
FORMULA:	$CH_3COCH_2CH_3$	
MOLECULAR MASS IN Daltons:	72.1	
PROPERTIES AND APPEARANCE:	Colourless liquid, odour similar to acetone. Soluble in 1 : 4 ratios with water, alcohol and ether, miscible with fixed oils	
BOILING POINT IN °C:	79.6	
MELTING RANGE IN °C:	−86	
FLASH POINT IN °C:	−4.4	
DENSITY AT 4°C (AND OTHER TEMPERATURES) IN g/L:	0.8255	
PURITY %:	>99	
STORAGE:	Cool, dry ventilated area, out of direct sunlight; away from corrosives, heat/ignition sources	
FOOD SAFETY ISSUES:	Flammable, explosive (limits in air 2–10%); incompatible with mixtures of haloforms and strong bases, oxidising agents, mixtures of nitric acid and hydrogen peroxide; emits acrid smoke/fumes when heated to decomposition	
FUNCTION IN FOOD:	Extraction solvent in food processing, synthetic flavouring agent	
LEGISLATION:	**USA:** FEMA GRAS	**CANADA:** Spice extracts, natural extractives: 50 ppm

REFERENCES:

Ash, M. and Ash, I. (2008) *Handbook of Food Additives*. Synapse Information Resources Inc., New York.
Food and Drug Administration (2009) Listing of Food Additives. Accessed at www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm.
Food and Drugs Act (2009) Food and Drug Regulations. Accessed at http://laws.justice.gc.ca/en/showdoc/cr/C.R.C.-c.870/bo-ga:l_B-gb:l_16/20090831/en#anchorbo-ga:l_B-gb:l_16.

NAME:	Methylene chloride	
CATEGORY:	Solvent	
FOOD USE:	Decaffeinated coffee/Fruits/Hops extract/Spice oleoresins/Vegetables	
SYNONYMS:	Dichloromethane/Methane dichloride/Methylene bichloride/Methylene dichloride/CAS 75-09-2	
FORMULA:	CH_2Cl_2	
MOLECULAR MASS IN Daltons:	84.93	
PROPERTIES AND APPEARANCE:	Colourless liquid, volatile, soluble in alcohol, phenols, aldehydes, ether, ketones, miscible with oils, moderately soluble in water (1.32 g/100 g water at 20°C)	
BOILING POINT IN °C:	40.1	
MELTING RANGE IN °C:	−97	
DENSITY AT 15/4°C (AND OTHER TEMPERATURES) IN g/L:	1.335	
PURITY %:	>99	
HEAVY METAL CONTENT IN ppm:	≤1	
STORAGE:	Cool, dry ventilated area, out of direct sunlight; store smallest quantities possible	
FOOD SAFETY ISSUES:	Explosive vapour when exposed to flame/heat; heated to decomposition emits highly toxic fumes. Incompatible with methanol, aluminium powders, amines, quaternary ion exchange resins, DMSO, perchloric acid, alkali metals, nitric acid, etc.	
FUNCTION IN FOOD:	Extraction solvent, colour diluent in foods	
LEGISLATION:	**USA:** <30 ppm, as residual solvent in manufacture of spice oleoresins <10 ppm, in decaffeinated roasted coffee and decaffeinated soluble (instant) coffee	**CANADA:** Spice extracts, natural extractives: 30 ppm Hop extract: 2.2% Green coffee beans and tea leaves for decaffeination purposes: 10ppm in decaffeinated roasted coffee, instant coffee, instant tea, and tea leaves

	<2.2%, as residue in hop extract. Extract added before or during cooking of beer
	<5 ppm, in modified hop extract for beer

REFERENCES:

Ash, M. and Ash, I. (2008) *Handbook of Food Additives*. Synapse Information Resources Inc., New York.

Food and Drug Administration (2009) Listing of Food Additives. Accessed at www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm.

Food and Drugs Act (2009) Food and Drug Regulations. Accessed at http://laws.justice.gc.ca/en/showdoc/cr/C.R.C.-c.870/bo-ga:l_B-gb:l_16/20090831/en#anchorbo-ga:l_B-gb:l_16.

National Academy of Sciences (1981) *Food Chemicals Codex*. 3rd edn. National Academy Press, Washington, DC.

NAME:	Mono- and diglycerides (glycerol monostearate is used as an example)
CATEGORY:	Carrier solvent
FOOD USE:	Annatto butter colour/Annatto margarine colour/Beverages/Baked goods/Fats/Poultry/Ice-cream/Frozen desserts/Cottage cheese/Sausage casing/Sherbert/Fudge and fudge sauces/Whipped topping/Sour cream/Cakes/Caramel/Chewing gum/Coffee whiteners/Peanut butter
SYNONYMS:	INS 471/E471
FORMULA:	$CH_2OOCR\text{-}CHOH\text{-}CH_2OH$ ($CH_2OOCR\text{-}CHOOCR\text{-}CH_2OH$)
MOLECULAR MASS IN Daltons:	Monostearate 357.6; distearate 625.0
ALTERNATIVE FORMS:	Glyceryl monopalmitate/Glyceryl monostearin/Glyceryl dioleate/Glyceryl monooleate/Glyceryl monopalmitin/Glyceryl distearate/Glyceryl monoolein/Glyceryl dipalmitate, etc.
PROPERTIES AND APPEARANCE:	White or cream-coloured fat of waxy appearance
MELTING RANGE IN °C:	56–58
WATER CONTENT MAXIMUM IN %:	2
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ARSENIC CONTENT MAXIMUM IN ppm:	3
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** Insoluble
in ethanol solution (5%):	Soluble
in propylene glycol:	**@ 100°C** Soluble in chloroform and benzene
FUNCTION IN FOODS:	Primarily used as emulsifier, texture modifying agent, humectant, release agent. Can be used as a solvent for antioxidants and spices in beverages. Consists of a mixture of glyceryl mono- and di-esters prepared from fats or oils of edible origin
TECHNOLOGY OF USE IN FOODS:	Soluble in hot organic solvents such as alcohol

FOOD SAFETY ISSUES:	These compounds have not been subject to concern regarding safety		
LEGISLATION:	**USA:** GMP for lard and shortening GRAS as a solvent	**UK and EUROPE:** GMP in soft drinks	**CANADA:** GMP in flavours, annatto butter/margarine colour, unstandardised flavour preparations, food additive preparations

NAME:	Monoglyceride citrate
CATEGORY:	Solvent
FOOD USE:	Helps dissolve antioxidant formulations in foods
SYNONYMS:	CAS 36291-32-4
FORMULA:	N/A; mixture of glyceryl mono-oleate and its citric acid monoester
MOLECULAR MASS IN Daltons:	N/A
PROPERTIES AND APPEARANCE:	White/ivory colour, waxy solid, bland taste/odour, soluble in alcohol, most fat solvents, insoluble in water
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ARSENIC CONTENT MAXIMUM IN ppm:	3
STORAGE:	Store in dry, cool, ventilated area (heat sensitive), out of direct sunlight and away from heat/ignition sources
FOOD SAFETY ISSUES:	Flammable when exposed to heat/flame/oxidisers, may explode upon heating. Incompatible with strong oxidisers, acids, amines, bases, activated carbon, hydrocarbons, chlorosulphonic acid, lead/copper/alloys. When heated to decomposition emits toxic CO, CO_2 and NO_2 fumes
FUNCTION IN FOOD:	Synergist and solubiliser for antioxidants added to fats and oils
LEGISLATION:	**USA:** <200 ppm as a synergist and solubiliser for antioxidants in oils and fats **CANADA:** Spice extracts, natural extracts, unstandardised flavouring preparations: GMP
REFERENCES:	Ash, M. and Ash, I. (2008) *Handbook of Food Additives*. Synapse Information Resources Inc., New York. Food and Drug Administration (2009) Listing of Food Additives. Accessed at www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm. Food and Drugs Act (2009) Food and Drug Regulations. Accessed at http://laws.justice.gc.ca/en/showdoc/cr/C.R.C.-c.870/bo-ga:l_B-gb:l_16/20090831/en#anchorbo-ga:l_B-gb:l_16.

NAME:	2-Nitropropane
CATEGORY:	Solvent
FOOD USE:	Vegetable oils
SYNONYMS:	Dimethylnitromethane/Isonitroproprane/Nitroisopropane/Nitropropane/s-Nitropropane/β-Nitropropane/ Propane 2-nitro-/CAS 79-46-9/2-NP
FORMULA:	$CH_3CH(NO_2)CH_3$
MOLECULAR MASS IN Daltons:	89.09
PROPERTIES AND APPEARANCE:	Colourless or light yellow, oily liquid with mild fruit odour, soluble in alcohol, esters, aromatic hydrocarbons and ethers, slightly soluble in water (1.7 mL/100 mL)
BOILING POINT IN °C:	119–122
MELTING POINT IN °C:	−93
FLASH POINT IN °C:	24
DENSITY AT 25°C (AND OTHER TEMPERATURES) IN g/mL:	0.992
PURITY %:	≥96
STORAGE:	Store in dry, cool, ventilated area (heat sensitive), out of direct sunlight and away from heat/ignition sources
FUNCTION IN FOOD:	Solvent: fractionation of edible fats and oils
FOOD SAFETY ISSUES:	Flammable when exposed to heat/flame/oxidisers, may explode upon heating. Incompatible with strong oxidisers, acids, amines, bases, activated carbon, hydrocarbons, chlorosulphonic acid, lead/copper/alloys. When heated to decomposition emits toxic CO, CO_2 and NO_2 fumes
LEGISLATION:	**USA:** FDA 21 CFR (Registration number 175.105), SARA reportable **CANADA:** Vegetable oils: 0.5 ppm

REFERENCES:

Ash, M. and Ash, I. (2008) *Handbook of Food Additives*. Synapse Information Resources Inc., New York.
Food and Drug Administration (2009) Listing of Food Additives. Accessed at www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm.
Food and Drugs Act (2009) Food and Drug Regulations. Accessed at http://laws.justice.gc.ca/en/showdoc/cr/C.R.C.-c.870/bo-ga:l_B-gb:l_16/20090831/en#anchorbo-ga:l_B-gb:l_16.

NAME:	Octyl alcohol
CATEGORY:	Solvent
FOOD USE:	Processing aid for extraction of citric acid/Beverages/Candy/Gelatin desserts/Ice-cream/Pudding mixes
SYNONYMS:	Caprylic alcohol/Alcohol-C8/Octanol/Heptyl carbinol/*n*-Octanol/l-Hydroxyoctane
FORMULA:	$C_8H_{18}O$
MOLECULAR MASS IN Daltons:	130.26
PROPERTIES AND APPEARANCE:	Colourless, viscous liquid
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	239.7
MELTING RANGE IN °C:	16.7
FLASH POINT IN °C:	81
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	0.910
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 0.068
in ethanol solution (5%):	Miscible
FUNCTION IN FOODS:	Extraction solvent for citric acid produced during fermentation with *Aspergillus niger*. Combustible liquid if exposed to heat; flame can react with oxidising materials
TECHNOLOGY OF USE IN FOODS:	Used as a processing aid in the production of citric acid
LEGISLATION:	**USA:** Limited to 16 ppm residual in citric acid. Only used for encapsulation of essential oils

NAME:	1,2-Propanediol
CATEGORY:	Solvent
FOOD USE:	Margarine/Baked goods/Poultry/Seasonings/Beverages (alcoholic)/Flavourings/Wine/Frostings/Frozen dairy products/Hog carcasses/Confections/Nut products
SYNONYMS:	Propylene glycol/Methyl glycol/Methylethylene glycol/1,2-Dihydroxypropane/INS No. 1520/CAS No. 57-55-6/Trimethylglycol/Propabe-1,2-diol
FORMULA:	$CH_3CHOHCH_2OH$
MOLECULAR MASS IN Daltons:	76.10
ALTERNATIVE FORMS:	L or D form available
PROPERTIES AND APPEARANCE:	Viscous, clear, colourless liquid; slight bitter taste
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	45.5 at 1.0 mmHg
MELTING RANGE IN °C:	59
FLASH POINT IN °C:	99
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.0362 at 25°C
WATER CONTENT MAXIMUM IN %:	0.2
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ARSENIC CONTENT MAXIMUM IN ppm:	3
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** Miscible
in ethanol solution (5%):	Miscible

FUNCTION IN FOODS: Solvent for flavour extracts. Also used as an anti-caking agent in salt. Can be used as a humectant

ALTERNATIVES: Glycerol; butylene glycol; sorbitol

TECHNOLOGY OF USE IN FOODS: Miscible with water. Will dissolve many essential oils. Under normal conditions is stable but when exposed to high temperatures, will oxidise. Combustible liquid when exposed to heat or flame can react with oxidising materials

FOOD SAFETY ISSUES: *Codex Alimentarius* acceptable daily intake is 25 mg/kg

LEGISLATION:

USA:
GMP that results in maximum of 5% for alcoholic beverages; 24% for confections and frostings; 2.5% for frozen dairy products; 97% for seasonings and flavourings; 5% for nuts and nut products and 2% for all other food categories.
GRAS

UK and EUROPE:
UK: allowed without limit in baked goods; GMP in soft drinks
Finland: 3000 ppm in baked goods; GMP in soft drinks
Sweden: GMP in baked goods
Norway: GMP in tea, coffee and chocolate drinks

CANADA:
GMP in flavour extracts, essence, oil-soluble annatto butter colour, annatto-coloured margarine; colour mixtures and preparations; and food additive preparations

AUSTRALIA/PACIFIC RIM:
Japan: GMP in baked goods; 600 ppm tea, coffee and chocolate drinks

NAME:	Triacetyl glycerin
CATEGORY:	Solvent
FOOD USE:	Baked goods and baking mixes/Alcoholic beverages/Fresh fruit and vegetables/Chewing gum/Confections and frostings/Frozen dairy desserts/Raisins/Gelatins/Puddings and fillings/Non-alcoholic beverages/Frostings
SYNONYMS:	Triacetin/1,2,3-Propanetriol triacetate/Glycerintriacetate/Enzactin/Fungacetin/INS 1518/CAS 102-76-1
FORMULA:	$C_3H_5(OCOCH_3)_3$
MOLECULAR MASS IN Daltons:	218.21
PROPERTIES AND APPEARANCE:	Colourless, oily liquid; bitter taste
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	258–260
MELTING RANGE IN °C:	78
FLASH POINT IN °C:	138
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.1562 at 25°C 1.1596 at 20°C
PURITY %:	98.5
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ARSENIC CONTENT MAXIMUM IN ppm:	3
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 7.14 (soluble)
in ethanol solution (5%):	Miscible
FUNCTION IN FOODS:	Solvent for additives, such as flavouring and colourings
TECHNOLOGY OF USE IN FOODS:	Combustible when exposed to heat, flame and powerful oxidisers

FOOD SAFETY ISSUES:	Not an additive that has been subject to concern		
LEGISLATION:	**USA:** GMP in baked goods, baking mixes, alcoholic beverages, non-alcoholic beverages and beverage bases, chewing gum, confections and frostings, frozen dairy desserts and mixes, gelatins, puddings and fillings, hard candy and soft candy. GRAS	**UK and EUROPE:** Belgium: 1000 ppm in egg powder Ireland: GMP Norway: GMP in tea, coffee and chocolate drinks Switzerland: GMP in cake mixes France: <3000 ppm in raisins UK: GMP in soft drinks	**CANADA:** GMP in flavours and unstandardised flavouring preparations

NAME:	Triethyl citrate	
CATEGORY:	Solvent	
FOOD USE:	Dried egg whites/Flavouring agent	
SYNONYMS:	Ethyl citrate/2-Hydroxy-1,2,3-propanetricarboxylic acid/Triethyl ester/Triethyl-2-hydroxypropan-1,2,3-tricarboxylate/CAS 77-93-0, TEC	
FORMULA:	$C_3H_5O(COOC_2H_5)_3$	
MOLECULAR MASS IN Daltons:	276.32	
PROPERTIES AND APPEARANCE:	Colourless liquid, oily, odourless, bitter taste, soluble in water (65 g/100 mL), soluble in oil (0.8 g/100 mL), miscible with alcohol and ether, sweet (plum like) flavour	
BOILING POINT IN °C:	294	
FLASH POINT IN °C:	150.6	
DENSITY AT 25°C (AND OTHER TEMPERATURES) IN g/L:	1.136	
HEAVY METAL CONTENT MAXIMUM IN ppm:	10	
ARSENIC CONTENT MAXIMUM IN ppm:	3	
PURITY %:	≥99	
STORAGE:	Store in well-closed containers	
FOOD SAFETY ISSUES:	Combustible when exposed to heat/flame. When heated to decomposition emits acrid smoke and irritating fumes	
FUNCTION IN FOOD:	Flavouring agent, foam stabiliser	
LEGISLATION:	**USA:** FEMA GRAS, limit 0.25% in dried egg whites	**CANADA:** Flavours and unstandardised flavouring preparations: GMP

REFERENCES:

Ash, M. and Ash, I. (2008) *Handbook of Food Additives*. Synapse Information Resources Inc., New York.
Food and Drug Administration (2009) Listing of Food Additives. Accessed at www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm.
Food and Drugs Act (2009) Food and Drug Regulations. Accessed at http://laws.justice.gc.ca/en/showdoc/cr/C.R.C.-c.870/bo-ga:l_B-gb:l_16/20090831/en#anchorbo-ga:l_B-gb:l_16.

Part 14

Sweeteners

Lily Hong-Shum

This Part is based upon the First Edition contribution of David K. MacKinnon

Food Additives Data Book, Second Edition. Edited by Jim Smith and Lily Hong-Shum.

NAME:	Acesulfame-K
CATEGORY:	Non-nutritive sweetener/Flavour modifier
FOOD USE:	Baked goods (dry bases for mixes)/Beverages (dairy beverages, instant tea, instant coffee, dry bases for mixes, fruit-based beverages)/Soft drinks (colas, citrus-flavoured drinks, fruit-based soft drinks)/Sugars, sugar preserves and confectionery (calorie-free dustings, frostings, icings, toppings, fillings, syrups)/Alcoholic drinks (beer)/Vinegar, pickles and sauces (sandwich spreads, salad dressings, pickles, sauces, toppings)/Dairy products (yoghurt and yoghurt-type products, dry bases for puddings, desserts and dairy analogues, sugar-free ice-cream)/Fruit, vegetables and nut products (fruit drinks, fruit products, fruit yoghurt, sugar-free jams and marmalades, low-calorie preserves)/Other (oral cosmetics, pharmaceuticals, chewing gums, liquid concentrates, frozen and refrigerated desserts)
SYNONYMS:	As potassium salt: CFSAN = Acesulfame potassium/CAS 5589-62-3/Potassium acesulfame/Acesulfame K/Sunnette/Acetosulfam/Potassium 6-methyl-1,2,3-oxathiazin-4(3*H*)-1,2,2-dioxide/HOE-095K/E950 General form: 6-Methyl-1,2,3-oxathiazin-4(3*H*)-1,2,2-dioxide/6-Methyl-3,4-dihydro-1,2,3-oxathiazin-4-1,2,2-dioxide/Acetosulfam
FORMULA:	$C_4H_5NSO_4$ (general form); $C_4H_4NSO_4K$ (potassium salt)
MOLECULAR MASS IN Daltons:	163.15 (201.24 as potassium salt)
ALTERNATIVE FORMS:	Potassium salt
PROPERTIES AND APPEARANCE:	White crystalline solid. Potassium salt: colourless, odourless powder. Sweet taste (200 times sweeter than sucrose); very slight bitter/astringent aftertaste, noticeable at high concentrations. Rapid onset time; thin mouthfeel body
MELTING RANGE IN °C:	250 (potassium salt); begins to decompose at 225°C on slow heating
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	Solid: 1.81 g/cm^3 Bulk: 1.1–1.3 kg/dm^3
PURITY %:	99.0 after drying
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ARSENIC CONTENT MAXIMUM IN ppm:	3

SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:

in water:	**@ 20°C** 31% weight/unit volume, or 360 g/L **@ 50°C** 830 g/L **@ 100°C** 100% weight/unit volume or 1300 g/L
in ethanol solution:	
20%	221 g/L in 20:80 vol/vol ethanol/water solution at 23°C
100%	0.1% at 20°C or 1 g/L

FUNCTION IN FOODS: Non-nutritive sweetening agent (200 times sweetness of sucrose); flavour modifier.

ALTERNATIVES: Aspartame (similar to acesulphame–thaumatin mixture)

TECHNOLOGY OF USE IN FOODS:

Very soluble in water, DMF, DMSO. Non-hygroscopic. Soluble in alcohol, glycerin-water. Stable for several months at pH 3 or higher; stable to pasteurisation and sterilisation at pH >3; stable to baking at temperatures >200°C.

Shelf-stable for more than 5 years in solid form; no hydrolysis of sterilised solution stored for 1 month at 40°C.

A solution of 400–700 mg/L produces a medium sweetness in drinks. Chemically and sensorily compatible with all sugars; best used in acidic foods; sweetness intensity not diminished in hot drinks.

No hydrolytic decomposition of stock solutions with pH >3 for several months. When used in solution, adjust pH to 5.5–6.0 range using appropriate buffer system.

Can supplement sugar alcohols in sugar-free ice-cream without affecting melting and whipping properties. Use at 500 mg/kg. Can be used to mask bitter and other unpleasant taste characteristics of other products. Can be used alone in food products. Some benefits from combinations with bulk sweeteners; may be some cost advantage to combining with thaumatin with a taste result equivalent to aspartame.

Good solubility and stability in aqueous media. Sweetness in acid foods slightly higher than in neutral; heat does not cause reduction in sweetness relative to room temperature as it does in other sweeteners; can be added to liquid concentrates; can be processed in spray towers and in instant beverage powders due to its heat stability.

In combination with other sweeteners, best taste profile in soft drinks obtained when each sweetener contributes 50% of sweetness; pleasant taste results from mixtures with other high-intensity sweeteners, particularly aspartame and cyclamate.

Heat stability and good solubility aids in use in production of table-top formulations, solutions (should be adjusted to pH 5.5 to 6.0 with appropriate buffer systems) or spray-dried granular or powder preparations.

Disintegrant (e.g. low-viscosity carboxymethylcellulose or polyvinyl pyrrolidine) required when compressing into tablets. In production of effervescent tablets, use sodium hydrogen carbonate (carbon dioxide donor), tartaric acid (acid medium) and small amounts of cold water-soluble gelatin. Result has a good shelf-life when stored in a dry place. Table-top powders can be produced by combining with inert substances or with citrates, tartrates, lactose and/or polyols. Calorie-free dustings can be produced by combining with pure cellulose.

Low-calorie preserves produced by combining with pectins and other gelling agents which provide bulk. More susceptible to microbiological spoilage than preserves containing sugar. Should be pasteurised or add 0.05–0.1% potassium sorbate preservative (if permitted). Add as an aqueous solution of 500–2500 mg/kg final product

weight to aid even dispersion. Sugar-free jams and marmalades produced in combination with sorbitol. More susceptible to microbiological spoilage than preserves containing sugar. Should be pasteurised or add 0.05–0.1% potassium sorbate preservative (if permitted). Add as an aqueous solution of 500–2500 mg/kg final product weight to aid even dispersion. At a level of 1000–3000 mg/kg final product weight can be used to replace sugar in confectionery due to good heat stability. Combine with polydextrose, disaccharide alcohols, sorbitol or isomalt to provide bulk. At a level of 500–2000 mg/kg final product weight can be used to replace sugar in bakery products due to good heat stability. Combine with polydextrose, disaccharide alcohols, sorbitol or isomalt to provide bulk.

At a level of 500–600 mg/kg final product weight can replace sugar in desserts. At a level of 500–3000 mg/kg final product weight can replace sugar in chewing gum; 500 mg/kg final product weight may be added to sugar-free ice-cream to supplement polyols to achieve a well-balanced taste. Does not affect melting and whipping properties of the mix. Can be used to sweeten pharmaceuticals and oral hygiene products as it masks bitter and other unpleasant tastes.

At room temperature, 0.1% soluble in ethanol (0.1 g/100 mL), and more than 30% soluble in DMSO. Solubility in water as follows:

14 g/100 mL at 0°C

27 g/100 mL at 20°C (31%)

130 g/100 mL at 100°C (100%)

No browning reaction. Solubility in organic solvents poor; solubility increases in solvent/water mixtures.

Sweetness potency relative to sucrose decreases with increasing concentration; sweetness potency relative to sucrose varies with the medium in which the sweetener is being tested and the method used for quantifying sweetness; values range from 110 at 10% sucrose equivalence to 200 at 3% sucrose equivalence; taste profile considered to be superior to that of saccharin; sugar alcohols, maltol and ethyl maltol can be used to mask aftertaste.

Using acesulfame only: 600–800 mg/L appropriate for cola soft drinks; 550–750 mg/L appropriate for citrus-flavoured soft drinks. Blending aspartame gives a more acceptable soft-drink product.

Using 50/50 combination of acesulfame and aspartame: 160–170 mg/L appropriate for cola soft drinks; 140–150 mg/L appropriate for citrus soft drinks.

Appears to be non-reactive with other soft-drink ingredients. Adds potassium ions to beverage mixes, so care must be taken when selecting clouding agents and stabilisers.

HPLC may be used for quantitative analysis with detection in the UV range; quantitative analysis may be performed using thin-layer chromatography; methods using isotachophoretic techniques can be used to detect acesulfame-K, saccharin and cyclamate simultaneously. UV absorption in water: maximum 227 nm; fluorine, not more than 30 mg/kg.

Commercially successful combination of sucrose/acesulfame/aspartame: at 270:1.5:1.0 (or 40%/30%/30%) gives good sweetness at 33% of calories from sucrose alone. Used in blackcurrant, where fruitiness enhancement is important. Good stability in fruit-based soft drinks.

Solubility in water:

0°C	150 g/L
10°C	210 g/L
20°C	270 g/L
30°C	360 g/L
40°C	460 g/L
50°C	580 g/L
70°C	830 g/L
100°C	1300 g/L

Solubility at 20°C:

Methanol = 10 g/L
Anhydrous ethanol = 1 g/L
Anhydrous glycerol = 30 g/L
80:20 glycerol/water (v/v) = 82 g/L
50:50 glycerol/water (v/v) = 162 g/L
Acetone = 0.8 g/L
Glacial acetic acid = 130 g/L

Solubility at 23°C:

80:20 ethanol/water (v/v) = 46 g/L
60:40 ethanol/water (v/v) = 100 g/L
40:60 ethanol/water (v/v) = 155 g/L
20:80 ethanol/water (v/v) = 221 g/L

SYNERGISTS:

Sorbitol (1:150–200); sucrose (1:100–150); isomalt (1:250–300), said to round up sorbitol's sweet taste; maltitol (1:150); up to 30% increase in sweetness intensity with cyclamate and aspartame; aspartame (1:1); sodium cyclamate (1:5); also with fructose, thaumatin; barely noticeable improvement in combination with saccharin

FOOD SAFETY ISSUES:

Emits toxic fumes of SO_x when heated to decomposition. Non-mutagenic. No adverse reactions have been found; not metabolised in the body, has no calorific value and suitable for diabetics; excreted rapidly and completely. Non-cariogenic with acute oral toxicity being extremely low. Metabolised by few microorganisms. Decomposes to acetoacetamide under certain conditions, but both acesulfame and acetoacetamide were found to be non-toxic.

LEGISLATION:

USA:

FDA approved for ADI of 15 mg/kg body weight. Expected to be sufficient to allow almost complete replacement of all sugar in the diet of the average person.

Approved by US FDA in 1988 for use in dry beverage mixes, instant coffee, tea, gelatins, puddings, non-dairy creamers, and chewing gum

CFR 21

PART 172: Food Additives Permitted for Direct Addition to Food for Human Consumption Subpart I – Multipurpose Additives

172.800 – Acesulfame potassium

[53 FR 28382, July 28, 1988, as amended at 57 FR 57961, Dec. 8, 1992; 59 FR 61540, 61543, 61545, Dec. 1, 1994]

Acesulfame potassium (CAS Reg. No. 55589-62-3), also known as acesulfame K, may be safely used as a sweetening agent in food in accordance with the following prescribed conditions:

(a) Acesulfame potassium is the potassium salt of 6-methyl-1,2,3-oxathiazine-4(3*H*)-one-2,2-dioxide.

(b) The additive meets the following specifications:

(1) Purity is not less than 99% on a dry basis. The purity shall be determined by a method titled 'Acesulfame Potassium Assay' (see reference). Copies are available from the Division of Food and Color Additives, Center for Food Safety and Applied Nutrition (HFF-330), Food and Drug Administration, 200 C St. SW., Washington, DC 20204, or available for inspection at the Office of the Federal Register, 800 North Capitol Street, NW., suite 700, Washington, DC 20408.

(2) Fluoride content is not more than 30 parts per million, as determined by method III of the Fluoride Limit Test of the *Food Chemicals Codex*, 3d edn (1981), p. 511 (see reference). Copies are available from the National Academy Press, 2101 Constitution Ave NW., Washington, DC 20418, or available for inspection at the Office of the Federal Register, 800 North Capitol Street, NW., suite 700, Washington, DC 20408.

(c) The additive may be used in the following foods when standards of identity established under section 401 of the Federal Food, Drug, and Cosmetic Act do not preclude such use:

(1) Sugar substitute, including granulated, powdered, liquid, and tablet form.

(2) [Reserved].

(3) Chewing gum.

(4) Dry bases for beverages, instant coffee, and instant tea.

(5) Dry bases for gelatins, puddings, and pudding desserts.

(6) Dry bases for dairy product analogues.

(7) Confections, hard candy, and soft candy.

(8) Baked goods and baking mixes, including frostings, icings, toppings, and fillings for baked goods.

(9) Yoghurt and yoghurt-type products.

(10) Frozen and refrigerated desserts.

(11) Sweet sauces, toppings, and syrups.

(d) If the food containing the additive is represented to be for special dietary uses, it shall be labelled in compliance with part 105 of this chapter.
(e) The additive shall be used in accordance with current good manufacturing practice in an amount not to exceed that reasonably required to accomplish the intended effect.

UK and EUROPE:

Permitted for use in EU in non-alcoholic drinks (350 mg/L)
Desserts and similar products (350 mg/kg)
Confectionery (200–2000 mg/kg)
Food Supplements or Dietary Foods (25–200 mg/kg)
FACC: 1983 (in UK)
JECFA assigned ADI of 0–9 mg/kg body weight in 1983
JECFA found was not mutagenic, carcinogenic, or any other toxicological properties
Approved for general use in Germany, Russia, Belgium and Denmark
Approved for use in toothpaste in Bulgaria and USSR
Regulatory Status: ADI level as of 1990 for use in soft drinks

Belgium	600 mg/L
Denmark	250 mg/L
Finland	Not permitted
France	360 mg/L
East Germany	Not permitted
West Germany	Permitted
Greece	Permitted
Ireland	Permitted
Netherlands	600 mg/L (pending approval)
Norway	Not permitted
Spain	Not permitted
Switzerland	Permitted
Turkey	Permitted
UK	Permitted
USSR	Not permitted
Yugoslavia	Not permitted

CANADA:

Canada CFR 67.30, Table IX: Food additives that may be used as Sweeteners, Item A.01 (September 12, 2009)

Permitted in or on	Maximum level of use
(1) Table-top sweeteners	Good Manufacturing Practice
(2) Carbonated beverages	0.025% in beverages as consumed
(3) Beverages; beverage concentrates, beverage mixes; dairy beverages; (except for any of these products for which standards are set out in these Regulations)	0.05% in beverages as consumed
(4) Desserts; dessert mixes; toppings; fillings; filling mixes; (except for any of these products for which standards are set out in these Regulations)	0.1% in products as consumed
(5) Chewing gum; breath-freshener products	0.35%
(6) Fruit spreads (except for any of these products for which standards are set out in these Regulations)	0.1%
(7) Salad dressings (except for any of these products for which standards are set out in these Regulations)	0.05%
(8) Confectionery	0.25%
(9) Bakery mixes; bakery products; (except for any of these products for which standards are set out in these Regulations)	0.1% in products as consumed

AUSTRALIA/PACIFIC RIM:

Approved for use in Australia

Regulatory Status: ADI level as of 1990 for use in soft drinks

Australia	3000 mg/kg
Japan	Not permitted
New Zealand	Pending approval

OTHER COUNTRIES:

Accepted as safe by WHO/FAO with an ADI of 0–9 mg/kg body weight

Approved for use in South Africa, Cyprus, and Egypt

No approval required for use in many countries because of its demonstrated safety

Regulatory Status: ADI level as of 1990 for use in soft drinks

Argentina	Not permitted
Brazil	600 mg/L
Israel	Not permitted
Kenya	Not permitted
Mexico	Not permitted
Saudi Arabia	Not permitted
South Africa	1000 mg/L

REFERENCES:

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O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ.

Smith, J. (1991) *Food Additive User's Handbook.* Blackie Publishing, Glasgow.
Smoley, C.K. (1993) *Everything Added to Food in the United States.* US Food and Drug Administration, CRC Press, Boca Raton, FL.
Solutions CFR + Database (1996). Accessed at: http://www.gpoaccess.gov/cfr/
Wong, D.W.S. (1989) *Mechanism and Theory in Food Chemistry.* Van Nostrand Reinhold, New York.

ANY OTHER RELEVANT INFORMATION:

A potassium salt derived from acetoacetic acid. Discovered by accident in 1967 by employees of Hoechst AG. Currently marketed by Hoechst as Sunnett®.

NAME:	*N*-Acetylglucosamine
CATEGORY:	Sweetener
SYNONYMS:	CAS 7512-17-6/EINECS 231-368-2
FORMULA:	$C_8H_{15}NO_6$
MOLECULAR MASS IN Daltons:	221.21
MELTING RANGE IN °C:	215
LEGISLATION:	**AUSTRALIA/PACIFIC RIM:** Japan: approved
REFERENCES:	Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook.* Gower Publishing, Brookfield, VT. Smoley, C.K. (1993) *Everything Added to Food in the United States.* US Food and Drug Administration, CRC Press, Boca Raton, FL.

NAME:	Alitame
CATEGORY:	Sweeteners
SYNONYMS:	L-α-Aspartyl-*N*-(2,2,4,4-tetramethyl-3-thietanyl)-D-alaninamide, hydrated/CAS 80863-62-3 (anhydrous)/CAS 99016-42-9 (hydrated)/INS956/Aclame (Danisco)/CP-54802
FORMULA:	$C_{14}H_{25}N_3O_4S \cdot 2.5H_20$ (empirical)
MOLECULAR MASS:	331.435
PROPERTIES AND APPEARANCE:	White crystalline powder, odourless or slightly characteristic odour, intensely sweet taste, freely soluble in water and ethanol, dipeptide amine, approximately 2000 times sweeter than sucrose. Dipeptide made of two amino acids, L-aspartic acid and D-alanine. Non-hygroscopic powder, solubility in water (%w/v) (pH 5.6) −13.1; methanol (41.9), ethanol (61.0), propylene glycol (53.7); chloroform (0.02); *n*-heptane (0.001)
MELTING RANGE IN °C:	136–147
FUNCTION IN FOODS:	Non-nutritive sweeteners
LEGISLATION:	**AUSTRALIA/PACIFIC RIM:** Permitted for use in Australia, New Zealand, Indonesia and China
REFERENCES:	www.medicinescomplete.com/mc/merck/current. Merck Index Online. Accessed 5–6 September 2009. Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York. Shmuel, Y. (ed.) (2004) *Dictionary of Food Compounds with CD-ROM: Additives, Flavors and Ingredients*. Chapman & Hall/CRC, USA.
ANY OTHER RELEVANT INFORMATION:	Manufacturer/Distributor: Adept Sol'ns., Advanced Ingreds., Danisco Cultor, TasteTech Ltd Trade names: Aclame™

NAME:	Arabinose
CATEGORY:	Sweetener
SYNONYMS:	CFSAN L-Arabinose/CAS 5328-37-0/Pectin sugar/FEMA 3255
FORMULA:	$C_5H_{10}O_5$
MOLECULAR MASS IN Daltons:	150.13
MELTING RANGE IN °C:	157–160
PROPERTIES AND APPEARANCE:	Orthorhombic bi-sphenoidal crystals
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 1 g/mL
in alcohol:	250 mL in 90% alcohol
FUNCTION IN FOODS:	Used as a culture medium for some bacteria. Application in foods under investigation. Natural sweetener for foods and pharmaceuticals.

LEGISLATION:	**USA:**	**CANADA:**	**AUSTRALIA/PACIFIC RIM:**
	FEMA GRAS	DSL (Canadian Provisional Domestic Substance List)	Japan: approved

REFERENCES:

www.medicinescomplete.com/mc/merck/current. Merck Index Online. Accessed 5–6 September 2009.

Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook.* Gower Publishing, Brookfield, VT.

Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York.

Shmuel, Y. (ed.) (2004) *Dictionary of Food Compounds with CD-ROM: Additives, Flavors and Ingredients*. Chapman & Hall/CRC, USA.

Smoley, C.K. (1993) *Everything Added to Food in the United States.* US Food and Drug Administration, CRC Press, Boca Raton, FL.

ANY OTHER RELEVANT INFORMATION:	Natural sweetener; can be found in plants in the form of a complex polysaccharide; can be found in mycobacteria. Manufacturer/Distributor: CarboMer; Danisco Sweeteners; Ferro Pfanstiehl Europe; Fleurchem; Fluka; P.L. Thomas; Ruger; Spectrum Quality Prods Sweetness: 0.37 times sweeter than sucrose

NAME:	Aspartame
CATEGORY:	Sweetener/Non-Nutritive additive/Flavour enhancer/Dipeptide
FOOD USE:	Baked goods (desserts, dessert toppings, dessert mixes, topping mixes, fillings, filling mixes)/Bakery products (encapsulated aspartame)/Bakery mixes (encapsulated aspartame)/Dairy products (dry mixes for dairy products, frozen desserts)/Beverages (beverage concentrates, tea beverages, beverage mixes)/Cereals and cereal products/Soft drinks/Sugars, sugar preserves and confectionery (table use, confectionery, sugar-free syrups, jams and jellies, purées and sauces, confectionery glazes)/Other (pharmaceutical tablets, chewable vitamins, chewing gum, emulsions, breath mints, breath-freshener products)/Vinegar, pickles and sauces (salad dressings, condiments)/Fruit, vegetable and nut products (peanut and other nut spreads)
SYNONYMS:	CFSAN Aspartame/CAS 22839-47-0/EINECS/ELINCS 245-261-3/INS951/Aspartylphenylalanine methyl ester/*N*-L-α-aspartyl-L-phenylalanine-1-methyl ester/3-Amino-*N*-(α-carboxyphenethyl)succinamic acid *N*-methyl ester/SC 18862/Tri-Sweet/APM/Usal/Cauderal/Pouss-Suc/HSC Aspartame/Canderel/Equal/NutraSweet/Sanecta/Methyl aspartylphenylalanate/1-Methyl N L-α-aspartyl-L-phenylalanine, Equal (Nutrasweet Co.); Nutrasweet (Nutrasweet Co.); Sanecta (Holland Sweetener)
FORMULA:	$HOOCCH_2CH(NH_2)CONHCH(CH_2C_6H_5)COOCH_3$
MOLECULAR MASS IN Daltons:	294.31
ALTERNATIVE FORMS:	α-(L)-Asp-(L)-Phe-OMe/α-(L)-Asp-(L)-Met-OMe/α-(L)-Asp-(L)-Phe-OEt[b]/D,L-Ama-(L)-Phe-OMe[c]/α-(L)-Asp-(L)-Tyr-OMe
PROPERTIES AND APPEARANCE:	White crystalline powder or colourless needles. Odourless. Clean sweet, agreeable taste (160 to 200 times sucrose); prolonged sweet aftertaste; no bitter or metallic aftertaste; fair mouthfeel; consists of L-aspartic acid and the methyl ester of L-phenylalanine; artificial sweetener. Slightly soluble in water alcohol
MELTING RANGE IN °C:	245–248
PURITY %:	98–102 assay
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 38% (pH 4.5–6.0 in 0.8% aqueous solution) 1.0 g/L
in vegetable oil:	Insoluble
in ethanol solution:	**@ 100%** 0.4% at 25°C

FUNCTION IN FOODS: Intense sweetener (160 to 250 times sweetness of sucrose); flavour enhancer, particularly in citrus drinks.

TECHNOLOGY OF USE IN FOODS:

Unstable in aqueous solution: 50% degraded after 36 days; 50–60% degraded at pH 3.5 after 36 days. 100% hydrolysed in pH 7.4 in 9 days. 5-year shelf-life in tightly closed container with sealed inner bag under cool, dry conditions.

Do not use in canned foods or products which will be baked or roasted. Can be used in acidified liquids and high-acid carbonated beverages. Not soluble in fats and oils.

Does not act the same as sucrose, so should not be used as a simple substitute; unstable under certain conditions; mixtures result in improved processing and shelf stability, and producing a balanced taste; blends well with other food flavours; interacts with other flavours differently than does sucrose so should not be used as a simple sucrose substitute; has flavour-enhancing properties, especially with citrus fruit drinks; overall acceptability of certain carbonated soft drinks remains high over a range of concentrations.

Can be used in HTST (high-temperature/short time) processes, allowing it to be used in dairy products and baking using this method. Not soluble in fats and oils. At pH 3.5 after 36 days, 50–60% degraded. At pH 7.4 after 9 days, fully hydrolysed. No browning reaction.

Solubility is adequate for most food applications; solubility increases in acid conditions and with increasing temperatures; sparingly soluble in solvents.

Has a similar taste profile to sucrose (one of the main reasons for its success); relative sweetness 180 at 10% sucrose equivalence, level most often used in soft drink preparations.

Flavour enhancement with fruit flavours, notably natural flavours. As sole sweetener: 500–600 mg/L appropriate for cola beverages; 400–600 mg/L appropriate for lemonade beverages.

Degrades in solution: hydrolysis of ester bond produces aspartyl-L-phenylalanine and methanol; at pH 5 and above, degrades to diketopiperazine (DKP) and methanol; then DKP hydrolyses to aspartyl-L-phenylalanine which can hydrolyse to aspartic acid and phenylalanine; pH, temperature, moisture and time dictate rate of decomposition; optimum pH range is 3.0–5.0 with maximum stability at pH 4.3.

Minimally affected by UHT aseptic processes; typical losses in the range of 0.5–5%.

More stable in ready-to-drink products than in post-mix or fountain syrups due to lower pH in concentrates. As aspartame concentration decreases, relative sweetness of the product increases; up to 40% can be lost before the product becomes unacceptable.

Stable for several years when properly stored in dry form, so ideal for powdered soft drinks; research into making aspartame more stable has resulted in several patents, most involving co-drying with acidulants and/or bulking agents or encapsulating the product. None is applicable to liquid situations.

When used in soft drinks, qualitative and quantitative spectroscopic analyses can be made through amino acid detection based on its reaction with ninhydrin; presence in soft drinks can be detected using HPLC methods, which may also allow for simultaneous detection of other product constituents; presence in soft drinks can be detected using a non-chromatographic method based on non-aqueous perchloric acid titration.

Granular form reduces dusting and increases flowability; encapsulated form recommended for baked goods.

Liquid provides quick dissolution and handling ease; cannot be used in canned or fried foods due to low thermal stability; can be thermally stabilised somewhat through encapsulation.

Slow to hydrolyse; susceptible to hydrolysis, other chemical interactions, and microbial degradation in aqueous system. At alkaline pH, solution reacts readily with vanillin, resulting in a loss of vanilla flavour.

Commercially successful formulations are:

Aspartame

Aspartame/saccharin: at ratio of 2:1 or 50%/50% sweetness; gives good sweetness and saccharin stabilises sweetness to provide longer shelf-life.

Sucrose/acesulfame/aspartame: at ratio of 270:1.5:1.0 or 40%/30%/30% sweetness gives good sweetness and 33% of calories of using sucrose alone; used in blackcurrant, where fruitiness enhancement is important.

Solubility increases with decrease in pH.

Storage stability affected by instability in high-acid/low-pH beverages; cannot be used in in-pack pasteurised products; compatible with most flavours, and enhances fruit flavours.

SYNERGISTS:

Saccharin, acesulfame, cyclamates, sucrose, glucose, isomalt (isomalt steuroside), stevioside.

With saccharin, produces sweeter tastes than either alone; cost reduction by mixing with acesulfame-K, sodium saccharin, sodium cyclamate, glucose or sucrose: Chewing gum: sodium saccharinate/aspartame (1:2); cola drinks: sodium saccharin/aspartame (1:1); orange juice: aspartame/glycosyl stevioside (1–10:1); dry-mix: 1 g aspartame to 50 g sorbose; table-top sweetener: sodium saccharinate/aspartame (4:2 mg); table-top sweetener: sodium saccharinate/aspartame/sodium cyclamate (4:10:30 mg); sucrose substitute for diabetics: xylitol (44.184 g)/sorbitol (179 g)/aspartame (0.35 g).

Aspartame/cyclamate (1–2:6–1) and acesulfame K/aspartame (1:1) are more stable, improve flavour of sweeteners.

Cost can be reduced using mixtures with acesulfame K, sodium saccharin, sodium cyclamate, glucose or sucrose as they are synergistic.

Isomalt is synergistic with aspartame as it masks the metallic aftertaste.

ANTAGONISTS:

Conditions of pH, temperature and moisture cause decomposition of aspartame, resulting in loss of flavour. Loss of sweetness may result on prolonged exposure to high temperatures; loses flavour in neutral solutions such as dairy products. Sweetness loss from hydrolysis. In alkaline pH solutions, reacts readily with glucose to reduce aspartame's sweetness

FOOD SAFETY ISSUES:

Allergic dermatitis by ingestion (human systemic). Possible link to neural problems. Headaches, dizziness to those sensitive to chemicals. Experimental reproductive effects.

Emits toxic fumes of NO_x, CO and CO_2 when heated to decomposition.

Not to be used by individuals with phenylketonuria (PKU) as it contains an amino acid the intake of which must be limited in these individuals. Label must state: 'Phenylketonurics: contains phenylalanine'.

One of the most thoroughly tested food additives; toxicity of components (amino acids, aspartic acid, phenylalanine) and metabolite (methanol) is dose-related. Expected levels of consumption are not expected to pose a risk.

Metabolised by the body into methanol and two amino acids, aspartic acid and phenylalanine, which are then further metabolised. All three are available from other foods, so no non-natural chemicals are being introduced into the body.

Anticariogenic.

Calorific value of 4 calories/g.

Substantial evidence lacking to link aspartame with claims of adverse health effects.

Virtually non-calorific due to intense sweetness.

Average consumption by Canadians 1.7–3.7 mg/kg body weight; upper estimate of Canadian intake 5.8–16.8 mg/kg body weight; current Canadian consumption levels, even among children, considered well within acceptable limits.

FDA Advisory Committee on Hypersensitivity to Food Constituents concluded some individuals have an unusual sensitivity to aspartame, although this does not represent a significant health risk.

Risk to pregnant women of aspartame consumption leading to children with PKU considered non-existent.

LEGISLATION:

USA:

Approved by FDA in 1974 for use as a sweetener, flavour enhancer and an ingredient in some dry food products.

Approved by FDA in 1983 for use in carbonated beverages and carbonated beverage syrups. Later approved for chewable multivitamin tablets.

Approved by FDA in 1987 for use in frozen juice drinks, frozen novelties, tea beverages and breath mints.

USFDA gave ADI of 50 mg/kg body weight.

Approved in US for use in soft drinks, desserts, dessert toppings and household use.

Regulatory Status: ADI level as of 1990 for use in soft drinks – Permitted

CFR 21

PART 172 Food Additives Permitted for Direct Addition to Food for Human Consumption

Subpart I – Multipurpose Additives

172.804 – Aspartame (September 19, 2009)

The food additive aspartame may be safely used in food in accordance with GMP as a sweetening agent, or for an authorised technological purpose in foods for which standards of identity established under section 401 of the Act do not preclude such use under the following conditions:

(a) Aspartame is the chemical 1-methyl *N*-L-α-aspartyl-L-phenylalanine ($C_{14}H_{18}N_2O_5$).

(b) The additive meets the specifications of the *Food Chemicals Codex*, 3rd edition (1981) pp. 28–29 and First Supplement p. 5, which is incorporated by reference in accordance with 5 U.S.C. 552(a). Copies are available from the National Academy Press, 2101 Constitution Avenue NW., Washington, DC 20418, or for inspection at the Office of the Federal Register, 800 North Capitol Street, NW., suite 700, Washington, DC 20408.

(c) The additive may be used as a sweetener in the following foods:

(1) Dry, free-flowing sugar substitutes for table use (not to include use in cooking) in package units not exceeding the sweetening equivalent of 1 pound of sugar.

(2) Sugar substitute tablets for sweetening hot beverages, including coffee and tea. L-leucine may be used as a lubricant in the manufacture of such tablets at a level not to exceed 3.5 percent of the weight of the tablet.

(3) Breakfast cereals.

(4) Chewing gum.

(5) Dry bases for:

(i) Beverages.

(ii) Instant coffee and tea beverages.

(iii) Gelatins, puddings, and fillings.

(iv) Dairy product analogue toppings.

(6) Ready-to-serve non-alcoholic flavoured beverages, tea beverages, fruit juice-based beverages, and their concentrates or syrups.

(7) Chewable multivitamin food supplements.

(8) [Reserved]

(i) Fruit juice-based drinks (where food standards do not preclude such use).

(ii) Fruit flavoured drinks and ades.

(iii) Imitation fruit-flavoured drinks and ades.

(9) Frozen stick-type confections and novelties.

(10) Breath mints, hard and soft candy.

(11) and (12) are reserved categories.

(13) Refrigerated ready-to-serve gelatins, puddings, and fillings.

(14) Fruit (including grape) wine beverages with ethanol contents below 7 percent volume per volume.

(15) Yoghurt-type products where aspartame is added after pasteurisation and culturing.

(16) Refrigerated flavoured milk beverages.

(17) Frozen desserts.

(18) Frostings, toppings, fillings, glazes, and icings for pre-cooled baked goods.

(19) Frozen, ready-to-thaw-and-eat cheesecakes, fruit, and fruit toppings.

(20) Frozen dairy and non-dairy frostings, toppings, and fillings.

(21) Fruit spreads, fruit toppings, and fruit syrups.

(22) Malt beverages of less than 7 percent ethanol by volume and containing fruit juice.

(23) Baked goods and baking mixes in an amount not to exceed 0.5 percent by weight of ready-to-bake products or of finished formulations prior to baking. Generally recognised as safe (GRAS) ingredients or food additives approved for use in baked goods shall be used in combination with aspartame to ensure its functionality as a sweetener in the final baked product. The level of aspartame used in these products is determined by an analytical method entitled 'Analytical Method for the Determination of Aspartame and Diketopiperazine in Baked Goods and Baking Mixes' October 8, 1992, which was developed by the NutraSweet Co., and is incorporated by reference in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. Copies are available from the Office of Premarket Approval, Center for Food Safety and Applied Nutrition, 200 C St. SW., Washington, DC 20204, or are available for inspection at the Office of the Federal Register, 800 North Capitol St. NW., suite 700, Washington, DC.

(d) The additive may be used as a flavour enhancer in chewing gum, hard candy, and malt beverages containing less than 3 percent alcohol by volume.

(e) To assure safe use of the additive, in addition to the other information required by the Act:

(1) The principal display panel of any intermediate mix of the additive for manufacturing purposes shall bear a statement of the concentration of the additive contained therein;

(2) The label of any food containing the additive shall bear, either on the principal display panel or on the information panel, the following statement:

PHENYLKETONURICS: CONTAINS PHENYLALANINE

The statement shall appear in the labelling prominently and conspicuously as compared to other words, statements, designs or devices and in bold type and on clear contrasting background in order to render it likely to be read and understood by the ordinary individual under customary conditions of purchase and use.

(3) When the additive is used in a sugar substitute for table use, its label shall bear instructions not to use in cooking or baking.

(4) Packages of the dry, free-flowing additive shall prominently display the sweetening equivalence in teaspoons of sugar.

(f) If the food containing the additive purports to be or is represented for special dietary uses, it shall be labelled in compliance with part 105 of this chapter.

[42 FR 14491, Mar. 15, 1977, as amended at 48 FR 31382, July 8, 1983; 49 FR 22468, May 30, 1984; 51 FR 43000–43002, Nov. 28, 1986; 53 FR 20837–20842, June 7, 1988; 53 FR 40879, Oct. 19, 1988; 53 FR 51273, Dec. 21, 1988; 54 FR 23647, June 2, 1989; 54 FR 31333, July 28, 1989; 57 FR 3702, 3703, 3704, Jan. 30, 1992; 58 FR 19771, Apr. 16, 1993; 58 FR 21097, 21098, 21099, Apr. 19, 1993; 58 FR 48598, Sept. 17, 1993]

UK and EUROPE:

Permitted in foods in EU at 300–5500 ppm

JECFA gave ADI of 40 mg/kg body weight

UK gave Group A classification in Sweeteners in Food Regulations in 1983

Regulatory Status: ADI level as of 1990 for use in soft drinks

JECFA	0–40 mg/kg body weight
Belgium	750 mg/L (pending approval to increase from 500 mg/L)
Denmark	500 mg/L
Finland	500 mg/L
France	600 mg/L

East Germany	Not permitted
West Germany	300 mg/L
Greece	600 mg/L
Ireland	Permitted
Netherlands	750 mg/L (pending approval to increase from 700 mg/L)
Norway	500 mg/L
Spain	Permitted
Switzerland	Permitted
Turkey	600 mg/L
UK	Permitted
USSR	Permitted
Yugoslavia	Not permitted

CANADA:

Approved for use in Canada in 1981

Table IX, Food additives that may be used as Sweeteners, Item A.1 (September 19, 2009): Aspartame

Permitted in or on	**Maximum level of use**
(1) Table-top sweeteners	Good Manufacturing Practice
(2) Breakfast cereals	0.5%
(3) Beverages; beverage concentrates, beverage mixes; (except for any of these products for which standards are set out in these Regulations)	0.1% in beverages as consumed
(4) Desserts; dessert mixes; toppings; topping mixes; fillings; filling mixes; (except for any of these products for which standards are set out in these Regulations)	0.3% in products as consumed
(5) Chewing gum; breath freshener product	1.0%
(6) Fruit spreads; purées and sauces; table syrups; (except for any of these products for which standards are set out in these Regulations)	0.2%

(7) Salad dressings; peanut and other nut spreads; (except for any of these products for which standards are set out in these Regulations)	0.05%
(8) Condiments (except for any of these products for which standards are set out in these Regulations)	0.2%
(9) Confectionery glazes for snack foods; sweetened seasonings or coating mixes for snack foods	0.1%
(10) Confections and their coatings (except for any of these products for which standards are set out in these Regulations)	0.3%

Table IX, Food additives that may be used as Sweeteners, Item A.2 (25 May 1993): Aspartame, encapsulated to prevent degradation during baking

Permitted in or on	**Maximum level of use**
Bakery products and baking mixes (except for any of these products for which these standards are set out in these Regulations). Encapsulated to prevent degradation during baking.	0.4% in product as consumed

Canada first country to allow use in soft drinks in 1981

Acceptable for use in table-top sweeteners, ready-to-eat cereals, beverages, beverage concentrates and mixes, desserts, toppings, fillings and their mixes, chewing gum and breath fresheners.

Canadian ADI 40 mg/kg body weight which is greater than the 8.3 mg/kg that would be consumed on average if it replaced all sucrose in the diet or the 25 mg/kg if it replaced all carbohydrate in the diet

Item A.A3, Table III, pages 67–22 and 67–22a of Canada FDR-Update as of 1996

sweetener and flavour enhancer in table-top sweeteners – Good Manufacturing Practice

use as sweetener and favour enhancer in unstandardised food extended in 1995 to provide for use in beverages, beverage concentrates, beverage mixtures, confectionery glazes for grain, nut and corn-based snack foods, sweetened seasonings, or coating mixes for snack foods at a level of 0.1%

in desserts, dessert mixes, toppings, topping mixes, fillings, filling mixes, confections and their coatings, candies, frostings and icings at a level of 0.3%

AUSTRALIA/PACIFIC RIM:

Regulatory Status: ADI level as of 1990 for use in soft drinks

Australia: 1000 mg/L

Japan: permitted
New Zealand: permitted

OTHER COUNTRIES:
WHO: ADI 40 mg/kg
Now permitted for use in more than 50 countries
Permitted for use in soft drinks in 39 countries
Regulatory Status: ADI level as of 1990 for use in soft drinks

Argentina	Permitted
Brazil	750 mg/L
Israel	700 mg/L
Kenya	Permitted
Mexico	Permitted
Saudi Arabia	Not permitted
South Africa	1000 mg/L

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Solutions CFR + Database (1996). Accessed at: http://www.gpoaccess.gov/cfr/
Status summary by the IFT Expert Panel on Food Safety and Nutrition, August (1991) *Sweeteners: Nutritive and Non-Nutritive*.
Wong, D.W.S. (1989) *Mechanism and Theory in Food Chemistry*. Van Nostrand Reinhold, New York.

ANY OTHER RELEVANT INFORMATION:

Manufacturers: Ajinomate, Browne & Dureau Intl., Calaga Food Ingredients fruitsource, Holland Sweetener, NutraSweet AG, Quimdis, Sanafi, Scan chem, Sweeteners Plus, FH Worlee Gmblt

Marketed by G.D. Searle as Nutrasweet®, Equal® and Canderel® (as table sweetener), a dipeptide methyl ester composed of two amino acids (phenylalanine and aspartic acid)

Marketed by Holland Sweetener Company of the Netherlands as Sanecta®

Discovered in 1965 by J. Schlatter of G.D. Searle Laboratories.

First food ingredient marketed using a 'branded ingredient' strategy under the brand name NutraSweet by G.D. Searle. All products sweetened with this ingredient branded with the NutraSweet logo.

NAME:	Corn syrup
CATEGORY:	Nutritive sweetener
FOOD USE:	Soft drinks/Dietary supplements/Carrier in foods/Feedstock in fermentation/Thickener/Bodying agent/Texturiser
SYNONYMS:	Corn sugar syrup/Glucose syrup/Syrups/Hydrolysed starch/CAS 8029-43-4/977004-12-8/EINCS/ELINCS 232-436-4
PROPERTIES AND APPEARANCE:	Aqueous syrup. Mixture of D-glucose, maltose and maltodextrins, through partial hydrolysis of corn starch
FOOD SAFETY ISSUES:	May cause allergic reaction.
LEGISLATION:	**USA:** FDA 21 CFR131.112, 133.124, 133.178, 133.179, 145.3, 145.134, 145.180, 146.3, 146.145, 146.146, 155.200, 169.175, 184.1865, GRAS Cleared by MID for flavouring of sausage, hamburger, meat loaf, luncheon meat, chopped or pressed ham For use alone at 2% *or* combined with corn syrup solids or glucose syrup for a total of 2% on dry basis
REFERENCES:	Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York. Shmuel, Y. (ed.) (2004) *Dictionary of Food Compounds with CD-ROM: Additives, Flavors and Ingredients*. Chapman & Hall/CRC, USA.
ANY OTHER RELEVANT INFORMATION:	Manufacturer/Distributor: A.E Staley Mfg., ADM, Ashland, Cerestar USA, DSM Food Spec., Degussa AG/Health & Nutrition, Jungbuzlauer, Varsal Instruments Trade names: Clearsweet®, Corn Sweet®, IsoClear®, Satin Sweet®, Staley®, Sweetose®, Honi-Bake®, Honi-Flake

NAME:	Cyclamate
CATEGORY:	Non-nutritive Sweetener/Flavour enhancer
FOOD USE:	Beverages (dry beverage mixes)/Sugars, sugar preserves and confectionery (table-top sweeteners, jams and jellies, low-calorie frozen desserts)/Fruit, vegetables and nut products/Jams and jellies/Soft drinks/Vinegar, pickles and sauces (salad dressings)/Other (chewing gum)
SYNONYMS:	Cyclamate: CFSAN Cyclamate/CAS 977016-96-8 Cyclamic acid: CFSAN Cyclamic acid/CAS 100-88-9/Cyclohexanesulfamic acid/Cyclohexylsulfamic acid/*N*-cyclohexyl-sulphamic acid/Hexamic acid Sodium cyclamate: Sodium cyclohexylsulfamate/Cyclamate sodium/Assugrin/Sucryl sodium/Sucrosa Cyclamate is the generic name for cyclohexylsulphamate
FORMULA:	Sodium cyclamate $C_6H_{12}NNaO_3S$; cyclamic acid $C_6H_{13}NO_3S$
MOLECULAR MASS IN Daltons:	Cyclamic acid 179.24; sodium cyclamate 201.2
ALTERNATIVE FORMS:	Cyclamic acid/Calcium cyclamate/Sodium cyclamate
PROPERTIES AND APPEARANCE:	White crystalline powder. Good tasting and low in cost. Sweet sour crystals; fairly strong acid; slightly soluble in water; slowly hydrolysed by hot water; more soluble in Na form. Practically insoluble in alcohol, ether, benzene and chloroform. In soft drinks, sweetness relative to sucrose is 30 to 40. Sodium cyclamate: 'chemical' sweetness with no aftertaste; sweet taste has slow onset time; detectable sweet/sour aftertaste most noticeable at high concentrations; clean sweet taste of high intensity, close resemblance to sugar in sweetness; no bitter aftertaste; 30 to 60 times sweeter than sucrose; distinct off-taste noticeable at high concentrations.

Characteristics of sweeteners (cyclamate alone)

Sweetness intensity (at 10% sucrose)	33
Sweetness quality	Slight chemical sweetness
Time profile	Slower and persistent
Associated taste	Off-taste at high concentrations
Mouthfeel body	Good
Enhancement of fruitiness	Good

Characteristics of sweeteners (1:10 saccharin:cyclamate)

Sweetness intensity (at 10% sucrose)	100
Sweetness quality	Sugar-like
Time profile	As sucrose
Associated taste	None
Mouthfeel body	Good
Enhancement of fruitiness	Good

Cyclamic acid: Sweet–sour crystals

Sodium cyclamate:
Pleasantly sweet crystals
30 times as sweet as refined cane sugar
Sweetness easily perceptible at dilution of 1:10 000 in water

MELTING RANGE IN °C: Cyclamic acid 169–179

SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:

in water: **@ 20°C** Sodium salt 200 g/L Calcium salt 250 g/L

FUNCTION IN FOODS: Sweetener. Cyclamic acid has some flavour-enhancing capabilities at low levels. Cyclamate/aspartame also found to improve stability and taste profiles of diet soft drinks, dry beverage mixtures and chewing gum.

TECHNOLOGY OF USE IN FOODS:

Sodium and calcium salt forms most often used. One-tenth sweetness of equal weight of saccharin. 10:1 cyclamate/saccharin ratio masked the aftertaste of saccharin which boosted the low sweetness of cyclamates. Cyclamate/aspartame also found to improve stability and taste profiles of diet soft drinks, dry beverage mixtures and chewing gum. Sodium and calcium salts are soluble is water at room temperature.

Stable at pH 2–7 at normal process temperatures; in aqueous solution at pH 2.1 it hydrolyses to:

350 mg cyclohexylamine per kg cyclamate at 30°C

500 mg/kg at 44°C

Both after 40 days.

Stable in tablet form for several years; in aqueous solution it hydrolyses slowly to sulphuric acid and cyclohexylamine.

Lower cost versus sucrose.

No browning reaction.

Decomposition is accelerated in the presence of amino acids and water-soluble vitamins at elevated temperatures.

Alone in soft drinks did not provide sweetness taste quality of the saccharin/cyclamate blend.
Sodium salt most commonly used.
Stable under conditions of soft drink manufacture such as pH 2–7, pasteurisation and UHT heat treatment.
Can be detected in soft drinks by spectrophotometric methods and titration followed by liquid chromatography.
Popular in soft drinks as a cyclamate/saccharin blend of 10:1; has been used in combination with saccharin to overcome bitterness and aftertaste; recommended for use in beverages, fruit juices, processed fruits, desserts, jellies, jams, toppings, salad dressings, and confections.
Fairly thermostable.
Commercially successful combination as cyclamate/saccharin at 10:1 or 50%/50% sweetness gives clean sugar-like sweetness at low cost with good storage stability; often used mixed with other sweeteners.
Readily soluble in water; good stability in fruit beverages.
Compatible with a broad range of beverage ingredients.
Cyclamic acid: fairly strong acid, sparingly soluble in water, slowly hydrolysed by hot water.
Sodium cyclamate: freely soluble in water, practically insoluble in alcohol, ether, benzene, chloroform.
Sodium cyclamate: pH of 5.5–7.5 in 10% solution.

SYNERGISTS:

Synergistic with aspartame, saccharin, sucrose and acesulfame.

Sweetness quality improved by combining with other intense sweeteners.

Citric acid and other citrus products have a synergistic effect on sweetness.

FOOD SAFETY ISSUES:

Non-cariogenic. Non-caloric as metabolism does not release any energy.

May be concerns of toxicity. At high enough doses, cyclamate found to be metabolised into cyclohexylamine which has been implicated in the occurrence of bladder tumours after 2 years. This based on studies of rats fed a 10:1 cyclamate/saccharin mixture. There are other concerns about its effects on genetic material. Due to low sweetness, quantities required would probably exceed ADI.

Most people metabolise only 1% of cyclamate intake, but 47% of the population can metabolise (in intestine) 20–60% to cyclohexylamine, a known carcinogen. Recent studies do not support the claim of cyclamates being carcinogenic; some have linked the metabolite cyclohexylamine to high blood pressure, testicular atrophy and cancer promotion in rats. In 1985, National Academy of Sciences (NAS) and National Research Council (NRC) decided that cyclamates act as carcinogen promoters or co-carcinogens in the presence of substances like saccharin.

LD_{50} of sodium cyclamate is 15.25–17.0 g/kg.

LEGISLATION:

USA:

Approved by USFDA in 1949. GRAS status by USFDA in 1957. Banned in US in 1969 for general-purpose foods based on studies linking bladder tumours in rats with repeated use of cyclamate:saccharin blend in rats. Banned for all foods in August 1970 by US FDA

CFR 21 PART 189: 189.135 – Cyclamate and its derivatives.

[42 FR 14659, Mar. 15, 1977, as amended at 49 FR 10114, Mar. 19, 1984; 54 FR 24899, June 12, 1989]

(a) Calcium, sodium, magnesium and potassium salts of cyclohexane sulfamic acid $(C_6H_{12}NO_3S)2Ca$, $(C_6H_{12}NO_3S)Na$, $(C_6H_{12}NO_3S)2Mg$, and $(C_6H_{12}NO_3S)K$. Cyclamates are synthetic chemicals having a sweet taste 30 to 40 times that of sucrose, are not found in natural products at levels detectable by the official methodology, and have been used as artificial sweeteners.

(b) Food containing any added or detectable level of cyclamate is deemed to be adulterated in violation of the act based upon an order published in the FEDERAL REGISTER of October 21, 1969 (34 FR 17063).

(c) The analytical methods used for detecting cyclamate in food are in sections 20.162–20.172 of the *Official Methods of Analysis of the Association of Official Analytical Chemists*, 13th Ed. (1980), which is incorporated by reference. Copies may be obtained from the Association of Official Analytical Chemists, 2200 Wilson Blvd., Suite 400, Arlington VA 22201-3301, or may be examined at the Office of the Federal Register, 800 North Capitol Street, NW., suite 700, Washington, DC 20408.

ADI level as of 1990 for use in soft drinks: not permitted

UK and EUROPE:

Still permitted in some applications in countries such as Spain, Germany and Switzerland.

JECFA approved cyclamates with an ADI of 11 mg/kg body weight in 1982. Accepted in UK in 1964. EEC Directive on Additives includes cyclamates on the positive list.

Regulatory Status: ADI level as of 1990 for use in soft drinks

JECFA	0–11 mg/kg body weight
Belgium	400 mg/L (pending approval for change from Not permitted)
Denmark	250 mg/L
Finland	100–400 mg/L depending upon type of soft drink
France	Not permitted
East Germany	450–600 mg/L depending upon type of soft drink
West Germany	800 mg/L
Greece	Permitted
Ireland	Permitted
Netherlands	400 mg/L (pending approval to change from Not permitted)
New Zealand	1500 mg/L

Norway	Permitted
Spain	4000 mg/L
Switzerland	800 mg/L
Turkey	Not permitted
UK	Not permitted
USSR	Not permitted
Yugoslavia	Permitted

CANADA:

Part E Cyclamate and Saccharin Sweeteners

E.01.001 (1) In this Part, "cyclamate sweetener" means

(a) cyclohexyl sulfamic acid or a salt thereof, or

(b) any substance containing cyclohexyl sulfamic acid or a salt thereof that is sold as a sweetener;

(2) Part B of these Regulations does not apply to any cyclamate sweetener or saccharin sweetener.

E.01.002 – **(Sale)** No person shall

(a) sell a cyclamate sweetener or a saccharin sweetener that is not labelled as required by this Part

E.01.003 – **(Advertising)** No person shall, in advertising to the general public a cyclamate sweetener or saccharin sweetener, make any representation other than with respect to the name, price and quantity of the sweetener

E.01.004 – **(Labelling)**

(1) Every cyclamate sweetener that is not also a saccharin sweetener shall be labelled to state that such sweetener should be used only on the advice of a physician

E.01.005 – Commencing June 1, 1979, every cyclamate sweetener or saccharin sweetener shall be labelled to show

(a) a list of all the ingredients and, in the case of (i) cyclohexyl sulfamic acid, (ii) a salt of cyclohexyl sulfamic acid, the quantity thereof contained in the sweetener; and

(b) the energy value of the sweetener expressed in calories (i) per teaspoonful, drop, tablet or other measure used in the directions for use, and (ii) per 100 grams or 100 millilitres of the sweetener

ADI level as of 1990 for use in soft drinks: Not permitted

AUSTRALIA/PACIFIC RIM:

Regulatory Status: ADI level as of 1990 for use in soft drinks

Australia	600 mg/L
Japan	Not permitted
New Zealand	1500 mg/L

OTHER COUNTRIES:

Lost GRAS status in 1969. Banned in other countries (e.g. UK, Canada, Japan) soon after US ban. Permitted for use in soft drinks in 25 countries.

Regulatory Status: ADI level as of 1990 for use in soft drinks

Argentina	2000 mg/L
Brazil	1600 mg/L
Israel	193 mg/L
Kenya	Not permitted
Mexico	Not permitted
Saudi Arabia	Not permitted
South Africa	2500 mg/L

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Wong, D.W.S. (1989) *Mechanism and Theory in Food Chemistry.* Van Nostrand Reinhold, New York.

ANY OTHER RELEVANT INFORMATION:

Synthetic sweetener; discovered in 1937 by Michael Sveda of Abbott Laboratories in Chicago. Use as sweetener started in mid-1950s; popular in 1960s, instrumental in making diet products popular. Cyclamate/saccharin first commercial multiple sweetener. Use of saccharin/cyclamate blends ended with cyclamate ban in 1970.

Manufacturer/Distributor: AB R Lundberg; City Chem; Fluka; Sigma

NAME:	Fructose		
CATEGORY:	Sweetener		
FOOD USE:	Humectant/Sweetener/Preservative in foods/Processing aid/Formulation aid for foods/Flavour enhancer		
SYNONYMS:	Arabino-2-hexulose/β-D-Fructopyranose/D-Fructose/Fruit sugar/Laevosan/Laevulose/Levulose/ CAS 57-48-7 (D-)/7660-25-5/30237-26-4/EINECS/ELINCS 200-333-3 (D-)/Fructosteril/Levugen		
FORMULA:	$C_6H_{12}O_6$		
MOLECULAR MASS:	180.18		
PROPERTIES AND APPEARANCE:	Colourless crystal or white crystalline powder. Odourless, sweet taste. Soluble in methanol, ethanol, water, pyridine, ethylamine, methylamine. pH is almost neutral. Decomposes at 103–105°C. Sweetest of all sugars; 1 g dissolves in 15 mL alcohol, in 14 mL methanol, slightly soluble in cold, freely in hot acetone, soluble in pyrindine, ethylamine, methylamine		
MELTING RANGE IN °C:	103–105		
FUNCTION IN FOODS:	Ferritose (Calbiochem) CAS 12286-76-9, CB-302, ferric form of fructose is used to prevent sandiness in ice-cream.		
FOOD SAFETY ISSUES:	Practically non-toxic by ingestion. Very large doses may cause abdominal pain and diarrhoea. Some people are fructose intolerant. Dust is of nuisance. Probably not irritating to eyes except as 'foreign object'. Experimental tumorigen.		
LEGISLATION:	**USA:** FDA 21 CFR101.9; 131.11; 131.112; 131.170; 131.200; 131.203; 131.206; 133.179; 140.132; 155.170; FDA approved for orals	**UK and EUROPE:** EU: approved for use with the following provisions: a) Fructose content 98% minimum. b) Glucose content 0.5% maximum. c) Loss on drying not more than 0.5% by weight. d) Conductivity ash not more than 0.1% by weight	**CANADA:** Canadian Provisional Domestic Substance Listed CFIA approved and states that any glucose syrup with fructose concentration of less than 6% may be listed on ingredient list as glucose-fructose

REFERENCES:

www.medicinescomplete.com/mc/merck/current. Merck Index Online. Accessed 5–6 September 2009.
Ash M. and Ash I. (2004) *Handbook of Preservatives*. Synapse Information Resources Inc., New York.
Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York.

ANY OTHER RELEVANT INFORMATION:

Manufacturer/Distributor: A.E. Staley Mfg, ADM Corn Processing, AMERSCO, Aldrich, Ashland, CarboMer, Danisco Sweetener, Fluka, Sigma, VMR Int'l, Vopak USA

Trade names: CornSweet®Crystalline Fructose, Fructofin®C, Sucrosweet 210, Sucrosweet 311

NAME:	Glycine
CATEGORY:	Sweetener
FOOD USE:	Flavour modifier/Sweetener in foods/Reduces bitter taste of saccharin/Retards rancidity in animal and vegetable fats
SYNONYMS:	Aminoacetic acid/Gly/Glycocoll/Glycolixir/CAS 56-40-6/EINECS/ELINCS 200-272-2/FEMA 3287/INS640/E640
FORMULA:	H_2NCH_2COOH
MOLECULAR MASS:	75.08
PROPERTIES AND APPEARANCE:	White crystal or crystal powder. Odourless, sweet taste. Soluble in water. Very slightly soluble in alcohol, ether
MELTING RANGE IN °C:	232–236 (decomposition)
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.1607
FOOD SAFETY ISSUES:	Moderately toxic by intravenous route; mildly toxic by ingestion, mutagenic data available. Toxic Substance Control Act listed. When heated to decomposition will emit toxic fumes of NO_x.
LEGISLATION:	**USA:** FDA 21 CFR 170.50, 172.812 (0.2% in finished beverage), USDA 9 CFR 318.7 (0.01% in rendered animal fat) **CANADA:** Canadian Provisional Domestic Substance List **AUSTRALIA/PACIFIC RIM:** Japan: approved for use
REFERENCES:	Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York.
ANY OTHER RELEVANT INFORMATION:	Manufacturing/Distributor: AB R Lundberg, ADA Int'l, AMERSCO, Adept Sol'n, Ajinomoto, Ashland, Degussa AG/Health & Nutrition, Fluka, J.T. Baker, Ruger, Sigma, Vopak USA, Whyte Chems Ltd

NAME:	Glycyrrhizin/glycyrrhizic acid
CATEGORY:	Sweetener/Nutritive additive/Foaming agent
FOOD USE:	Baked goods/Dairy products (frozen dairy desserts)/Fruit, vegetables and nut products (hydrolysed vegetable protein (HVP), bean paste)/Beverages (non-alcoholic beverages)/Soft drinks (root beer)/Sugars, sugar preserves and confectionery (confectionery manufacture, soft candy, confection, frosting, hard candy)/Alcoholic drinks (liqueurs)/Vinegar, pickles and sauces (soy sauce)/Other (tobacco, chocolate, vanilla, medicines, gelatin, pudding, chewing gum)
SYNONYMS:	CAS 1405-86-3/EINECS/ELINCS 215-785-7/INS958/Glycyron/Glycyrrhizin: CFSAN Glycyrrhizin/Ammoniated (*Glycyrrhiza* spp.)/CAS 5395-04-0 Glycyrrhizinic acid: Glycyrrhetinic acid glucoside/(3β,20β)-20-Carboxy-11-oxo-30-norolean-12-en-3-yl 2-O-β-D-glucopyranuronosyl-α-D-glucopyranosiduronic acid Ammonium glycyrrhizinate: CAS = 1407-03-0/FEMA 2528/18-β-Glycyrrhizic acid/β-Glycyrrhizin
FORMULA:	Ammonium glycyrrhizinate pentahydrate: $C_{42}H_{65}NO_{16} \cdot 5H_2O$ (molecular weight 930.04) Monoammonium glycyrrhizin: $C_{42}H_{61}O_{16}NH_4 \cdot 5H_2O$ Glycyrrhizic acid: $C_{46}H_{62}O_{16}$ Dipotassium glycyrrhizin: $C_{42}H_{60}K_2O_{16}$ (molecular weight 899.11)
MOLECULAR MASS IN Daltons:	822.94 (Glycyrrhizic acid)
ALTERNATIVE FORMS:	Calcium glycyrrhizinate/Disodium glycyrrhizinate/Monoammonium glycyrrhizinate/Potassium glycyrrhizinate/Magnesium glycyrrhizinate/Ammonium glycyrrhizinate pentahydrate
PROPERTIES AND APPEARANCE:	Ammonium glycyrrhizine (AG): spray-dried brown powder; monoammonium glycyrrhizin (MAG): white crystalline powder Slow to taste, but taste long-lasting; leaves strong, lingering licorice-like aftertaste Ammoniated salt approximately 50 to 100 times sweeter than sucrose Natural material extracted from *Glycyrrhiza glabra* (an active component of licorice)
MELTING RANGE IN °C:	Ammonium glycyrrhizinate pentahydrate: decomposes at 212–217
FUNCTION IN FOODS:	Foaming agent; nutritive sweetener; aromatisation; foam stabiliser; sweetener; flavour enhancer in foods and confectionery.

TECHNOLOGY OF USE IN FOODS:

Does not dissolve well in cold water, but is soluble in hot water or ethanol; practically insoluble in ether; ammoniated form soluble in hot or cold water and propylene glycol; 50 to 100 times sweeter than sucrose.

Ammoniated salt generally used at the following levels:

Baked goods	61 ppm
Frozen dairy	91 ppm
Non-alcoholic beverages	36–51 ppm
Soft candy	1511 ppm
Confection, frosting	625 ppm
Gelatin, pudding	79 ppm
Alcoholic beverages	59 ppm
Hard candy	676 ppm
Chewing gum	2278 ppm

Ammonium glycyrrhizin inactivated in acid media (pH < 4.5) due to precipitation of acid form. Relatively heat-stable, but flavour tends to deteriorate above 105°C; can precipitate at pH below 4.5.

Strong licorice flavour, so use in bakery products limited (a few confectionery products); applied mostly in tobacco and pharmaceutical products.

Has foam-enhancing properties which can be useful in beverage formulation.

SYNERGISTS: Glycyrrhizin potentiated to 100 times original sweetness in presence of sucrose

FOOD SAFETY ISSUES: Non-calorific.

Poisonous by intravenous route; moderately toxic by ingestion and intraperitoneal routes; human systemic effects by ingestion. TCSA (Toxic Substance Control Act) Listed. Heated to decomposition will emit acrid smoke and irritating fumes. Adverse effect of hypermineralocorticoidism from excessive intake.

LEGISLATION:

USA:

GRAS flavouring agent

CFR 21: Part 184

184.1408 – Licorice and licorice derivatives.

(a) (1) Licorice (glycyrrhiza) root is the dried and ground rhizome and root portions of *Glycyrrhiza glabra* or other species of *Glycyrrhiza*. Licorice extract is that portion of the licorice root that is, after maceration, extracted by boiling water. The extract can be further purified by filtration and by treatment with acids and ethyl alcohol. Licorice extract is sold as a liquid, paste ("block"), or spray-dried powder.

(2) Ammoniated glycyrrhizin is prepared from the water extract of licorice root by acid precipitation followed by neutralisation with dilute ammonia.

(b) The ingredients shall meet the following specifications when analysed:

(1) *Assay.* The glycyrrhizin content of each flavouring ingredient shall be determined by the method in the *Official Methods of Analysis of the Association of Official Analytical Chemists*, 13th Ed., §§ 19.136–19.140, which is incorporated by reference, or by methods 19.CO1 through 19.CO4 in the *Journal of the Association of Official Analytical Chemists*, 65:471–472 (1982), which are also incorporated by reference. Copies of all of these methods are available from the Association of Official Analytical Chemists, 2200 Wilson Blvd., Suite 400, Arlington, VA 22201-3301, or available for inspection at the Office of the Federal Register, 800 North Capitol Street, NW., suite 700, Washington, DC 20408.

(2) *Ash.* Not more than 9.5 percent for licorice, 2.5 percent for ammoniated glycyrrhizin, and 0.5 percent for monoammonium glycyrrhizinate on an anhydrous basis as determined by the method in the *Food Chemicals Codex*, 3rd edn. (1981), p. 466 (see reference). Copies are available from the National Academy Press, 2101 Constitution Ave. NW., Washington, DC 20418, or available for inspection at the Office of the Federal Register, 800 North Capitol Street, NW., suite 700, Washington, DC 20408.

(3) *Acid unsoluble ash.* Not more than 2.5 percent for licorice on an anhydrous basis as determined by the method in the *Food Chemicals Codex*, 3rd edn. (1981), p. 466 (see reference).

(4) *Heavy metals (as Pb).* Not more than 40 parts per million as determined by method II in the *Food Chemicals Codex*, 3rd edn. (1981), p. 512 (see reference).

(5) *Arsenic (As).* Not more than 3 parts per million as determined by the method in the *Food Chemicals Codex*, 3rd edn. (1981), p. 464 (see reference).

(c) In accordance with §181.1(b)(2), these ingredients are used in food only within the following specific limitations:

Category of food	**Maximum level in food (percent glycyrrhizin content of food)**	**Functional use**
Baked foods, §170.3(n)(1) of this chapter	0.05	Flavour enhancer, §170.3(o)(11) of this chapter; flavouring agent, §170.3(o)(12) of this chapter.
Alcoholic beverages, §170.3(n)(2) of this chapter	0.1	Flavour enhancer, §170.3(o)(11) of this chapter; flavouring agent, §170.3(o)(12) of this chapter; surface active agent, §170.3(o)(29) of this chapter.
Non-alcoholic beverages, §170.3(n)(3) of this chapter	0.15	Do.
Chewing gum, §170.3(n)(6) of this chapter	1.1	Flavour enhancer, §170.3(o)(11) of this chapter; flavouring agent, §170.3(n)(12) of this chapter.
Hard candy, §170.3(n)(25) of this chapter	16.0	Do.

Herbs and seasonings, §170.3(n)(26) of this chapter	0.15	Do.
Plant protein products, §170.3(n)(33) of this chapter	0.15	Do.
Soft candy, §170.3(n)(38) of this chapter	3.1	Do.
Vitamin or mineral dietary supplements	0.5	Do.
All other foods except sugar substitutes, §170.3(n)(42) of this chapter. The ingredient is not permitted to be used as a non-nutritive sweetener in sugar substitutes	0.1	Do.

(d) Prior sanctions for this ingredient different from the uses established in this section do not exist or have been waived.

[50 FR 21044, May 22, 1985, as amended at 54 FR 24899, June 12, 1989]

UK and EUROPE:

FEMA:

No. 2630 (root)
No. 2628 (extract)
No. 2629 (extract powder)
No. 2528 (ammoniated salt)

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Ash, M. and Ash, I. (1995) *Food Additives: Electronic Handbook.* Gower Publishing, Brookfield, VT.

Burdock, G.A. (1995) *Fenaroli's Handbook and Flavour Ingredients*, 3rd edn, Vol. I. CRC Press, Boca Raton, FL, pp. 173–175.

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Fennema, O.R. (1985) *Food Chemistry*, 2nd edn. Marcel Dekker, New York.

Krutosikova, U. and Uher, M. (1992) *Natural and Synthetic Sweet Substances.* Ellis Horwood, Chichester and VEDA.

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Smoley, C.K. (1993) *Everything Added to Food in the United States.* US Food and Drug Administration, CRC Press, Boca Raton, FL.

Status summary by the IFT Expert Panel on Food Safety and Nutrition, August (1986) *Sweeteners: Nutritive and Non-Nutritive*.

Wong, D.W.S. (1989) *Mechanism and Theory in Food Chemistry.* Van Nostrand Reinhold, New York.

ANY OTHER RELEVANT INFORMATION:

Glucoside; extracted from licorice root; root extract contains both calcium and sodium salts; hydrolysis yields glycyrrhetinic acid and glucuronic acid. Licorice root contains 6–20% glycyrrhizin; commercial block juice contains 14–20% glycyrrhizin. Triterpenoid glycoside with two glyceronic units. Detectable at 1/50 the threshold taste level of sucrose. Hygroscopic: caution with storage.

NAME:	High fructose corn syrup
CATEGORY:	Sweetener
FOOD USE:	Moisturiser/Crystallisation control agent/Sweetener for foods, beverages, ice cream/Microbiological growth control agent
SYNONYMS:	HFCS/High fructose corn syrup
LEGISLATION:	**USA:** FDA 21 CFR131.111, 131.112, 131.170, 131.200, 131.203, 131.206, 184.1866, GRAS
REFERENCES:	Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York.
ANY OTHER RELEVANT INFORMATION:	Manufacturer/Distributor: Degussa AG/Heatlth & Nutrition, Glorybee Natural Sweeteners Trade names: Dri-Mol®, Honi-Bake®, Honi-Flake

NAME:	Isomalt
CATEGORY:	Sweetener/Nutritive additive/Flavour modifier/Bulking agent
FOOD USE:	Baked goods/Soft drinks/Sugars, sugar preserves and confectionery (confectionery, coatings for hard-boiled and chewable candies, soft caramels, soft candies)/Other (chewing gums)
SYNONYMS:	Hydrogenated isomaltulose/Hydrogenated palatinose/Isomaltitol/CAS 64519-82-0/INS953/E953
MOLECULAR MASS IN Daltons:	368
PROPERTIES AND APPEARANCE:	White, odourless crystals. Pleasant sweet taste (sweetness intensity 0.45 compared to sucrose); no aftertaste. Available in crystalline form. A polyol derived exclusively from sugar mixture of two components: 6-*O*-D-glucopyranosyl-D-sorbitol and 1-*O*-D-glycopyranosyl-D-mannitol-dihydrate
MELTING RANGE IN °C:	145–150
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 25
FUNCTION IN FOODS:	Bulking agent: adds texture and mouthfeel properties. Sweetening agent: functionally similar to sucrose, sweetness intensity of 0.45 compared to sucrose. Enhances shelf-life of hygroscopic products; increases chemical stability; increases affinity for water without altering sweetening power; reduces tendency to crystallise. Use in baking: reduces fermentability; increases resistance to non-enzymic browning reactions; decreases tendency to crystallise; increases hygroscopicity.
ALTERNATIVES:	Sucrose; other polyols

TECHNOLOGY OF USE IN FOODS:

Solubility in water is a function of temperature. 25% solubility at 25°C and 55% solubility at 60°C. Solubility decreases linearly with the addition of alcohol. Highly stable against chemical and microbial breakdown; has no Maillard reaction so does not require browning inhibitors.

Changes colour slightly when held at 170°C for 60 minutes, but no further colour changes, unlike sucrose solutions.

Viscosity in aqueous solution comparable to sucrose solutions.

Less sweet than sugar, so require intense sweeteners as supplements to bring to equivalence with sucrose.

Does not produce a cooling sensation when dissolving; mixtures with saccharin and aspartame mask the metallic aftertaste; can be mixed with polydextrose in calorie-reduced foods.

Crystallises easily, so useful in simplifying coating of hard-boiled and chewable candies. With the addition of a crystallisation inhibitor such as HGS, can be used as a melt for manufacturing soft caramels, chewing gums and soft candies due to the high percentage of solids dissolved in the aqueous phase.

Low hygroscopicity; resistant to chemical and microbial breakdown.

SYNERGISTS: Synergistic with other polyols (sorbitol, xylitol, HGS) and with intense sweeteners (saccharin, aspartame)

FOOD SAFETY ISSUES: Non-carcinogenic. Non-hygroscopic. Low cariogenicity. Suitable for inclusion in diabetic products because not dependent on insulin for metabolism and so results in no significant change in blood glucose. Low energy due to malabsorption in intestine (2 kcal/g). Has been proven to have no adverse health effects. Laxative effect at high doses, so warning labels are required in some countries (laxative effect 20–30 g/day). Metabolism (50% in humans) will break down to form sorbitol, mannitol and glucose. Short-term animal study shows increase in bilirubin levels.

LEGISLATION:

UK and EUROPE:

One of 12 sweeteners listed as permissible for use in the UK as of 1983

JECFA allocated an ADI of 'Not Specified' in 1985

CANADA:

Canada FDA: 67.31 – Table IX – Food additives that may be used as Sweeteners, Item I.1 (September 12, 2009)

– Permitted on Unstandardised Foods at levels dependent upon Good Manufacturing Practice

REFERENCES:

Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York.

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Smith, J. (1991) *Food Additive User's Handbook*. Blackie Publishing, Glasgow.

Smoley, C.K. (1993) *Everything Added to Food in the United States*. US Food and Drug Administration, CRC Press, Boca Raton, FL.

ANY OTHER RELEVANT INFORMATION: Polyol produced through hydrogenation of isomaltulose (also known as palantinose).
Marketed by Suddeutsche Zucher AG of Germany as Palatinit®
Marketed by Tate and Lyle of UK as Lylose®
Marketed under trade name of C*IsoMaltidex

NAME:	Lactitol
CATEGORY:	Sweetener/Nutritive additive/Bulking agent/Dimeric polyol
FOOD USE:	Baked goods (bakery products, biscuit-making)/Dairy products (ice-cream)/Fruit, vegetables and nut products (jams and marmalades)/Beverages (instant beverages)/Soft drinks/Sugars, sugar preserves and confectionery (confectionery, surface dustings for confectionery, table-top sweeteners, chocolate, hard and soft candies)/Other (chewing gums, fruit gums, pastilles)
SYNONYMS:	CAS 585-86-4/EINECS/ELINCS 209-566-6/INS966/E966/CAS 81025-04-9 (monohydrate)/4-*O*-β-D-Galactopyranosyl-D-glucitol (monohydrate)/β-Galactoside sorbitol/Lactitol MC (monohydrate)/Lactit/Lactit M/Lactite/Lactobiosit/Lactosit/Lactositol
FORMULA:	$C_{12}H_{24}O_{11}$
MOLECULAR MASS IN Daltons:	Monohydrate 362; dihydrate 380; molecular weight 344.32
ALTERNATIVE FORMS:	Lactitol monohydrate/Lactitol dihydrate
PROPERTIES AND APPEARANCE:	Monohydrate: white, sweet, odourless, crystalline solid, non-hygroscopic Dihydrate: white, sweet, odourless, crystalline powder Pleasant sweet taste (sweetness intensity 0.35 compared to sucrose); no aftertaste Derived by controlled hydrogenation of lactose into disaccharide polyol
MELTING RANGE IN °C:	Lacititol 146; monohydrate salt 94–98, also reported as 120; dihydrate salt 75
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	
Monohydrate salt	**@ 20°C** 150 g/100 mL **@ 25°C** 206 g/100 g solvent **@ 50°C** 512 g/100 g solvent
Dihydrate salt	**@ 25°C** 140g/100 mL
in ethanol solution (100%)	
Monohydrate	**@ 25°C** 0.75 g/100 g solution **@ 50°C** 0.88 g/100 g solution
FUNCTION IN FOODS:	Bulking agent: adds texture and mouthfeel properties. Sweetener: sweetness intensity 0.35 compared to sucrose; functionally similar to sucrose.

Texturising agent. Lowers freezing point of solutions in a manner similar to that of sucrose; increases chemical stability; increases affinity for water without altering sweetening power; reduces tendency to crystallise.

When used in baking: reduces fermentability; increases resistance to non-enzymic browning reactions; decreases tendency to crystallise; increases hygroscopicity.

For use in low calorie, low fat or sugar-free foods.

ALTERNATIVES: Sucrose; other polyols

TECHNOLOGY OF USE IN FOODS:

Good solubility in water which increases with temperature (at 25°C, 150 g of monohydrate salt or 140 g dihydrate salt will dissolve in 100 mL water).

Monohydrate **@ 25°C** 0.4g/100 g solvent (ether) **@ 75°C** 917g/100 g solvent (water)

Partially converted to lactitan, sorbitol and other lower polyols at 179 to 240°C.

Viscosity in solution equal to that of sucrose (weight for weight).

Decomposition a function of temperature and acidity. In solution, stable at pH 3.0–7.5 and at temperatures up to 60°C for up 1 month. A 10% solution demonstrated 15% decomposition at pH 3.0 after 2 months; 10% solution displayed no decomposition at 105°C at pH 12.0 after 2 months.

Less sweet than sugar, so require intense sweeteners as supplements to bring to equivalence with sucrose. Generally aspartame or acesulfame-K is used. A 10% lactitol solution containing 0.03% of either is equivalent to a 10% sucrose solution.

Can replace sucrose as a texturising or bulking agent where the sweet taste is beneficial. Result considered to have equal palatability and no aftertaste.

Low hygroscopicity and low calorific value, so suitable for use as a bulking agent for intense sweeteners in table-top use and biscuit making; crispness maintained as a result.

Suitable for inclusion in low-calorie and sugarless products such as chewing gum, fruit gums and pastilles, chocolate, instant beverages and jams, but a crystallisation inhibitor such as HGS (Hydrogenated Glucose Syrup, e.g. Lycasin®) may be required.

In solution, good at pH 3.0–7.5 and at temperatures below 60°C for 1 month.

FOOD SAFETY ISSUES: Low cariogenicity. Contains 50% fewer calories than sugars; energy: 2 kcal/g.

Suitable for inclusion in diabetic products because not dependent on insulin for metabolism and results in no significant change in blood glucose.

Low energy due to malabsorption in intestine, and can also act as dietary fibre as it is fermented by the microflora of the large intestine and contributes to faecal mass.

Laxative effect at high doses, so warning labels are required in some countries (laxative effect 70–80 g/day).

LEGISLATION:	USA:	UK and EUROPE:	CANADA:
	FDA: Petition for GRAS status filed with FDA	One of 12 sweeteners listed as permissible for use in the UK as of 1988 JECFA allocated an ADI of 'Not Specified' in 1983	Canada FDR 67.31, Table IX, Food additives that may be used as Sweeteners, Item L.1 (September 12, 2009) – Permitted in Unstandardised Foods to a maximum level of use dictated by Good Manufacturing Practice

REFERENCES:

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Smith, J. (1991) *Food Additive User's Handbook*. Blackie Publishing, Glasgow.

Smoley, C.K. (1993) *Everything Added to Food in the United States*. US Food and Drug Administration, CRC Press, Boca Raton, FL.

ANY OTHER RELEVANT INFORMATION:	Polyol produced through hydrogenation of lactose. Lactitol dihydrate developed by CC Biochem of the Netherlands. Sold by Philpot Dairy Products in UK as Lacty®; Lacty is marketed by Purac Biochem. Manufacturer/Distributor: AB R Lundberg; Danisco Sweeteners; Indofine Marketed under trade name of Lactitol AC

NAME:	Lactose
CATEGORY:	Sweetener
FOOD USE:	Dietary supplement/Nutritive sweetener/Formulation aid/Processing aid/Humectants/Texturiser/Infant foods/Animal feed ingredients/Moisture control agent/Stabiliser/Thickener
SYNONYMS:	4-*O*-β-Galactopyranosyl D-glucose/Lactin/Lactobiose/δ-Lactose/Lactosum/Milk sugar/Saccharum lactin/Saccharum lactis/CAS 63-42-3/EINECS/ELINCS 200-559-2
FORMULA:	$C_6H_7O(OH)_4OC_6H_7O(OH)_4$
MOLECULAR MASS:	324.34
PROPERTIES AND APPEARANCE:	White hard crystal mass or white powder, odourless to slightly characteristic odour but readily absorbs odours. Mildly sweet taste, soluble in water, alcohol, ether, slightly soluble in alcohol. Lactose is 0.68 times sweeter than sucrose. Store in closed container
MELTING RANGE IN °C:	203.5 (decomposition)
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.525
ANTAGONISTS:	Mix with oxidisers may have explosion hazard
FOOD SAFETY ISSUES:	Moderately toxic by intravenous route; found to cause tumors when injected under skin of mice, derivatives can be irritating to the colon, questionable carcinogen, experimental tumorigen, teratogen, Toxic Substance Control Act Listed. Heated to decomposition will emit acrid smoke and irritating fumes.
LEGISLATION:	**USA:** FDA 21 CFR131.112; 131.170; 131.200; 131.203; 131.206; 133.124; 133.178; 133.179; 168.122; 169.179; 169.182, GRAS **CANADA:** Canadian Provisional Domestic Substance List
REFERENCES:	Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York.

	Shmuel, Y. (ed.) (2004) *Dictionary of Food Compounds with CD-ROM: Additives, Flavors and Ingredients*. Chapman & Hall/CRC, USA.
ANY OTHER RELEVANT INFORMATION:	Manufacturer/Distributor: AMRESCO, Adept Sol'n, Aldrich, Ashland, Asiamerica Int'l, CarboMer, Land O'Lakes, Magnesia GmbH, Univar Ltd, VWR Int'l, Vopak USA, Zeta Pharm

NAME:	Maltitol
CATEGORY:	Sweetener/Nutritive additive/Humectant/Stabiliser/Emulsifier
FOOD USE:	Baked goods (glazes for baked goods, muesli bars)/Dairy products (frozen desserts, ice-cream)/Fruit, vegetables and nut products (fruit fillings, jams, jellies, canned fruit, fruit toppings)/Beverages/Soft drinks/Sugars, sugar preserves and confectionery (chocolate and compound coatings, confectionery (especially gloss coatings), hard-boiled candies, soft caramels)/Vinegar, pickles and sauces (sauces)/Other (chewing gum, chewing gum coatings, pharmaceuticals, dietary products, diabetic products, chocolate, gelatin gums and jellies, sugarless tablets)
SYNONYMS:	CAS 585-88-6/EINECS/ELINCS 209-567-0/INS965; E965/Amalty/Finmalt-L/4-*O*-α-glucopyranosyl-D-sorbitol/4-*O*-β-D-glucopyranosyl-D-glucitol
FORMULA:	$C_{12}H_{24}O_{11}$
MOLECULAR MASS IN Daltons:	344.47
PROPERTIES AND APPEARANCE:	White crystalline powder, also available in liquid form. Crystalline form 0.8 to 0.9 relative to sucrose, liquid form 0.6 relative to sucrose. Pleasant, sweet taste with no aftertaste; low mouth-cooling effect; very stable at different pH conditions and temperatures
MELTING RANGE IN °C:	149–152
PURITY %:	Maximum 92.5 assay (anhydrous)
WATER CONTENT MAXIMUM IN %:	1.5
HEAVY METAL CONTENT MAXIMUM IN ppm:	10
ARSENIC CONTENT MAXIMUM IN ppm:	2.5
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 60% weight/unit volume
FUNCTION IN FOODS:	Bulking agent, so adds texture and mouthfeel to properties. Functionally similar to sucrose; has an affinity for water without altering sweetening power.

	Highly hygroscopic, so reduced tendency to crystallise. Aids moisture retention in baked goods. For use in baking: reduced fermentability; increased resistance to non-enzymic browning reactions; decreased tendency to crystallise; increased hygroscopicity; Enhances and retains shelf-life of baked goods. Crystalline form stabilises colour and improves shelf-life of fillings. Bulk sweetening agent and glaze-former. Syrup form: excipient; humectant: anti-crystallisation agent.
TECHNOLOGY OF USE IN FOODS:	Functionally similar to sucrose. More chemically stable; heat stable, no loss of colour during boiling Low fermentability by common moulds and bacteria Less sweet than sugar, so require intense sweeteners as supplements to bring to equivalence with sucrose Aids moisture retention in baked goods Energy: 2 kcal/g No browning reaction; medium solubility in water at room temperature; chemically and thermally stable Available in both crystalline and liquid forms In liquid form, has applications in sugar-free confections, chewing gums, pharmaceuticals, sauces and variegates, baked goods and frozen desserts. Crystalline maltitol has applications in chocolate, confectionery, chewing gum, baked goods and fruit spreads Amalty MR Grades crystalline maltitol: % sulphates: 0.010 maximum % chlorides: 0.005 maximum % reducing sugars: 0.30 maximum % residue on ignition: 0.1 maximum Lead: 1 ppm maximum Classification: polyhydric alcohol (polyol) Mesh size: MR 20, 100% through #20 US sieve Mesh size: MR 50, 100% through #20 US sieve Mesh size: MR 100, 80% maximum through #20 US sieve ERH at 20°C: 89% Slightly soluble in alcohol; heat of solution −5.5 to −16.3 cal/g; solubility at 37°C, 201 g/100 mL water Cooling effect (150 g powder/50 mL water at 37°C): −12 Sweetening power: 0.9

FOOD SAFETY ISSUES:

Low energy due to malabsorption in intestine, so suitable for inclusion in diabetic products because not dependent on insulin for metabolism. Does not significantly increase serum glucose or serum insulin levels after ingestion.

Non-cariogenic as it is not metabolised by oral bacteria.

Laxative threshold of 100 g/day.

Material Safety Data Sheet for AMALTY Crystalline Maltitol

pH: neutral

% volatile by volume: negligible

Extinguishing media: water fog, alcohol foam, carbon dioxide, dry chemical, halogenated agents.

Special fire-fighting protective equipment: self-contained breathing apparatus with full facepiece and protective clothing

Unusual fire and explosive hazards: this product may form explosive dust clouds in air

Incompatibility: oxidising agents

Hazardous decomposition products: carbon dioxide, carbon monoxide.

Ingestion: LD_{50} in rats above 25 g/kg (2500 mg/kg). Classified as 'relatively harmless' by ingestion; low acute toxicity, non-mutagenic, non-teratogenic.

First-aid procedures:

Skin: wash off with plenty of soap and water. If redness, itching or a burning sensation develops, obtain medical attention

Eyes: immediately flush with plenty of water for at least 15 minutes. If redness, itching, or a burning sensation develops, have eyes examined and treated by medical personnel

Ingestion: do not induce vomiting. Give one or two glasses of water to drink and refer to medical personnel or take direction from either a physician or a poisons control centre. Never give anything to an unconscious person

Inhalation: remove victim to fresh air. If a cough or other respiratory symptoms develop, consult medical personnel.

In case material is released or spilled: sweep up and recover or mix material with a moist absorbent and shovel into a chemical waste container. Wash residue from spill area with water and flush to a sewer serviced by a permitted waste water treatment facility.

Container disposal: empty container retains product residue. Do not distribute, make available, furnish or reuse empty container except for storage and shipment of original product. Empty container, remove all product residue, puncture or otherwise destroy empty container before disposal.

TLV or suggested control value: minimise exposure in accordance with good hygiene practice.

Ventilation: use ventilation adequate to maintain safe levels.
Respiratory protection: use MSHA-NIOSH approved respirator for organic vapours, dusts and mists.
Protective clothing: impervious gloves and apron.
Eye protection: safety glasses with side shields.
Other protective equipment: eyewash station in work area.

LEGISLATION:

USA:
Not permitted for use in foods

UK and EUROPE:
Used in some European and Asian countries in dark and milk chocolate, hardboiled candies, soft caramels, arabic, gelatin gums and jellies, chewing gums and bubble gums, chocolate dragees, sugarless tablets, muesli bars, jams, and ice-cream

CANADA:
Crystalline Maltitol
Table IX – Food additives that may be used as Sweeteners: Item M.1 (September 12, 2009)

Permitted in or on	**Maximum level of use**
Unstandardised foods	Good Manufacturing Practice

Maltitol syrup
Table IX – Food additives that may be used as Sweeteners: Item M.2 (September 12, 2009)

Permitted in or on	**Maximum level of use**
Unstandardised foods	Good Manufacturing Practice

AUSTRALIA/PACIFIC RIM:
Japan: permitted for use in certain foods; has been used since before 1981

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Wong, D.W.S. (1989) *Mechanism and Theory in Food Chemistry.* Van Nostrand Reinhold, New York.

ANY OTHER RELEVANT INFORMATION:

Polyol produced through hydrogenation of maltose; marketed as Malbit®

Lycasin: Roquette America Inc., Maltitol Syrup

SunMalt: Mitsubishi International Corporation, Fine Chemicals Department: crystalline maltose; maltose monohydrate carbohydrate sweetener

Maltisorb: Roquette America Inc.: crystalline maltitol

Manufacturer/Distributor: AB R Lundberg; Adept Sol'ns; Aldrich; Amalgamet; Ashland; CarboMer; Cerestar; Danisco Cultur; Dastech Int'l; Fluka; Forum Bioscience; Lonza; Roquette AM; SPI Polyols; Sigma; Univar Ltd.; Universal Preserv-A-Chem; Vopak USA

Marketed under trade names of Amalty®; C*Maltidex; Finmalt L; Lycasin®; Maltisorb®; Maltisweet™ 3145; Stabilite™

NAME:	Mannitol
CATEGORY:	Sweetener/Nutritive additive/Bulking agent/Dietary Supplement/Texturiser/Humectant/Flavoring agent/Lubricant/Release agent/Anticaking agent/Flow aid/Stabiliser/Thickener/Formulation aid/Processing aid/Firming agent
FOOD USE:	Baked goods/Sugars, sugar preserves and confectionery (sugar-free confections)/Other (chewable tablets, chewing gum, vitamins, chocolates, effervescent powders, intravenous osmotic diuretics, oral intestinal transit enhancers)
SYNONYMS:	CFSAN D-Mannitol/CAS 69-65-8/EINECS/ELINCS 200-711-8/INS421; E421/Mannose sugar/Mannite/Manna sugar/Cordycepic acid/1,2,3,4,5,6-Hexanehexol/UniSweet MAN/Manicol/Mannidex/Diosmol/Osmitrol/Osmosal/Resectisol
FORMULA:	$C_6H_{14}O_6$
MOLECULAR MASS IN Daltons:	182.17
PROPERTIES AND APPEARANCE:	Pleasant, sweet taste with no aftertaste (0.6 relative to sucrose). White crystalline, orthorhombic needles, odourless, slightly sweet powder. Low mouth-cooling effect. Hexahydric alcohol. Density 1.52 (20°C)
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	290–295
MELTING RANGE IN °C:	165–169
ARSENIC CONTENT MAXIMUM IN ppm:	1
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 14.5 g/100 g solution **@ 50°C** 31 g/100 g solution
in ethanol solution (100%)	Very slightly soluble
FUNCTION IN FOODS:	Bulking agent, so adds texture and mouthfeel to properties. More chemically stable. Has an affinity for water without altering sweetening power. Reduced tendency to crystallise. Anti-adhesion agent. Excipient for use in baking: reduced fermentability; increased resistance to non-enzymic browning reactions; decreased tendency to crystallise; increased hygroscopicity.

TECHNOLOGY OF USE IN FOODS:

Functionally similar to sucrose. Naturally occurring; low solubility in water. Useful as an anti-adhesion agent (inhibits crystallisation of other polyalcohols) in the manufacture of chewing gum.

Less sweet than sugar, so require intense sweeteners as supplements to bring to equivalence with sucrose. Generally used in chewing gums as a sugar substitute, supplemented by intense sweeteners, typically saccharin (added in a small quantity to keep saccharin's taste imperceptible). Claimed to require no intense sweetener to have near-sucrose equivalence in sweetness and flavour-release properties. Mainly used in crystalline form in sugar-free chewing gum. Also used in chewable pharmaceutical products because it is inert to most drug components.

Due to low solubility, not generally used in soft drinks or ice-cream.

Low hygroscopicity; no browning reaction; chemically stable.

Applications: sugar-free confections, chocolates, chewing gums, tablets, vitamins; use in chocolate, cocoa and confectioneries limited by low solubility; special use in sugarless chewing gum due to low solubility; special use in effervescent powders due to low hygroscopicity.

Solubility in water:

0°C 9.1 g/100 g solution
10°C 12.3 g/100 g solution
20°C 14.5 g/100 g solution
30°C 20 g/100 g solution
40°C 25 g/100 g solution
50°C 31 g/100 g solution
60°C 37.5 g/100 g solution

Pharmaceutical applications: Excipient: ideal for dry formulations due to pleasant taste, high physicochemical stability and lack of reducing power and low hygroscopicity; ideal freeze-drying carrier due to quick-drying characteristics. Results in enhanced drug stability; freeze-dried powders using this dissolve quickly; granulated form has excellent flow and compression properties.

Pharmaceutical applications: Active properties: due to special biological properties, can be used in applications such as intravenous osmotic diuretics and oral intestinal transit enhancers; mannitol hexanitrate has vasodilating properties similar to nitrated esters.

Food applications: recommended as sweetener in confectionery or in sugarless confectionery; may be used as an anti-crystallising agent in chewing gums or bubble gums; useful as dusting product due to low hygroscopicity; used as an aroma carrier; used for flow-improving; used as a mould-releasing additive.

Loss on drying: 0.3% max.; reducing sugars nil.

Specific optical rotation in borax solution: $+23°$ to $+24°$; specific optical rotation in molybdic solution: $+137°$ to $+145°$.

Acidity (NaOH 0.02N for 5 g): 0.3 mL max.

Chlorides: 50 ppm max.; sulphates: 100 ppm max.

Solubility: 1 g/5.5 mL water; 1 g/18 mL glycerol; 1 g/83 mL alcohol; readily soluble in alkaline solutions; very slightly soluble in pyridine; aniline, very slightly soluble in oxygenated solvents. In alcohol (1 g dissolves in 83 mL alcohol at room temperature); practically insoluble in ether; insoluble in vegetable and mineral oil; soluble in glycerol (1 g dissolves in 18 mL glycerol at room temperature).

Compliance: USP XXII.

B.P 88 French Pharmacopoeia. EEC Directive E421.

Particle size: crystalline, standard grade – 10% max. residue on 250 microns (60mesh); crystalline, F grade – 2% max. residue on 150 microns (100mesh); crystalline, SF grade – 0.5% max. residue on 100 microns (150mesh); granular, Pearlitol® MG – 20% max. residue on 500 microns (32mesh); granular, Pearlitol® MG – 85% min. residue on 100 mirons (150mesh); granular, Pearlitol® GG2 – 0.5% max. residue on 840 microns (20mesh); granular, Pearlitol® GG2 – 90% min. residue on 150 microns (100mesh).

FOOD SAFETY ISSUES:

Suitable for inclusion in diabetic products because not dependent on insulin for metabolism. Low energy due to malabsorption in intestine (< 4 kcal/g). Useful for caries prevention. Laxative effect at high doses, so warning labels are required in some countries (20 g/day); has a low laxative threshold so is not recommended for diabetic products, and glucose is a breakdown product in the gut.

Mildly toxic by ingestion, intraperitoneal and/or intravenous routes. Human systemic effect by intravenous route (increased blood pressure, bladder tubule changes, nausea, vomiting). Human mutagenic data available; TSCA (Toxic Substance Control Act) listed. Heated to decomposition will emit acrid smoke and fumes.

LEGISLATION:

USA:

CFR 21

PART 100 – General

Subpart G® Specific Administrative Rulings and Decisions 100.130 Combinations of nutritive and non-nutritive sweeteners in 'diet beverages'.

(4) To avoid confusion by diabetics, the label of a beverage containing sorbitol, mannitol, or other hexitol, must bear the statement 'Contains carbohydrates, not for use by diabetics without advice of a physician'. To further avoid confusion of these beverages with those sweetened solely with non-nutritive artificial sweeteners which have been marketed in containers bearing prominent statements such as 'sugar free', 'sugarless', or 'no sugar', the labels of beverages containing hexitols must not bear these or similar statements.

PART 180® Food Additives Permitted in Food on An Interim Basis Or in Contact with Food Pending Additional Study

Subpart B® Specific Requirements for Certain Food Additives 180.25 Mannitol.

[42 FR 14636, Mar. 15, 1977, as amended at 49 FR 5610, Feb. 14, 1984]

(a) Mannitol is the chemical 1,2,3,4,5,6-hexanehexol ($C_6H_{14}O_6$) a hexahydric alcohol, differing from sorbitol principally by having a different optical rotation. Mannitol is produced by the electrolytic reduction, or the transition metal catalytic hydrogenation, of sugar solutions containing glucose or fructose.

(b) The ingredient meets the specifications of the *Food Chemicals Codex*, 3rd edn. (1981), pp. 188–190, which is incorporated by reference. Copies may be obtained from the National Academy Press, 2101 Constitution Ave. NW., Washington, DC 20418, or may be examined at the Office of the Federal Register, 800 North Capitol Street, NW., suite 700, Washington, DC 20408.

(c) The ingredient is used as an anticaking agent and free-flow agent as defined in §170.3(o)(1) of this chapter, formulation aid as defined in §170.3(o)(14) of this chapter, firming agent as defined in §170.3(o)(10) of this chapter, flavouring agent and adjuvant as defined in §170.3(o)(12) of this chapter, lubricant and release agent as defined in §170.3(o)(18) of this chapter, nutritive sweetener as defined in §170.3(o)(21) of this chapter, processing aid as defined in §170.3(o)(24) of this chapter, stabiliser and thickener as defined in §170.3(o)(28) of this chapter, surface-finishing agent as defined in §170.3(o)(30) of this chapter, and texturiser as defined in §170.3(o)(32) of this chapter.

(d) The ingredient is used in food at levels not to exceed 98 percent in pressed mints and 5 percent in all other hard candy and cough drops as defined in §170.3(n)(25) of this chapter, 31 percent in chewing gum as defined in §170.3(n)(6) of this chapter, 40 percent in soft candy as defined in §170.3(n)(38) of this chapter, 8 percent in confections and frostings as defined in §170.3(n)(9) of this chapter, 15 percent in non-standardised jams and jellies, commercial, as defined in §170.3(n)(28) of this chapter, and at levels less than 2.5 percent in all other foods.

(e) The label and labelling of food whose reasonably foreseeable consumption may result in a daily ingestion of 20 grams of mannitol shall bear the statement ''Excess consumption may have a laxative effect''.

(f) In accordance with §180.1, adequate and appropriate feeding studies have been undertaken for this substance. Continued uses of this ingredient are contingent upon timely and adequate progress reports of such tests, and no indication of increased risk to public health during the test period.

(g) Prior sanctions for this ingredient different from the uses established in this regulation do not exist or have been waived.

UK and EUROPE:

One of 12 sweeteners listed as permissible for use in the UK as of 1983

Subject to certain restrictions, permitted as sweetener or food additive in UK, Belgium, Denmark, Greece, Spain, France, Germany, Switzerland and Sweden

CANADA:

Canada FDA: 67.31

Table IX, Food additives that may be used as Sweeteners – Item M.3 (September 12, 2009)

DSL (Canadian Provisional Domestic Substance) Listed

Permitted in or on	**Maximum level of use**
Unstandardised foods	Good Manufacturing Practice

Page 67–25a of Canada FDR, 1996 update: sweetener and texture modifier in carbohydrate or calorie reduced foods meeting the requirements of B.24.004 and B.24.006 – Good Manufacturing Practice. Release agent and sweetener in confectionery – Good Manufacturing Practice.

AUSTRALIA/PACIFIC RIM:
Japan and Australia: subject to certain restrictions, permitted for use as sweetener or food additive

OTHER COUNTRIES:
South Africa: subject to certain restrictions, permitted as sweetener or food additive

REFERENCES:

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Wong, D.W.S. (1989) *Mechanism and Theory in Food Chemistry*. Van Nostrand Reinhold, New York.

ANY OTHER RELEVANT INFORMATION:

Polyhydric alcohol produced through hydrogenation of mannose.

Developed in the 1970s; sold as Malbit® (90% maltitol and 5% maltotritol). Roquettes Frères applied for French patent in 1987 for compressible maltitol powder (85% maltitol); relatively expensive due to the process required to separate it from sorbitol and other contaminants. A hexahydric sugar alcohol; isomeric with sorbitol; occurs widely in nature in celery, larch and manna ash (*Fraxinus ornus*) for example. Juice of manna ash called 'manna'; found in high concentrations (15–20%) in certain varieties of mushrooms, marine algae (particularly genus *Laminaria*).

Manufacturer/Distributor: AB R Lundberg; ADA Int'l; ADM; AMERISCO; Aceto; Adept Sol'ns; Aldrich; Alfa Aesar; Fluka; Univar Ltd.; Sigma; Roquette UK; Vopak USA; Thomas Scientific

Marketed under trade names of C*Mannidex16700; Mannogem™

NAME:	Monellin
CATEGORY:	Sweetener/Nutritive additive/Low calorie sweetener
FORMULA:	Polypeptide chain of approximately 91 amino acids
MOLECULAR MASS IN Daltons:	11 500
PROPERTIES AND APPEARANCE:	Sweet taste (3000 times that of sucrose by weight). Slow onset time; lingering sweet aftertaste (for up to 1 hour)
FUNCTION IN FOODS:	Sweetening agent: up to 3000 times sweeter than sucrose. Essentially free from carbohydrate < 5 μg/mg protein.
TECHNOLOGY OF USE IN FOODS:	Stable at pH 2–10. Sweetness irreversibly lost above 60°C. Unstable to heat. Complete loss of sweetness below pH 2 when held in solution at room temperature
REFERENCES:	www.medicinescomplete.com/mc/merck/current. Merck Index Online. Accessed 5–6 September 2009. Fennema, O.R. (1985) *Food Chemistry*, 2nd edn. Marcel Dekker, New York. O'Neil, M.J., Heckelman, P.E., Koch, C.B. and Roman, K.J. (eds) (2006) *The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals*, 14th edn. Merck & Co., Inc., Whitehouse Station, NJ. Shmuel, Y. (ed.) (2004) *Dictionary of Food Compounds with CD-ROM: Additives, Flavors and Ingredients*. Chapman & Hall/CRC Press, USA. Smoley, C.K. (1993) *Everything Added to Food in the United States.* US Food and Drug Administration, CRC Press, Boca Raton, FL.
ANY OTHER RELEVANT INFORMATION:	Derived from the fruit of *Dioscoreophyllum cumminisii* (also known as serendipity berries). Characteristics similar to thaumatin. Expensive.

NAME:	Saccharin
CATEGORY:	Sweetener
FOOD USE:	Baked goods/Fruit, vergetables and nut products (fruit drinks, preserves)/Beverages (cola beverages, coffee)/Soft drinks/Sugars, sugar preserves and confectionery (table-top sweeteners, candies, preserves, chocolate products)/Vinegar, pickles and sauces (salad dressings)/Other (oral hygiene products, chewing gum, gelatin desserts, cocoa)
SYNONYMS:	Insoluble form: CFSAN Saccharin/CAS 81-07-2/EINECS/ELINCS 201-321-0/Saccharin insoluble/*O*-Benzoic acid sulfimide/3-Oxo-2,3-dihydro-1,2-benzisothiazole-1,1-dioxide/2,3-Dihydroxy-1,2-benzothiazolin-3-one-1,1-dioxide/1,2-Benzisothiazol-3(2*H*)-one-1,1-dioxide/2,3-Dihydro-3-oxobenzisosulfonazide/2,3-Dihydro-3-oxobenzisosulfonazole/1,2-Dihydro-2-ketobenzisosulfonazole/1,2-Benzisothiazolin-3-one-1,1-dioxide/*O*-sulfobenzoic acid imide/Benzoic sulfimide/Sycal SDI/Unisweet SAC/Benzosulfimide/Benzoic sulfimide/Gluside/Glucid/Garantose/Saccharinol/Saccharinose/Saccharol/Saxin/Sykose/Hermesetas/*O*-Sulfobenzimide/Saccharimide/Saccharin acid form/Saccharum Ammonium salt: 1,2-Benzisothiazolin-3-one, 1,1-dioxide, ammonium salt/CFSAN Saccharin, ammonium salt/Sucline/Daramin/Saccharin ammonium/CAS 6381-61-9/EINECS 228-971-8 Calcium salt: CAS 6381-91-5/1,2-Benzisothiazolin-3(2*H*)-one, 1,1-dioxide, calcium salt/CAS 6485-34-3/EINECS 229-349-9/Syncal CAS/CFSAN Saccharin, calcium salt Sodium salt (anhydrous): FEMA2997/INS954/Sodium saccharide/Sodium benzosulfimide/1,1-Dioxide-1,2-benzisothiazol-3(2*H*)-one, sodium salt/Sodium 2,3-dihydro-1,2-benzisothiazolin-3-one-1,1-dioxide/Saccharin sodium/Crystallose/Dagutan/Soluble saccharin/CFSAN Saccharin, sodium salt/CAS 128-44-9/EINECS 204-886-1/Saccharin soluble/Sodium saccharine/Sodium *O*-benzosulfimide/Kristallose/Sucaryl/Sucromat/Sodiumgluside
FORMULA:	Insoluble: $C_7H_5NO_3S$; sodium salt (anhydrous): $C_7H_4NO_3SNa$; sodium salt (dehydrate): $C_7H_4NNaO_3S \cdot 2H_2O$; ammonium salt: $C_7H_8N_2O_3S$
MOLECULAR MASS IN Daltons:	Sodium salt 205.16; insoluble 183.19
ALTERNATIVE FORMS:	Ammonium saccharin/Calcium saccharin/Sodium saccharin/Insoluble saccharin
PROPERTIES AND APPEARANCE:	Saccharin is 300 times the sweetness of sucrose. White, monoclinic crystalline powder; bitter, astringent or metallic off-taste, particularly objectionable in delicately fruit-flavoured products and at high concentrations.

	Characteristics of sweeteners (saccharin alone)	
	Sweetness intensity (at 10% sucrose)	350
	Sweetness quality	Slightly chemical sweetness
	Time profile	Slower and persistent
	Associated taste	Bitter/metallic
	Mouthfeel body	Thin
	Enhancement of fruitiness	Nil
	Characteristics of sweeteners (1:10 saccharin:cyclamate)	
	Sweetness intensity (at 10% sucrose)	100
	Sweetness quality	Sugar-like
	Time profile	As sucrose
	Associated taste	None
	Mouthfeel body	Good
	Enhancement of fruitiness	Good
	Soluble in boiling water, alcohol, benzene, amy; acetate, ethyl acetate; slightly soluble in water, ether, chloroform. Density: 0.828. Non-caloric.	
MELTING RANGE IN °C:	Insoluble: 226–230	
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:		
in water (20°C)	Saccharin: 3 g/L	
	Sodium saccharin: 700 g/L (83%)	
	Calcium saccharin: 400 g/L (67%)	
in ethanol solution (100%)	Sodium saccharin: 20 g/L @ 20°C	
	Calcium saccharin: 200 g/L @ 20°C	

1 g dissolves in 290 mL water, 25 mL boiling water, 31 mL alcohol, 12 mL acetone, 50 mL glycerol
Freely soluble in solutions of alkali carbonates. Slightly soluble in chloroform and ether

FUNCTION IN FOODS: Non-nutritive sweetener

TECHNOLOGY OF USE IN FOODS:

Highly stable and relatively inexpensive. Mixed with other products to mask taste, provide bulk and take advantage of synergy. May also be combined with cream of tartar, glucono-δ-lactone, sodium gluconate, glycols, gentian root, maltol, pectin, lemon flavour, ribonucleotides, adipic acid, aldohexuronic acid, and citric acid.

1 g/day for 68 kg (150lb) person.

3:1 cyclamate/saccharin combination provided sugar-like sweetness in beverages until cyclamates were banned in the US in 1969.

Cyclamate combination replaced with a calcium chloride combined with cornstarch hydrolysate, lactose, sucrose, tartrates and fructose with gluconate salts.

High stability, even under extreme processing conditions. Only approved sweetener able to withstand heating, baking and high-acid media.

Has been used in soft drinks, candies, preserves, salad dressings, low-calorie gelatin desserts. Also combined with bulk sweeteners in baking for sugar-reduced products; used alone as table-top sweetener in tablet and liquid form, or in chewing gum.

In combination with other sweeteners, used as table-top sweetener; combined with sorbitol or aspartame, used in chewing gum; also popular for use in oral hygiene products.

Relative sweetness in soft drinks in range of 300–700 units; sodium saccharin sweetneess in soft drinks is 360–500 units.

Some people are more sensitive than others to the bitter/metallic aftertaste of saccharin; aftertaste can be masked using fructose, gluconates, tartrates, ribonucleotides, sugars, sugar alcohols (polyols) and other intense sweeteners.

One-twentieth the price of sugar in terms of sweetness equivalency.

Stable in pH range 2–7; heat stable: unchanged after 1 hour at 150°C in pH 3.3–8.0; no browning reaction. In dry form, is stable for several years when stored appropriately. Stable under normal soft-drink processing conditions.

Lower cost versus sucrose.

When used alone in soft drinks did not provide sweetness taste quality of the saccharin/cyclamate blend.

Does not interact with other ingredients encountered during soft-drink manufacture. Concentrated soft-drink solutions can be stored. Detected in beverages using HPLC or spectrophotometric techniques.

Excellent heat and pH stability. Often blended with aspartame to reduce bitter aftertaste; has bitter, astringent or metallic off-taste particularly objectionable in delicately fruit-flavoured products; off-notes may be partially concealed in foods containing sucrose or corn sweeteners; off-notes less obvious in cola beverages, hot cocoa and other chocolate products, coffee, etc.

Stable under normal storage and preparation conditions; stable in acidic environments and under extended heat treatment.

Commercially successful in fruit drinks as:

Sucrose/saccharin: 25–35% of sweetness from sacccharin with total cost 5% below that of using sucrose alone, dominated UK fruit drink market in 1960s and 1970s. Some consumers preferred this product to that with sucrose alone. Also marketed in a 500:1 ratio for 'light' drinks in the US with 50% calorie reduction and good sweetness and fruitiness.

Aspartame/saccharin: in ratio of 2:1 or 50%/50% sweetness gives good sweetness and saccharin stabilises total sweetness to extend shelf-life.

Fructose/saccharin: strong sweetness intensity synergism and good fruitiness enhancement.

Cyclamate/saccharin: at 10:1 ratio or 50%/50% sweetness gives clean, sugar-like sweetness at low cost with good storage stability.

Good stability in fruit juice beverages; readily soluble in fruit beverages as either sodium or calcium salt; compatible with other fruit beverage ingredients.

Sweet taste is still detectable in 1:100 000 dilution.

SYNERGISTS:

With isomalt, it masks the metallic aftertaste of saccharin or aspartame

Synergistic with cyclamates, aspartame, sucrose, isomalt, stevioside, NHDC (Neohesperidin); synergism has been reported with fructose, sorbitol, xylitol and sucralose

FOOD SAFETY ISSUES:

May have anti-cariogenic properties. Is not metabolised by the body, so has no calorific value; is excreted unchanged.

Some research has shown an increase in bladder tumours in rats fed a saccharin/cyclamate blend; this was later confirmed to be caused by the saccharin component of the blend. Effect was determined to be species-specific as studies of those who consume large doses, such as diabetics, revealed no link between saccharin and bladder tumours in humans.

May have carcinogenic effects. Mild acute toxicity by ingestion. May cause allergic reactions including uriticaria, nausea, vomiting, diarrhoea. Experimental teratogen, reproductive effects. Mutation data reported. TSCA (Toxic Substance Control Act) Listed. When heated to decomposition will emit toxic NO_x and SO_x.

LEGISLATION:

USA:

FEMA GRAS

FDA withdrew GRAS in 1972 and attempted to ban its use in 1977.

All products packaged in the US must bear a statement warning that saccharin has been shown to cause cancer in laboratory animals.

Only all-purpose non-nutritive sweetener approved for use in the US.

ADI level as of 1990 for use in soft-drinks: 12 mg/fluid ounce

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PART 100 – General

Subpart G® Specific Administrative Rulings and Decisions

100.130 Combinations of nutritive and non-nutritive sweeteners in 'diet beverages'.

As a result of the removal of cyclamic acid and its salts from the list of substances generally recognised as safe (part 182 of this chapter) by an order published in the Federal Register of October 21, 1969 (34 FR 17063), the Commissioner of Food and Drugs has received inquiries as to the proper composition and labelling, from the standpoint of application of the Federal Food, Drug, and Cosmetic Act, of so-called 'diet beverages' that will be made from mixtures of nutritive sweeteners and saccharin or its salts. The Commissioner concludes that:

(2) The label must bear a statement of the caloric content per fluid ounce, the carbohydrate content per fluid ounce, a statement of the percentage of saccharin or saccharin salt used, and the statement 'Contains •• mg saccharin (or saccharin salt, as the case may be) per ounce, a non-nutritive artificial sweetener.'

CFR 21

PART 100 – General

Subpart A – General Provisions

101.11 Saccharin and its salts; retail establishment notice.

[43 FR 8795, Mar. 3, 1978]

Each retail establishment (except restaurants) that sells food that contains saccharin shall display the following notice in the locations set forth in paragraph (b) of this section:

Each notice shall be displayed prominently, in a manner highly visible to consumers (e.g., not shielded by other store signs or merchandise displays) and set up to reduce the likelihood that a notice will be torn, defaced, or removed.

(a) The notice shall be printed in a combination of red and black ink on white card stock and be at least 11 by 14 inches. The background of the bold heading, "Saccharin Notice," and the boxed warning statement shall be bright red and the lettering, white. The remaining background shall be white with black ink. All lettering shall be in gothic typeface.

(b) Except as provided in paragraph (c) of this section, each retail establishment that sells food that contains saccharin shall display a notice in each of the following three locations:

(1) Near the entrance to the retail establishment and arranged so that consumers are likely to see the notice upon entering.

(2) Centrally located in the area of the retail establishment in which soft drinks containing saccharin are displayed. If there is more than one such place, then in the area where the greatest quantity of diet soft drinks are displayed.

(3) In the area in the establishment in which the largest quantity of saccharin-containing foods (including saccharin sold in package form as a sugar substitute) are displayed, other than the area where diet soft drinks are displayed.

(c) The following are exceptions to the requirements set forth in paragraph (b) of this section:

(1) A retail establishment with 3,200 square feet or less of floor space shall display at least one notice. The notice shall be located near the entrance to the retail establishment and arranged so that consumers are likely to see the notice upon entering.

(2) A retail establishment with more than 3,200 but less than 10,000 square feet of floor space shall display at least two notices. The first notice shall be located near the entrance to the retail establishment and arranged so that consumers are likely to see the notice upon entering. The second notice shall be centrally located in the area of the retail establishment in which soft drinks containing saccharin are displayed. If there is more than one such place, then in the area where the greatest quantity of diet soft drinks are displayed. If diet soft drinks are not sold, then in the area of the establishment in which the largest quantity of saccharin-containing foods (including saccharin sold in package form as a sugar substitute) are displayed.

(3) A large retail establishment, e.g., department store, whose primary business consists of selling nonfood items (i.e., the proportion of food sold is extremely small compared to other items) shall display at least one notice. The notice shall be located in the area of the establishment in which foods containing saccharin are displayed. If there is more than one such area, then a notice shall be displayed in each area.

(d) Each manufacturer of saccharin-containing food who customarily delivers his products directly to retail establishments shall make available at least three notices to each retail establishment in which his products are sold. Each manufacturer shall also arrange to supply additional notices to a retail establishment that asks for them.

(e) Manufacturers who do not customarily deliver their saccharin-containing food products directly to retail establishments may fulfill their obligation to provide notices either in the manner set forth in paragraph (d) of this section or by participating in, and performing the actions required by, a trade association coordinated program that meets the following requirements:

(1) The coordinating association shall have filed notice of the program with the Food and Drug Administration, including the association's name, mailing address, telephone number, and contact person.

(2) Each manufacturer participating in the program shall file notice of its participation with the coordinating association, including its name, mailing address, telephone number, and contact person.

(3) The association shall ensure that retail establishment notices, in the form specified in this section, are readily available to participating manufacturers.

(4) The association shall take affirmative steps to coordinate with retail establishments, their trade associations, and the trade press to disseminate information about the applicable requirements of the Saccharin Study and Labeling Act and these regulations, the existence of the association coordinated program, and the availability of notices through the program.

(5) Each manufacturer shall, in consultation with the association, communicate with its contacts in the distributional chain to inform them of the applicable requirements of the Saccharin Study and Labeling Act and these regulations, and the continued availability of notices.

(6) Each manufacturer shall ensure that notices are promptly provided on request to any retail establishment carrying its products.

(7) The association shall consult with participating manufacturers concerning the implementation and progress of the program and shall disseminate information to facilitate the conduct of the program based on such consultations or consultation with the Food and Drug Administration.

(8) The association shall, on request, permit the Food and Drug Administration to have access to the participation notices filed by manufacturers, samples showing the form of retail establishment notices made available, and typical communication materials used by the association in the course of the program.

UK and EUROPE:

EU: permitted for use in foods at 80–1200 ppm.

Approved in UK by FACC in 1982, JECFA and EEC in 1984.

MAFF in UK assigned a Group B status in Sweeteners in Food Regulations in 1983.

The SCF gave saccharin an ADI of 0–2.5 mg/kg body weight in December 1987 with proviso that this should come under review when further evidence became available.

JECFA ADI of 0–2.5 mg/kg

Regulatory Status: ADI level as of 1990 for use in soft drinks

JECFA	0–2.5 mg/kg body weight
Belgium	125 mg/L
Denmark	75 mg/L

Finland	30–70 mg/L depending upon type of soft drink
France	100 mg/L depending upon type of soft drink
East Germany	20–60 mg/L depending upon type of soft drink
West Germany	200 mg/L
Greece	Permitted
Ireland	Permitted
Netherlands	125 mg/L (pending approval to increase from 120 mg/L)
Norway	50–120 mg/L depending upon type of soft drink
Spain	200 mg/L
Switzerland	Permitted
Turkey	Permitted
UK	80 mg/L
USSR	Permitted
Yugoslavia	180 mg/day

CANADA:

ADI level as of 1990 for use in soft drinks – Not permitted

Part E Cyclamate and Saccharin Sweeteners

E.01.001

(1) In this Part, 'saccharin sweetener' means

(a) saccharin or a salt thereof, or

(b) any substance containing saccharin or a salt thereof that is sold as a sweetener.

(2) Part B of these Regulations does not apply to any cyclamate sweetener or saccharin sweetener

E.01.002 – (**Sale**) No person shall

(a) sell a cyclamate sweetener or a saccharin sweetener that is not labelled as required by this Part; or

(b) commencing Jun 15, 1978, sell any saccharin sweetener to the general public except on the premises of a pharmacy.

E.01.003 – (**Advertising**) No person shall, in advertising to the general public a cyclamate sweetener or saccharin sweetener, make any representation other than with respect to the name, price and quantity of the sweetener

E.01.004 – (**Labelling**)

(1) Every cyclamate sweetener that is not also a saccharin sweetener shall be labelled to state that such sweetener should be used only on the advice of a physician

(2) Commencing June 1, 1979, every saccharin sweetener shall be labelled to state that

(a) continued use of saccharin may be injurious to health; and

(b) it should not be used by pregnant women except on the advice of a physician.

E.01.005 – Commencing June 1, 1979, every cyclamate sweetener or saccharin sweetener shall be labelled to show

(a) a list of all the ingredients and, in the case of

(iii) a saccharin

(iv) a saccharin salt the quantity thereof contained in the sweetener; and

(b) the energy value of the sweetener expressed in calories

(i) per teaspoonful, drop, tablet or other measure used in the directions for use, and

(ii) per 100 grams or 100 millilitres of the sweetener.

AUSTRALIA/PACIFIC RIM:

Regulatory Status: ADI level as of 1990 for use in soft drinks

Australia	50 mg/L
Japan	300 mg/L
New Zealand	100 mg/L
Japan	Approved for use in chewing gum at maximum level of 0.05 g/kg

OTHER COUNTRIES:

Has been assigned an ADI of 2.5 mg/kg body weight

Used in more than 80 countries

Permitted for use in approximately 75 countries

Regulatory Status: ADI level as of 1990 for use in soft drinks

Argentina	150 mg/L
Brazil	500 mg/L
Israel	44 mg/L
Kenya	Permitted
Mexico	400 mg/L
Saudi Arabia	Not permitted
South Africa	500 mg/L

Determined safe by WHO

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ANY OTHER RELEVANT INFORMATION:

Discovered accidentally by Fahlberg and Remsen in 1879 at Johns Hopkins University. First manufactured in 1884 as an antiseptic and preservative; first commercial patent for manufacture in 1885. Sold as a sweetener in 1900. Was banned for use in food and drinks in Germany in 1898 and in the USA in 1912. Was reapproved during World War I due to a sugar shortage.

Synthesised commercially from toluene; one of the most widely used sugar substitutes in the world; was the first high-intensity sweetener to be marketed.

Use of saccharin/cyclamate blends ended with cyclamate ban in 1970.

Manufacturer/Distributor: AB R Lundberg; AMC Chems; Aisan Chem; Aldrich; Alfa Chem; Ashland; Fluka; Magnesia GmbH; Univar Ltd.; VWR Int'l; Vopak USA

Marketed under trade names as follows: Saccharin: Syncal® SDI; Saccharin (Sodium Salt, anhydrous): Sweet-Chew™; Syncal®

NAME:	Sorbitol
CATEGORY:	Sweetener/Nutritive additive/Humectant/Bulking agent/Anti-caking agent
FOOD USE:	Baked goods (cookies, cakes, icings, fillings, biscuits)/Sugars, sugar preserves and confectionery (confections, fondants, fudge, marshmallows, table-top sweetener, 'boiled' sweets)/Fruit, vegetables and nut products (preserves, jellies, fillings)/Dairy products (ice-cream, frozen desserts, sorbets)/Fish and seafood products (surimi, kamaboko, fish sausage, crab meat analogue)/Vinegar, pickles and sauces (sauces, mayonnaise, fats)/Alcoholic drinks (beer)/Beverages (coffee, tea, chocolate drinks, flavoured drinks)/Other (chewing gum, chocolate, caramels, toothpaste, liquid pharmaceuticals, solid pharmaceuticals, injectable pharmaceuticals, vitamins, mouthwash)/Meat, poultry and egg products (meat-based products)
SYNONYMS:	CFSAN D-Sorbitol/CAS 50-70-4/EINECS/ELINCS 200-061-5/INS 420; E420i/FEMA 3029/D-Glucitol/D-Sorbite/1,2,3,4,5,6-Hexanehexol/L-Gulitol/Sorbit/Cystosol/Sorbilax/Sorbol/Sorbicolan/Sorbo/Sorbostyl/Niuitin/Cholaxine/Karion/Sionit/Sionon/Sorbilande/Diakarmon/Hydex 100 Coarse Powder/Hydex 100 Coarse Powder 35/Hydex 100 Granular 205/Hydex 100 Coarse Powder 60/Hydex tablet grade/Hystar 7570/Liponic Sorbitol Powder/Liponic Sorbitol Solution 70% USP/Unisweet 70/Resulax/Sorbitur
FORMULA:	$CH_2OH\text{-}(CHOH)_4\text{-}CH_2OH$
MOLECULAR MASS IN Daltons:	182.17
PROPERTIES AND APPEARANCE:	High mouth-cooling effect. Imparts a cooling sensation due to heat absorption when dissolved. Pleasant sweet taste with no aftertaste Solution: clear, colourless syrup; sweet, bland taste; odourless Crystalline form: white hygroscopic crystal, granular, flakes or powder; slightly sweet odour Sweet taste: sweetness 60% of sucrose (w/w) Soluble in water, hot alcohol, methanol, isopropyly alcohol, formamide, acetic acid, phenol, acetamide solutions, oxygenated solvents Insoluble in vegetable and mineral oils pH ~7.0
BOILING POINT IN °C AT VARIOUS PRESSURES (INCLUDING 760 mmHg):	High mannitol solution and sorbitol solution: 105

MELTING RANGE IN °C:	Crystalline 93–97.5; anhydrous 110–112
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	High mannitol solution: **@ 25°C** 1292.9 kg/L (10.8 lb/gallon) **@ −5°C** 1.47
PURITY %:	Grade USP/FCC (High mannitol solution): minimum 64 D-Sorbitol (Assay) Grade NF/FCC (Non-crystallising): 45 to 55 D-Sorbitol (Assay) Grade USP/FCC (Solution): 69.5 in solution, 98.5 dry Grade NF/FCC (Crystalline): 91.0 to 100.5 Assay (anhydrous)
WATER CONTENT MAXIMUM IN %:	Solution: 28.5–31.5
HEAVY METAL CONTENT MAXIMUM IN ppm:	Solution 5; crystalline 10
ARSENIC CONTENT MAXIMUM IN ppm:	Solution 2.; crystalline 3
ASH MAXIMUM IN %:	Solution 0.1
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 68.7 g/100 g solution (max. 70%) **@ 50°C** 83.3 g/100 g solution
FUNCTION IN FOODS:	Bulking agent, so adds texture and mouthfeel to properties. More chemically stable; has an affinity for water without altering sweetening power. High-mannitol solution: cryoprotectant. Anti-crystallisation agent: reduced tendency to crystallise. Tenderising agent. Imparts a cooling sensation due to heat absorption when dissolved; viscosity of sorbitol syrup useful in retarding crystallisation; sorbitol syrup could provide some humectant properties to confection as well as softening the texture as a result of controlling crystallisation. For use in baking: acts as humectant and anti-caking agent in baked goods reduced fermentability increased resistance to non-enzymic browning reactions decreased tendency to crystallise

increased hygroscopicity
moisture binding.

Used in fondants, fudges, marshmallows and caramels to retard sucrose crystallisation; this results in freshness and flavour being retained.

TECHNOLOGY OF USE IN FOODS:

Functionally similar to sucrose. Available in crystal form.

Usage:

70–72% (in suspension)
6–35% (in solution)
5–25% (in syrup)
5–20% (in elixirs)

High-viscosity: at 20°C in aqueous solutions:

5%	1.230 cP
10%	1.429 cP
25%	2.689 cP
50%	11.09 cP
60%	35.73 cP
70%	185 cP
83%	> 10 000 cP

Moisture binding:

Intermediate water activity (0.6)	30 g/100 g solids
High water activity (0.95)	485 g/100 g solids

Readily soluble in water; virtually insoluble in all organic solvents except alcohol.

Less sweet than sugar, so requires intense sweeteners as supplements to bring to equivalence with sucrose.

Generally used in chewing gums as a sugar substitute, supplemented by intense sweeteners, typically saccharin (added in a small quantity to keep saccharin's tasteimperceptible).

Used in fondants, fudges, marshmallows and caramels to retard sucrose crystallisation. This results in freshness and flavour being retained.

Acts as humectant and anti-caking agent in baked goods.

Used in table-top sweeteners, preserves, jellies and confectionery for diabetics when supplemented with an intense sweetener.

May replace sucrose in chocolate and ice-cream for diabetics, but products are noticeably different as a result.

HGS (Hydrogenated Glucose Syrup) may be combined with sorbitol as a crystallisation inhibitor.

Hygroscopicity: high (solution); low (powder).
No browning reaction.
Solubility in water: high (75 g/100 mL at room temperature).
Stability: stable to heat, chemically unreactive.
Price ratio relative to sugar: 1.4 (liquid); 2.3 (crystalline).
Provides moistness, sweetness and stability to baked goods, confections and ice-creams.

Crystalline sorbitol:

Cryoprotectant
Excipient
Applications: sugar-free chewing gum, tablets, vitamins, surimi, baked goods, frozen desserts.

Sorbitol solution, high-mannitol

Composed chiefly of sorbitol
Small amount of mannitol added to provide high clarity in 'sugar-free' boiled sweets
Viscosity at 25°C: 110 cP
% mannitol: 3.0–4.0
Specific gravity at 25/25°C: 1.285 min.
Refractive index at 20°C: 1.455–1.465
% Residue on ignition: 0.1 max.
% Total sugars: 0.70 max.
% Reducing sugars: 0.21 max.
Sulphate: 80 ppm max.
Chloride: 35 ppm max.
Status: Meets all USP 23 and FCC requirements for Sorbitol Solution

Sorbitol solution, non-crystallising

Composed chiefly of sorbitol
Other polyhydric alcohols added to resist crystallisation
Recommended for dentrifices and sugar-free food applications
Useful as a humectant in a variety of food, pharmaceutical, cosmetic and industrial applications
Provides increased viscosity
Viscosity at 25°C: 190 cP

% Total sugars: 9.5–14.5
Specific gravity at 25/25°C: 1.290–1.320
Status: complies with all compendial requirements of the US National Formulary (NF 18)

Sorbitol solution, USP/FCC

Consists primarily of D-sorbitol with a small amount of mannitol and other polyhydric alcohols
Should be stored above 21°C to prevent crystallisation
Can be used as a humectant in confections, cosmetics, tobacco and adhesives
Contributes body and flavour to vehicles for pharmaceuticals and cosmetics, and to some beverages and foods
Non-cariogenic, so used in 'sugar-free' foods, dentrifices, and pharmaceuticals
Used as a plasticiser, stabiliser and a raw material in the manufacture of sorbitan esters/polysorbates and polyurethanes
Viscosity at 25°C: 110 cP
Specific gravity at 25/25°C: 1.300
% Residue on ignition: 0.01
% Total sugars: 0.20
% Reducing sugars: 0.02
Status: Meets all compendial USP 23 and FCC requirements

Sorbitol Crystalline, NF/FCC

Slightly soluble in alcohol, methanol and acetic acid
pH (5 g/100 mL water): 6.0–7.0
Appearance: white, free-flowing powder and granules, essentially free of foreign matter
Identification: Meets NF/FCC tests
Loss on drying: maximum 1.0%
Reducing sugars: max. 0.30%
Total sugars: max. 1.0%
Sulphate: max. 0.010%
Chloride: max. 0.0050%
Status: GRAS and complies with all the compendial requirements of the US National Formulary and Food Chemical Codex

Sorbitol Crystalline

Grade: NF/FCC
Granulation/concentration: granular coarse powder, tablet type, 60 mesh

Applications: used as tableting agent for making chewable and non-chewable tablets; replaces sugar in 'sugar-free' gums; adds a pleasant cooling taste to candy products.

Sorbitol solution

Grade: USP/FCC

Granulation/concentration: 70% concentration

Applications: used as humectant to preserve moistness; replaces sugar in 'sugar-free' formulations.

Sorbitol solution, high mannitol

Grade: USP/FCC

Granulation/concentration: 70% concentration

Applications: used as humectant to preserve moistness; replaces sugar in 'sugar-free' formulations; preferred in hard candy manufacture.

Sorbitol solution, non-crystallising

Grade: NF/FCC

Granulation/concentration: 70% concentration

Applications: same as Sorbitol Solution, USP/FCC but non-crystallising; preferred in dentrifices

Valuable in production of diabetic chocolate and confectionery because it adds bulk as well as sweetness

Purity and moisture content of crystalline form critical in use in chocolate and confectionery.

Liquid form used in many products, including confectionery and chewing gum, as a softener and prevents drying out.

Not often used in confectionery recipes as humectant as invert sugar produces the same results for less cost.

Viscosity of sorbitol syrup useful in retarding crystallisation.

Sorbitol syrup could provide some humectant properties to confection as well as softening the texture as a result of controlling crystallisation.

Sorbitol has a marked cooling effect when taken in solution.

Solubility in water:

0°C	59.5 g/100 g solution
10°C	64.3 g/100 g solution
20°C	68.7 g/100 g solution
30°C	73 g/100 g solution
40°C	78.3 g/100 g solution
50°C	83.3 g/100 g solution

Moisture-stabilising and textural properties used in confectionery, baked goods and chocolate to prevent drying and hardening, and maintain initial freshness during storage.

Chemically stable and unreactive.

Does not participate in Maillard (browning) reactions. Useful in production of cookies where no appearance of browning is desired.

Combines well with sugars, gelling agents, proteins and vegetable fats.

Functions well in chewing gums, candies, frozen desserts, cookies, cakes, icings and fillings, and oral care products such as toothpaste and mouthwash.

Useful in producing products listed as 'reduced calorie' (25% reduction in calories) and 'light' (one-third reduction in calories) in US.

Heat of solution: −28 cal/g; crystalline form has heat of solution of −26.5 cal/g.

Solubility at 37°C: 334 g/100 mL water.

Cooling effect (150 g powder/50 mL water at 37°C): −22.

Thermally stable: resistant to heat. No yellowing or browning at temperatures up to 180°C and up to 200–220°C under certain conditions.

Chemically stable: resistant to acids and dilute alkalis.

Due to the absence of aldehyde groups, does not undergo Maillard or Cannizzaro reactions; esterification of sorbitol by fatty acids produces compounds with surface-active properties useful in foods, cosmetics, textiles and metallurgy; etherification of sorbitol by ethylene or propylene oxides produces polyethers useful in the synthesis of rigid polyurethane foams; reaction of sorbitol with aldehydes and ketones produces acetals such as dibenzylidene sorbitol, used primarily as a nucleating agent in polyolefins production.

Acts as a good chelating agent in alkaline media in the presence of certain metal ions such as aluminium, copper or iron. Particularly useful in chelating of alkaline-earth metal ions.

Low heat of solution and high solubility provides a pleasant cool taste.

Unfermentable by many microorganisms, particularly those actively involved in tooth decay.

Commercially available 70% aqueous solution has a pH between 6 and 7.

Addition of ethanol to an aqueous solution decreases solubility.

Slightly soluble in: methanol, isopropanol, butanol, cyclohexanol, phenol, acetone, acetic acid, dimethylformamide, pyridine, acetamide solutions.

Solubility decreases with increase in level of dissolved HGS.

Higher density than other polyols at the same concentration.

Higher viscosity than other polyols at the same concentration and temperature.

Refractive index increases linearly with dry solids concentration.

Boiling temperature increases with increase in concentration.

Decrease in freezing point of aqueous solutions with an increase in concentration.

Preserves protein fibres from denaturation during the freezing process, so useful as a cryoprotectant.

When placed in humid environments will absorb some of the moisture.

A fall in humidity levels will cause sorbitol to release some moisture to re-establish an equilibrium.

Can be used as a stabiliser by compensating for significant humidity changes.

Non-volatile, so is not affected by dry environments. Stabiliser content remains constant and permanent.

Can be used as a conditioning agent in creams or pastes.

Gives good product consistency and a high level of elasticity.

Heat of fusion: 43–45 cal/g.

High storage stability.

May be stored at 20°C without lumping at up to 68% relative humidity.

Has a dendritic surface and is readily compressible.

Humectant and stabiliser: good humectant under normal conditions:

Soft confectionery: at a level of 3–15% depending upon local legislative requirements; 10% use in fondant results in a 7% reduction in water activity.

Sugar-based chewing gum and bubble gum: used as humectant and softening agent for gum base.

Biscuits, cakes and pastries: at 3–15% prevents products from drying out. Aids in product appearance. Used in biscuits and cakes containing hazelnuts, coconuts and almonds to delay rancidity. Can replace all sugar in cake or biscuit recipes for diabetic products.

Meat-based products, sauces, mayonnaise, fats: stabilise moisture content and reduce rancidity.

Cryoprotective agent:

Fish products: 3–8% level prevents low-temperature denaturation of fish proteins, as lower sweetness, and does not cause browning. Traditionally used in the manufacture of surimi and as a base for fish products such as kamaboko, fish sausage, and crab meat analogue.

Non-fermentable extract (beer and other beverages) non-fermentable by brewing yeasts. Improves flavour and body of alcohol-free, low-alcohol, and traditional beers.

Aroma carrier: in powder or liquid form products, preserves flavour and taste, and acts as a stable sugar-free carrier in products such as coffee, tea, chocolate and flavoured drinks.

Lowers freezing point: in ices, ice-creams and sorbets lowers the freezing point to make them softer and easier to scoop, and inhibits the recrystallisation of other sugars.

Some properties may be useful in animal nutrition.

Liquid pharmaceuticals (syrups, drinkable solutions and drops, elixirs, suspensions, mouth washes): properties of sweetness, humectancy and bodying characteristics suitable for use as an excipient for the formulation of non-cariogenic liquid products. Prevents crystallisation around the cap of a bottle.

Solid pharmaceuticals (tablets, powders, capsules): used in tablets produced either following wet granulation or direct compression.

Useful as a plasticiser in the production of capsules.

If used as an excipient in the production of tablets, results in white, smooth and shiny appearance, a hardness suitable for suckable lozenges and tablets, and a cooling effect.

Injectable pharmaceuticals: may be injected as a 5–10% solution with products used in parenteral nutrition associated with amino acids and vitamins.

Cosmetics: used in concentrations of 2–15% in lotions, body milks, moisturising creams, liquid soaps, shampoos and shaving foams. Acts as a moisturiser, stabiliser, emollient and plasticiser, and is safe for the skin.

Toothpaste: stabilises the moisture content and gives good consistency and plasticity (used in a concentration of 20–60%). Non-cariogenic, has a pleasant taste, and enhances the cooling effect of flavours used for this product. Has a refractive index similar to silica used in toothpaste, so can be used to make a transparent product.

Chemical intermediary in the synthesis of L-ascorbic acid (vitamin C).

Chemical production of surfactants: sorbitol can undergo anhydration and esterification with fatty acids to sorbitan esters which themselves undergo ethoxylation to produce a range of non-ionic surfactants able to function as oil-in-water or water-in-oil emulsifying agents.

Used in chemical production to generate derivatives for products such as polyolefins (propylene/ethylene) and certain pharmaceuticals.

Used as a humectant and plasticiser in: tobacco; gouaches; cellulose films.

Complexing agent for metal ions such as iron, copper and aluminium.

Enzyme stabiliser at concentrations of 45–50%.

Extends the shelf-life of suspensions of biological insecticide by inhibiting spore germination.

Used as media for the growth of *Claviceps*-type microorganisms.

Production of films and articles for food packaging.

Sweetness does not match sucrose in intensity.

Does not match mouthfeel body or fruitiness enhancement of sucrose.

Does not undergo browning reactions, so can improve shelf-life of fruit drinks.

SYNERGISTS: Isomalt

FOOD SAFETY ISSUES:

Energy: 4 kcal/g.

High suitability for diabetics. Can cause osmotic diarrhoea if taken in quantities much above 25 g. Laxative effect at high doses (50–75 g/day), so warning labels are required in some countries.

High Mannitol Solution: 2.6 cal/g (dry basis).

Sorbitol Solution, Noncrystallising: 3.0 cal/g (dry basis).

One-third the calories of sucrose.

Suitable for inclusion in diabetic products because not dependent on insulin for metabolism; low energy due to malabsorption in intestine.

70% of orally ingested sorbitol converted to CO_2 without appearing as glucose in the blood. Metabolism causes only an insignificant rise in blood glucose. Metabolism may produce some glucose but as a retarding effect. Suitable for diabetics.

Non-cariogenic; useful for caries prevention.

98% taken in food digested, the remainder is excreted; D-sorbitol enters the glycogenolytic pathways without requiring insulin, so may replace D-glucose.

Maximum daily intake recommended as 60–80 g; individual doses should not exceed 10–20 g. No toxic symptoms.

Mildly toxic by ingestion; intolerance noted by abdominal pain, bloating, diarrhoea.

If taken externally, no known toxicity.

Mutagenic data available.

TSCA (Toxic Substance Control Act) Listed.
When heated to decomposition will emit acrid smoke and irritating fumes.

LEGISLATION:

USA:
FEMA GRAS
GRAS by US FASEB (Federation of American Societies for Experimental Biology)
FDA requires on label 'Excess consumption may have a laxative effect'
GRAS by USFDA US
CFR 21
PART 100 – General
Subpart G® Specific Administrative Rulings and Decisions
100.130 Combinations of nutritive and nonnutritive sweeteners in 'diet beverages'.
(4) To avoid confusion by diabetics, the label of a beverage containing sorbitol, mannitol, or other hexitol, must bear the statement 'Contains carbohydrates, not for use by diabetics without advice of a physician'. To further avoid confusion of these beverages with those sweetened solely with nonnutritive artificial sweeteners which have been marketed in containers bearing prominent statements such as 'sugar free', 'sugarless', or 'no sugar', the labels of beverages containing hexitols must not bear these or similar statements.
CFR 21
Part 182
182.90 Substances migrating to food from paper and paperboard products.
Substances migrating to food from paper and paperboard products used in food packaging that are generally recognized as safe for their intended use, within the meaning of section 409 of the Act, are as follows: Alum (double sulfate of aluminum and ammonium potassium, or sodium). Aluminum hydroxide. Aluminum oleate. Aluminum palmitate. Casein. Cellulose acetate. Cornstarch. Diatomaceous earth filler. Ethyl cellulose. Ethyl vanillin. Glycerin. Oleic acid. Potassium sorbate. Silicon dioxides. Sodium aluminate. Sodium chloride. Sodium hexametaphosphate. Sodium hydrosulfite. Sodium phosphoaluminate. Sodium silicate. Sodium sorbate. Sodium tripolyphosphate. Sorbitol. Soy protein, isolated. Starch, acid modified. Starch, pregelatinized. Starch, unmodified. Talc. Vanillin. Zinc hydrosulfite. Zinc sulfate.
[42 FR 14640, Mar. 15, 1977]
CFR 21
PART 184® DIRECT FOOD SUBSTANCES AFFIRMED AS GENERALLY RECOGNIZED AS SAFE
Subpart B® Listing of Specific Substances Affirmed as GRAS
184.1835 Sorbitol.
(a) Sorbitol is the chemical 1,2,3,4,5,6-hexanehexol ($C_6H_{14}O_6$), a hexahydric alcohol, differing from mannitol principally by having a different optical rotation. Sorbitol is produced by the electrolytic reduction, or the transition metal catalytic hydrogenation of sugar solutions containing glucose or fructose.

(b) The ingredient meets the specifications of the *Food Chemicals Codex*, 3d edn. (1981), p. 308, which is incorporated by reference. Copies may be obtained from the National Academy Press, 2101 Constitution Ave. NW., Washington, DC 20418, or may be examined at the Office of the Federal Register, 800 North Capitol Street, NW., suite 700, Washington, DC 20408.

(c) The ingredient is used as an anticaking agent and free-flow agent as defined in §170.3(o)(1) of this chapter, curing and pickling agent as defined in §170.3(o)(5) of this chapter, drying agent as defined in §170.3(o)(7) of this chapter, emulsifier and emulsifier salt as defined in §170.3(o)(8) of this chapter, firming agent as defined in §170.3(o)(10) of this chapter, flavoring agent and adjuvant as defined in §170.3(o)(12) of this chapter, formulation aid as defined in §170.3(o)(14) of this chapter, humectant as defined in §170.3(o)(16) of this chapter, lubricant and release agent as defined in §170.3(o)(18) of this chapter, nutritive sweetener as defined in §170.3(o)(21) of this chapter, sequestrant as defined in §170.3(o)(26) of this chapter, stabilizer and thickener as defined in §170.3(o)(28) of this chapter, surface-finishing agent as defined in §170.3(o)(30) of this chapter, and texturizer as defined in §170.3(o)(32) of this chapter.

(d) The ingredient is used in food at levels not to exceed good manufacturing practices. Current good manufacturing practice in the use of sorbitol results in a maximum level of 99 percent in hard candy and cough drops as defined in §170.3(n)(25) of this chapter, 75 percent in chewing gum as defined in §170.3(n)(6) of this chapter, 98 percent in soft candy as defined in §170.3(n)(38) of this chapter, 30 percent in non-standardized jams and jellies, commercial, as defined in §170.3(n)(28) of this chapter, 30 percent in baked goods and baking mixes as defined in §170.3(n)(1) of this chapter, 17 percent in frozen dairy desserts and mixes as defined in §170.3(n)(20) of this chapter, and 12 percent in all other foods.

(e) The label and labeling of food whose reasonably foreseeable consumption may result in a daily ingestion of 50 grams of sorbitol shall bear the statement: ‘‘Excess consumption may have a laxative effect.’’

(f) Prior sanctions for this ingredient different from the uses established in this regulation do not exist or have been waived.

[42 FR 14653, Mar. 15, 1977, as amended at 49 FR 5613, Feb. 14, 1984]

UK and EUROPE:

One of 12 sweeteners listed as permissible for use in the UK as of 1983, affirmed with GRAS status

UK Food Labelling Regulations 1984 states require label ‘best eat less than 25 g of sorbitol a day’

European Union Nutritional Labelling Directive states all polyols have a calorific value of 2.4 cal/g

JECFA provides an ADI of ‘not specified’ so no limits on use

EU set no limits for use in 1985

Approved for use by European Union

Subject to certain restrictions, permitted as sweetener or food additive in Belgium, Denmark, Greece, Spain, France, Germany, Switzerland, Sweden, the Netherlands, Italy, Norway and Finland.

Europe: listed

UK: approved

CANADA:

Canada FDR 67-29

Available as crystalline solid in fibre containers of 5 to 300 pounds

Available in solutions of 70% to 85% in one- and five-gallon cans, lined steel drums and tank cars
Soluble in water
Slightly soluble in alcohol
Insoluble in ether, fats or oils
Excessive quantities may have laxative effect.
Mannitol is a chemical of similar structure and characteristics that is used for similar purposes
Unstandardised foods: sweetener, to modify texture – good manufacturing practice
Confectionery: Sweetener, release agent – good manufacturing practice
Humectant for marshmallows, shredded coconut – good manufacturing practice
To modify texture in a blend of prepared fish and prepared meat referred to in paragraph B.21.006 (n) at 3.5%

Table IX Food additives that may be used as Sweeteners: Item S.1 (September 12, 2009)

Permitted in or on	**Maximum level of use**
(1) A blend of prepared fish and prepared meat referred to in paragraph B.21.006(n) which states 'B.21.006 – Prepared fish or prepared meat shall be whole or comminuted food prepared from fresh or preserved fish or meat respectively, may be canned or cooked, and may (n) in the case of a blend of prepared fish and prepared meat that has the appearance and taste of flesh of a marine or freshwater animal, contain filler, fish binder, whole egg, egg-white, egg-yolk, food colour, gelling or stabilizing agents, texture-modifying agents, natural or artificial flavouring preparations, pH-adjusting agents, sweetener and in a proportion not exceeding two per cent of the blend, a legume;'	6.0%
(2) Unstandardised foods.	Good Manufacturing Practice

AUSTRALIA/PACIFIC RIM:

Japan and Australia: subject to certain restrictions, permitted as sweetener or food additive

OTHER COUNTRIES:

Codex: page 155
Permitted for use in raisins at a maximum level of 5 g/kg
ADI not specified
Artificial sweeteners:
Permitted for use in raisins
Maximum level: 5 mg/kg

ADI: not specified
Subject to certain restrictions, permitted as sweetener or food additive in South Africa and Brazil.
The following ADM Sorbitol products are certified Kosher
Sorbitol Crystalline
Sorbitol Solution
Sorbitol Solution, high mannitol
Sorbitol Solution, non-crystallising

REFERENCES:

www.medicinescomplete.com/mc/merck/current. Merck Index Online. Accessed 5–6 September 2009.

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ADM Technical Specifications, 1996.

Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York.

Calorie Control Council Informational Brochure, 1995.

Canadian Food and Drugs Act and Regulations (1994) Health Canada, Ontario.

Chilton's Food Engineering Master '95 (1994) ABC Publishing Group, pp.10; 288–289.

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European Parliament and Council Directive 94/35/EC of 30 June 1994 on sweeteners for use in foodstuffs. Available at http://eur-lex.europa.eu. Accessed 15 January 2010.

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Hicks, D. (1989) *Production and Packaging of Non-Carbonated Fruit Juices and Fruit Beverages.* Blackie Publishing, Glasgow.

Matz, S.A. (1992) *Bakery Technology and Engineering*, 3rd edn. Van Nostrand Reinhold, New York.

McCue, N. (1996) Showcase: natural and high intensity sweeteners. *Prepared Foods* March, 84.

Minifie, B.W. (1989) *Chocolate, Cocoa, and Confectionery: Science and Technology*, 3rd edn. Van Nostrand Reinhold.

Official Journal of the European Union Directives Commission Directive 2008/60/EC of 17 June 2008 laying down specific purity criteria concerning sweeteners for use in foodstuffs (Codified version). Available at http://eur-lex.europa.eu. Accessed 15 January 2010.

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Roquette Technical Bulletin, as provided by Kingsley & Keith (Canada) Inc., 1996.

Smith, J. (1991) *Food Additive User's Handbook.* Blackie Publishing, Glasgow.

Smoley, C.K. (1993) *Everything Added to Food in the United States.* US Food and Drug Administration, CRC Press, Boca Raton, FL.

Wong, D.W.S. (1989) *Mechanism and Theory in Food Chemistry.* Van Nostrand Reinhold, New York.

ANY OTHER RELEVANT INFORMATION:

Polyol produced through hydrogenation of glucose; first hydrogenated sugar produced in 1930s.

Naturally occurring; produced when crystalline form of lactitol heated to 179 to 240°C.

Used since 1920s by diabetics because metabolism causes only an insignificant rise in blood glucose because ingested sorbitol converts to CO_2 without appearing as glucose in the blood.

Hexahydric sugar alcohol; isomeric with mannitol; naturally occurring in small quantities in many fruits.

Prepared commercially by catalytic hydrogenation of glucose.

Polyhydric alcohol: richest source is rowan or mountain ash berry; no natural supply is commercially important. Polymorphic and exists in three crystalline states. Only gamma form is stable; other two forms will transform to gamma form under moisture or heat.

Provided in US by Archer Daniels midland, Lonza Inc., Roquette America Inc., SPI Polyols, Inc. Marketed as NeoSorb: discovered in 1872 by French chemist B.J. Boussingault as a non-fermentable sugar present in rowan juice which he named sorbite, a linear hexitol.

Also present in high concentrations in black grapes, apples, nectarines, peaches, apricots, plums, cherries, pears; formally named D-sorbitol.

Crystalline sorbitol: supplier Roquette America Inc.

Liquid sorbitol: suppliers Roquette America Inc. and USP – ADM Corn Processing.

ADM sorbitol as marketed by ADM Food Additives Division; available as crystalline 70% solution, high-mannitol solution, and non-crystallising solution.

Monotropic polymorphism: able to crystallise in different forms (α, β, γ). Alpha and beta forms are metastable and may be converted to the stable gamma form under certain temperature and humidity conditions, causing sorbitol powder to cake. Impossible physically to extract sorbitol from natural sources due to its high water solubility.

1 g of sorbitol can yield 3.994 calories, compared with 3.940 calories from 1 g of cane sugar.

Manufacturer/Distributor: AB R Lundberg; ADM; AMRESCO; AllChem Ind.; Ashland; CarboMer; Cerestar; Danisco; Fluka; Magnesia GmbH; San Yuan

Marketed under trade names of Arlex™ 83; C*Sorbidex; Hydex®; Hystal®; Liponic

NAME:	Stevioside
CATEGORY:	Sweetener/Flavour enhancer/Flavour modifier/Non-nutritive sweetener
FOOD USE:	Fruit, vegetable and nut products (fruit juices, fruit beverages)/Beverages (fruit beverages, carbonated beverages)/Sugars, sugar preserves and confectionery (cube sugar, table-top sweeteners)/Others (sugarless chewing gum)
SYNONYMS:	Steviosin: (4α)-13-[(2-*O*-β-D-glucopyranosyl-α-D-glucopyranosyl) oxy] kaur-16-en-18-oic acid-β-D-glucopyranosyl ester/Stevia Steviol: (4α)-13-Hydroxykaur-16-en-18-oic acid/Hydroxydehydrostevic acid CAS 57817-89-7
FORMULA:	$C_{38}H_{60}O_{18}$
MOLECULAR MASS IN Daltons:	804.88
PROPERTIES AND APPEARANCE:	White hygroscopic powder (in pure form). Commercially available form ranges from cream to tan colour, depending upon purity. Licorice-like taste; slow taste onset; thin mouthfeel body. Sweet taste (300 times that of sucrose); lingering bitter-licorice aftertaste. Soluble in water and dioxane. Slightly soluble in alcohol.
MELTING RANGE IN °C:	Steviosin 196–198; steviol 215
PURITY %:	90
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** Pure form has a solubility in water of 1.2 g/L Commercial forms are more soluble, in the range of 300–800 g/L 1 g stevioside dissolves in 800 mL of water
in ethanol solution (100%):	Insoluble
FUNCTION IN FOODS:	Sweetening agent (300 times sweetness of sucrose); flavour modifier (used to suppress pungent flavours); flavour enhancer in fruit drinks.

TECHNOLOGY OF USE IN FOODS:

Steviol is the aglucon of stevioside. On its own, produces an unacceptable liquorice-like taste in cola beverages. Combined with fructose to produce 50% calorie-reduced soft drinks; combined with polyols in sugarless chewing gums; combined with sucrose in calorie-reduced sugar cubes.

Gums using stevioside are considered highly acceptable by consumers.

Used in Japan in sugarless chewing gums, soft drinks, table-top sweeteners, juices and other products. Also used as a flavour modifier and to suppress pungent flavours in pickles, dried seafoods, fish, meat, bean pastes and soy sauce.

Stable at pH 3–9; withstands 100°C for 1 hour at pH 3–9. At room temperature, stable in citric acidified beverages for 3 months; stable in phosphoric acidified beverages for 5 months; also stable in the presence of salt. No browning reaction.

Stevioside has low solubility in alcohol.

In soft drinks, sweetness ranges from 140 to 280 times that of sucrose.

Not recommended as the sole sweetener due to its bitter/licorice taste.

Taste can be improved by increasing the fraction of rebaudioside-A or by combining with fructose, lactose, hitidine, chlorodeoxysugars, cyclodextrin, aspartame or cyclamate.

Stevia extracts are generally shelf-stable. In carbonated beverages, there is no reported degradation over 5 months at 22°C or lower; some breakdown of rebaudioside-A (36%) and stevioside (25%) at 37°C over 4 months.

Stevia extracts do not interact with other food components in soft drinks.

Stevia detection in soft drinks best using HPLC, but can be performed using GLC or colorimetric methods.

Currently used in Japan by over 50 companies in soft drinks, instant juices, and fruit-flavoured drinks; compatible in fruit beverages. Sweetness intensity at 10% sucrose is 150. Soluble in dioxane

SYNERGISTS: Glycyrrhizin (mixture is commercially available in Japan)/Aspartame/Cyclamate/Acesulfame-K/Sucrose/Glucose/Fructose

ANTAGONISTS: Degradation in carbonated beverages greater with phosphoric acid than citric acid systems. Rebaudioside-A breaks down under UV light.

FOOD SAFETY ISSUES: No significant mutagenic or genotoxic activity.

Question of whether stevioside and rebaudioside are degraded in the bowel to steviol, which has biological risks. Unclear whether stevioside is excreted unmetabolised or is reduced to steviol (this has been observed in rats, but not in humans).

There have been reports linking stevioside with anti-hormonal effects and infertility, but studies have not confirmed this.

Non-cariogenic.

LEGISLATION:

USA:

Not approved for use in USA as of 1990

Regulatory Status: ADI level as of 1990 for use in soft drinks – Not permitted

UK and EUROPE:

SCF indicated in December 1987 that stevia was not toxicologically acceptable

Regulatory Status: ADI level as of 1990 for use in soft drinks

JECFA	None specified
Belgium	Not permitted
Denmark	Not permitted
Finland	Not permitted
France	Not permitted
East Germany	Not permitted
West Germany	Not permitted
Greece	Not permitted
Ireland	Not permitted
Netherlands	Not permitted
Norway	Not permitted
Spain	Not permitted
Switzerland	Not permitted
Turkey	Not permitted
UK	Not permitted
Yugoslavia	Not permitted

CANADA:

Regulatory Status: ADI level as of 1990 for use in soft drinks – Not permitted

AUSTRALIA/PACIFIC RIM:

Natural product, so no clearance required in Japan

Permitted for use in Japan since 1970

Used in Japan in sugarless chewing gums, soft drinks, table-top sweeteners, juices and other products

In Japan, used as a flavour modifier and to suppress pungent flavours in pickles, dried seafoods, fish, meat, and bean pastes, and soy sauce

Permitted for use in China and South Korea

Currently used in Japan by over 50 companies in soft drinks, instant juices, and fruit-flavoured drinks

Regulatory Status: ADI level as of 1990 for use in soft drinks

Australia	Not permitted
Japan	Permitted
New Zealand	Not permitted

OTHER COUNTRIES:

Permitted for use in Brazil and Paraguay

Brazil's Health Ministry approved its use in diet drinks in November 1988

Regulatory Status: ADI level as of 1990 for use in soft drinks

Argentina	Not permitted
Brazil	750 mg/L
Israel	Not permitted
Kenya	Not permitted
Mexico	Not permitted
Saudi Arabia	Not permitted
South Africa	Not permitted

REFERENCES:

www.medicinescomplete.com/mc/merck/current. Merck Index Online. Accessed 5–6 September 2009.

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Wong, D.W.S. (1989) *Mechanism and Theory in Food Chemistry.* Van Nostrand Reinhold, New York.

ANY OTHER RELEVANT INFORMATION:

Discovered in 1905. Structurally related to glycyrrhizic acid. One of the only sweeteners extracted and refined from plant sources without chemical or enzymic modification; the others are sucrose and thaumatin.

Sweet diterpene glycosides extracted from the leaves of *Stevia rebaudiana* Bertoni, which is a variety of chrysanthemum found in Paraguay and Brazil. The plant has been successfully cultivated in Japan, Korea, South Africa, South America, Taiwan and China.

Commercially available in Japan as crude extract, 50% pure and 90% pure or higher grades.

Taste profile improves with purity.

Rebaudioside-A is a constituent of stevioside which has less aftertaste and is currently under study. Stevioside and rebaudioside-A are the two extracts from the *Stevia* plant which are of commercial importance. Three other extracts of lesser importance are named rebaudioside-C to rebaudioside-E.

In Japan, stevia is marketed through a consortium of 11 major companies called the Stevia Konwakior (Stevia Association).

NAME:	Sucralose
CATEGORY:	Sweetener/Flavour enhancer
FOOD USE:	Baked goods (baking mixes, bakery products, desserts, dessert mixes, toppings, topping mixes, fillings, filling mixes)/Dairy products (dry milk products, dairy beverages, dairy desserts, frozen desserts, puddings, pudding mixes)/Cereals and cereal products/Fruit, vegetable and nut products (fruit spreads, processed fruit and vegetable products)/Beverages (dairy beverages, beverage concentrates, beverage mixes, still beverages, carbonated beverages)/Sugars, sugar preserves and confectionery (table-top sweeteners, confections, confection coatings, confectionery glazes, table syrups)/Alcoholic drinks/Vinegar, pickles and sauces (salad dressings, condiments)/Other (chewing gum, breath freshener, sweetened seasonings, coatings mixes for snack foods)
SYNONYMS:	CAS 56038-13-2/INS955; E955/4,1′,6′-Trichlorogalactosucrose/1,6-Dichloro-1,6-dideoxy-β-D-fructofuranosyl-4-chloro-4-deoxy-α-D-galactopyranoside/4,1′,6′-Trichloro-4,1′,6′-trideoxy-galacto-sucrose/Trichlorogalactosucrose/TGS/4,1’,6’-Trichlorogalacto-sucrose
FORMULA:	$C_{12}H_{19}C_{13}O_8$
MOLECULAR MASS IN Daltons:	397.64
PROPERTIES AND APPEARANCE:	White crystalline powder. Odourless. Thin mouthfeel body; sweet (400–800 times that of sucrose); delayed onset of flavour; lingering sweet aftertaste; intensely sweet taste; taste similar to sucrose. Soluble in water, methanol, alcohol. Slightly soluble in ethyl acetate.
MELTING RANGE IN °C:	Anhydrous form 130; pentahydrate 36.5
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 28% weight/unit volume
in ethanol solution:	**@ 100%** Soluble
FUNCTION IN FOODS:	Sweetener (400–800 times that of sucrose); flavour enhancer in processed foods and beverages.

TECHNOLOGY OF USE IN FOODS:

Stable in solution at low pH; as stable in solution at high temperatures as sucrose.

Can be stored for several years in liquids. Resistant to enzymic hydrolysis; no browning reaction with proteins, gums, tannins and other carbohydrates.

Relative sweetness increases with a decrease in pH; in cola beverages, sweetness enhanced using aspartame.

Stable under most conditions of food processing; stable over pH range found in carbonated soft drinks.

Hydrolyses to 4-chloro-D-galactosucrose and 1,6-dichloro-D-fructose in extreme pH and temperature situations.

Does not interact with most food ingredients except some iron salts.

Stable in dry form when stored correctly; slow decomposition of dry form at elevated temperatures resulting in colour change from white to brown; resistant to enzymic hydrolysis.

Stable at pH 3–7.5; good stability and maintains integrity during baking; good stability in acidic drinks; compatible with fruit beverage ingredients.

Sweetness intensity at 10% sucrose is 450.

SYNERGISTS: Aspartame; cyclamate; saccharin; stevioside. High levels of synergism in tripartite blends with cyclamate and aspartame or acesulfame and saccharin

ANTAGONISTS: Negatively synergistic with aspartame in bipartite blends

FOOD SAFETY ISSUES: Non-toxic; non-carcinogenic; non-teratogenic; non-mutagenic; non-cariogenic. LD_{50} in rats > 16 g/kg. Non-caloric: not metabolised by mammals, and poorly absorbed by the body.

LEGISLATION:

USA:

Under FDA review as of 1992 for use in 15 food categories, including baked goods

UK and EUROPE:

JECFA ADI of 0–3.5 mg/kg

CANADA:

Canada FDR 67.31A Table IX Food additives that may be used as Sweeteners – Item S. 2 (September 12, 2009)

Permitted in or on	Maximum level of use
(1) Table-top sweeteners	Good Manufacturing Practice
(2) Breakfast cereals	0.1%
(3) Beverages; beverage concentrates; beverage mixes; dairy beverages; (except for any of these products for which standards are set out in these Regulations)	0.025% in beverages as consumed
(4) Desserts; dessert mixes; toppings; topping mixes; dairy desserts; frozen desserts; fillings; filling mixes; (except for any of these products for which standards are set out in these Regulations)	0.025% in products as consumed

(5) Chewing gum; breath freshener products	0.15%
(6) Fruit spreads (except for any of these products for which standards are set out in these Regulations)	0.045%
(7) Salad dressings; condiments; (except for any of these products for which standards are set out in these Regulations)	0.04%
(8) Confections and their coatings; confectionery glazes for snack foods; sweetened seasonings or coatings mixes for snack foods; (except for any of these products for which standards are set out in these Regulations)	0.07%
(9) Baking mixes; bakery products; (except for any of these products for which standards are set out in these Regulations)	0.065% in products as consumed
(10) Processed fruit and vegetable products (except for any of these products for which standards are set out in these Regulations)	0.015%
(11) Alcoholic beverages (except for any of these products for which standards are set out in these Regulations)	0.07%
(12) Puddings; pudding mixes	0.04% in products are consumed
(13) Table syrups (except for any products for which standards are set out in these Regulations)	0.15%

Amendment to Canada FDR – Item S.15a, Table VIII as of 1996 – to provide for use of sucralose as a sweetener and flavour enhancer

OTHER COUNTRIES:

Permitted for use in Australia, Russia, Romania and Mexico.

REFERENCES:

www.medicinescomplete.com/mc/merck/current. Merck Index Online. Accessed 5–6 September 2009.

Canadian Food and Drugs Act and Regulations (1994) Health Canada, Ontario.

European Parliament and Council Directive 94/35/EC of 30 June 1994 on sweeteners for use in foodstuffs. Available at http://eur-lex.europa.eu. Accessed 15 January 2010.

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Smith, J. (1991) *Food Additive User's Handbook.* Blackie Publishing, Glasgow.
Smoley, C.K. (1993) *Everything Added to Food in the United States.* US Food and Drug Administration, CRC Press, Boca Raton, FL.

ANY OTHER RELEVANT INFORMATION:

Trichloro derivative of sucrose; discovered in 1976. Produced using selective chlorination of sucrose, process patented by Tate & Lyle of London, England. Jointly developed by Tate & Lyle Specialty Sweeteners (UK) and McNeil Specialty Products Company (US). Manufactured and distributed by CarboMex and Sigma.

Marketed by Tate & Lyle in UK and Europe

Johnson & Johnson market the product in the USA

Marketed under the trade name of Splenda®

NAME:	Sucrose
CATEGORY:	Sweetener
FOOD USE:	Flavouring agent/Preservative/Antioxidant (in form of invert sugar) in foods
SYNONYMS:	Beet sugar/Cane sugar/Confectioner's sugar/β-D-Fructofuranosyl-α-D-glucopyranoside, α-D-glucopyranosyl β-D-fructofuranoside (α-D-Glucosido)-β-D-fructofuranoside/Granulated sugar/Rock candy/Saccharose/Saccharum/D-Sucrose/Sugar/Table sugar/CAS 57-50-1/EINECS/ELINCS 200-334-9
FORMULA:	$C_{12}H_{22}O_{11}$
MOLECULAR MASS:	342.30
PROPERTIES AND APPEARANCE:	White crystals or powder, odourless, sweet taste, very soluble in water, soluble in alcohol, glycerol, pyridine; insoluble in ether, chloroform. Sugar obtained from *Saccharum officinarum*, *Beta vulgaris* and other sources; molecule of glucose linked to one of fructose; available commercially as naturally occurring (+)-enantiomer. Hydrolysis with invertase or acid to give D-glucose and D-fructose
MELTING RANGE IN °C:	160–186 (decomposition)
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.587
ANTAGONISTS:	May form explosive dust–air mixtures. Incompatible with oxidisers (increases fire/explosive risks). Vigorous reaction with nitric acid or sulphuric acid
FOOD SAFETY ISSUES:	Non-toxic by ingestion, although inhalation at high concentration of dust may cause coughing. Mild temporary irritation; experimental teratogen; mutagenic data available. Toxic Substance Control Act listed. Avoid static charge, sparks and temperature above 160°C. Hazardous decomposition products (CO, CO_2). When heated to decomposition will emit acrid smoke and irritating fumes. Avoid generating dust.
LEGISLATION:	**USA:** FDA 21CFR 73.85, 100.130, 101.4, 101.9, 101.80, 131.112, 131.170, 131.200, 131.203, 131.206, 133.124, 133.178, 133.179, 145.3, 145.134, 148.180, 146.3, 146.140, 146.141, 146.145, 146.146, 150.160, 155.170, 155.200, 169.175, 169.179, 172.810, 172.816, 172.859, 172.861, 173.145, 184.1854, GRAS; USDA 9CFR318.7, 381.147; Cleared by MID to flavour sausage, ham, misc. meat products

CANADA:
Canadian Provisional Domestic Substance listed

REFERENCES:

Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York.

Shmuel, Y. (ed.) (2004) *Dictionary of Food Compounds with CD-ROM: Additives, Flavors and Ingredients*. Chapman & Hall/CRC, USA.

ANY OTHER RELEVANT INFORMATION:

Manufacturer/Distributor: AMERSCO, Adept Sol'ns, Aldrich, Ashland, British Sugar plc, CPI Chem, CarboMer, Cluka, J.T Baker, Penta Mfg., Roche Diagnostics, Ruger, Sigma, Spectrum Quality Products, Tate & Lyle N. America, VWR Int'l, Voigt Global Distributor, Vopak USA

Trade names: Di-Pac®, NF Bakers Special, NF Bottlers Grade, NF Canners, NF Confectioner's 6x, NF Confectioner's 10x, NF Confectioner's 12x, NF Extra Fine Granulated, NF Fruit Granulated, NF Medium Granulated, NF Sanding Granulated, NF Standard Granulated

NAME:	Tagatose		
CATEGORY:	Sweetener		
FOOD USE:	Flavour/Sweetener in low-calorie foods/Humectant/Texturiser/Stabiliser		
SYNONYMS:	CAS87-81-0/EINECS/ELINCS 201-772-3		
FORMULA:	$C_6H_{12}O_6$		
MOLECULAR MASS:	180.16		
PROPERTIES AND APPEARANCE:	White crystalline powder, odourless. Sweetness is about 0.75–0.92 times that of sucrose		
MELTING RANGE IN °C:	132–135		
ANTAGONISTS:	Incompatible with oxidisers		
FOOD SAFETY ISSUES:	Hazardous decomposition products (CO, CO_2). Can produce irritating and toxic fumes/gases. Avoid contact with skin and eyes.		
LEGISLATION:	**USA:** Approved for use GRAS	**UK and EUROPE:** Approved for use	**CANADA:** Approved for use
REFERENCES:	Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York. Shmuel, Y. (ed.) (2004) *Dictionary of Food Compounds with CD-ROM: Additives, Flavors and Ingredients*. Chapman & Hall/CRC, USA.		
ANY OTHER RELEVANT INFORMATION:	Trade name: Gaio Tagatose		

NAME:	Thaumatin
CATEGORY:	Sweetener/Flavour enhancer/Flavour modifier
FOOD USE:	Baked goods (desserts)/Dairy products (milk powders, ice-cream, iced milk)/Beverages/Soft drinks/Others (pet foods, animal feeds, chewing gum, salt substitutes, coffee-flavoured products, toothpaste, mouthwash, MSG replacement, medication)
SYNONYMS:	CFSAN Thaumatin/CAS 53850-34-3/Talin/Katemfe/FEMA 3732/INS957; E957
MOLECULAR MASS IN Daltons:	21 000–22 000
ALTERNATIVE FORMS:	Thaumatin I/Thaumatin II
PROPERTIES AND APPEARANCE:	Cream-coloured powder. Lingering licorice aftertaste; odourless. Sweet taste (750–1600 times that of sucrose by weight, 1300–2500 times that of sucrose in 5–10% sucrose range, 30 000–100 000 times sweeter than sucrose on a molar basis); delayed sweetness onset; Strongly cationic. Relatively stable in solution and on heating.
MELTING RANGE IN °C:	172–174
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 60% weight/unit volume
in propylene glycol:	**@ 20°C** 5% weight/unit volume
FUNCTION IN FOODS:	Sweetener: 750–1600 times that of sucrose by weight; 1300–2500 times that of sucrose in 5–10% sucrose range; primarily in beverages and desserts. Flavour enhancer (primarily used at below sweet-taste threshold); flavour potentiator: flavour masking agent (in medicines); aroma enhancer; taste modifier.
ALTERNATIVES:	Aspartame (equivalent to thaumatin/acesulfame)

TECHNOLOGY OF USE IN FOODS:

Protein loses sweetness on heating and in pH < 2.5.

Primarily used as a flavour enhancer at levels below sweet-taste threshold due to problems with stability, taste profile and compatibility.

When combined with acesulfame-K, provides a less costly alternative to aspartame with equivalent taste in some products.

Due to licorice taste and delayed sweetness, applications are limited.

More commonly used as a partial sweetener in combination with other rapid-tasting sweeteners.

Flavour potentiation and slow onset of sweetness beneficial in products such as toothpaste, mouthwash and chewing gum.

Boosts low sweetness of bulk sweeteners added to sugarless gums.

Powerful flavour enhancer, magnifies spearmint, cinnamon, wintergreen and peppermint up to 10 times.

Enhances and improves flavour of coffee and milk products so used in coffee-flavoured products, ice-cream, iced-milk drinks-on-sticks, and spray-dried milk powders.

Enhances savoury flavours; can be used to replace MSG (monosodium glutamate) when combined with nucleotides, spices and/or other flavours.

Solubility at room temperature: good solubility in ethyl alcohol, isopropyl alcohol, glycerol, propylene glycol and higher polyols such as sorbitol; insoluble in ether, acetone, toluene and triacetin.

Stable in pH 1–9 at ambient temperatures; heat-stable in pH 2.7–6.0, optimum at pH 2.8–3.5. At pH < 5.5, withstands 100°C for several hours.

Able to be stored indefinitely in dry form; able to be stored for several years in chemically preserved solutions at ambient temperatures.

Licorice aftertaste can be reduced slightly through combination with arabinogalactan, glucuronic acid, several types of sugars, or one of polyols.

Does interact with some food constituents by forming salts with suitable negatively charged compounds when they are present in excess.

Interaction with several types of gums and stabilisers such as CMC, xanthan, pectin, locust bean gum, and alginates.

In soft drinks, precipitation may occur with some synthetic colours which may be prevented by adding low levels of gum arabic.

Talin® used in UK in chewing gum as a flavour potentiator at subthreshold levels. Limited use worldwide in soft drinks.

Very soluble in cold water. Solubility: readily soluble in cold water to produce solutions in excess of 60% weight/volume; can produce solutions of 3–5% in 60% ethanol; can produce solutions of up to 5% in propylene glycol; soluble in other aprotic solvents.

Remains stable indefinitely in freeze-dried or spray-dried form if stored under ambient conditions; remains stable at 120°C in canning operations and under pasteurisation and UHT conditions; stable under acid conditions to below pH 2.0.

Has masking effect on bitter metallic ions such as sodium, iron, potassium. Can be used to mask aftertaste of saccharin, added minerals, or pharmaceutical products.

Masks bitter components of natural citrus flavours in products containing citrus fruits or juices.

Addition of 10 ppm thaumatin allows a 30% reduction in the level of aspartame required for a product of the same sweetness.

Used with non-nutritive sweeteners to mask synthetic taste, provide body, all allow a reduction in the amount of sweetener required.

The addition of less than 1 ppm of thaumatin in carbonated beverages dramatically reduces sugar or sweetener inclusion.

Due to licorice-like taste when used at high levels, applications limited to where sweetness requirement is less than the equivalent of 10% sucrose.

Unsuitable for use in fruit-flavoured beverages.

SYNERGISTS:

Saccharin (masks its aftertaste at low levels); acesulfame-K; stevioside.

Aluminium ions known to increase perceived sweetness by a factor of 2.

Interaction with taste receptors causes it to heighten response to sweeteners and certain flavour compounds.

Flavour-enhancing properties used in 'aggressive' flavours such as peppermint, ginger, cinnamon and coffee, as well as ability to reduce their fiery, peppery or bitter elements.

In savoury products, enhances flavour and synergises with flavour-enhancers such as MSG and 5′-nucleotides, creating the 'Umami' (delicious) flavour.

Taste increased by trivalent salts.

Works synergistically with saccharin and acesulfame-K

ANTAGONISTS: Taste reduced by monovalent and divalent salts. Denatured by metaphosphoric and phytic acids at pH 2.9. Loss of sweetness with xanthan, CMC, pectin and alginate. Incompatible with carrageenans; incompatible with certain beverage ingredients such as synthetic colours. Undergoes denaturation when exposed to extreme pH and high temperatures, resulting in a loss of sweetness (this denaturation may be reversible)

FOOD SAFETY ISSUES: Contributes the same number of calories as sucrose (4 kcal/g), but use is measured in ppm so it is essentially non-calorific in food products.

Is digested and metabolised completely by humans and animals.

No adverse effects found during toxicological studies; non-cariogenic.

In 1987, JECFA recorded no mutagenic, teratogenic or allergenic effects; concluded that the only dietary effect was an insignificant increase in normal protein intake. Generally accepted as a safe, natural substance.

LEGISLATION:

USA:

US granted GRAS for use as flavour enhancer in chewing gum in October 1984

Approved for general use in USA

Has been reviewed and listed as GRAS (Substance No. 3732) by FEMA

May be used in USA in products labelled as 'natural'

UK and EUROPE:

UK permitted use in foods, drinks and dietary products except baby foods by Sweeteners in Food Regulations with Group A status in 1983

JECFA declared ADI 'not specified' in 1985

Regulatory Status: ADI level as of 1990 for use in soft drinks

Belgium	Not permitted
Denmark	Permitted
Finland	Not permitted
France	Not permitted
East Germany	Not permitted

West Germany	Not permitted
Greece	Not permitted
Ireland	Not permitted
Netherlands	Permitted
Norway	Permitted
Spain	Not permitted
Switzerland	Not permitted
Turkey	Not permitted
UK	Permitted
USSR	Not permitted
Yugoslavia	Not permitted

CANADA:

Canada FDR s. 67.31B – Table IX – Food additives that may be used as Sweeteners – Item T.1 (September 12, 2009)

Permitted in or on	**Maximum level of use**
(1) Chewing gum; breath freshening products	500 ppm
(2) Salt substitutes	400 ppm
(3) (naming the flavour) Flavour referred to in section B.10.005;	100 ppm

Unstandardised flavouring preparations B.10.005 (naming the flavour) Flavour

(a) shall be a preparation, other than a flavouring preparation described in section B.10.003 as sapid or odorous principals, or both, derived from the aromatic plant after which the preparation is named;

(b) may contain a sweetening agent, food colour, Class II preservative, thaumatin, Class IV preservative or emulsifying agent; and

(c) may have added to it the following liquids only

(i) water;

(ii) any of, or any combination of, the following: benzyl alcohol; 1,3-butylene glycol, ethyl acetate, ethyl alcohol, glycerol, glyceryl diacetate, glyceryl triacetate, glyceryl tributyrate, isopropyl alcohol, monoglycerides and diglycerides; 1,2-propylene glycol or triethylcitrate;

(iii) edible vegetable oil; and

(iv) brominated vegetable oil, sucrose acetate isobutyrate or mixtures thereof, when such flavour is used in citrus-flavoured or spruce-flavoured beverages

B.10.003 (naming the flavour) Extract or (naming the flavour) Essence shall be a solution in ethyl alcohol, glycerol, propylene glycol or any combination of these, of sapid or odorous principles, or both, derived from the plant after which the flavouring extract or essence is named, and may contain water, a sweetening agent, food colour and a Class II preservative or Class IV preservative.

Changes to page 67-29 of Canada FDR as of 1996

sweetener and flavour enhancer for chewing gum and breath freshener products – 500 ppm

bitterness masking agent in salt substitutes – 400 ppm

flavour enhancer in (naming the flavour) flavour (division 10) and unstandardised flavouring preparations – 100 ppm

AUSTRALIA/PACIFIC RIM:

Permitted as a natural food in Japan since June 1979

Appproved for use as a sweetener and flavour enhancer in Australia

Regulatory Status: ADI level as of 1990 for use in soft drinks

Australia	Permitted
Japan	Permitted
New Zealand	Permitted

OTHER COUNTRIES:

The only natural high-intensity sweetener so products containing thaumatin do not require to be labelled 'artificially sweetened'

Approved for use as a sweetener and flavour enhancer in Mexico

Regulatory Status: ADI level as of 1990 for use in soft-drinks. May be permitted as a sweetener or flavour enhancer

Argentina	Not permitted
Brazil	Not permitted
Israel	Not permitted
Kenya	Not permitted
Saudi Arabia	Not permitted
South Africa	Permitted

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Smith, J. (1991) *Food Additive User's Handbook.* Blackie Publishing, Glasgow.
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Wong, D.W.S. (1989) *Mechanism and Theory in Food Chemistry.* Van Nostrand Reinhold, New York.

ANY OTHER RELEVANT INFORMATION:

Thaumatin I (TI) and Thaumatin II (TII) isolated by Van der Wel at Unilever in 1972 as two major sweet-tasting proteins.

Mixture of sweet-tasting proteins extracted from the fruit of *Thaumatococcus danielli* Benth or Katemfe plant, found in West Africa.

One of the only sweeteners extracted and refined from plant sources without chemical or enzymic modification (the others are sucrose and stevioside).

Fruit of plant source has been used for centuries in West Africa.

Five soluble proteins designated a, b, c, I and II, the latter two being the sweetest.

Made up of 207 'normal' amino acid residues linked by eight disulphide bridges.

Interacts with the majority of taste receptors; this function is shared only by MSG and nucleotides.

Contains the following amino acids: glycine, threonine, alanine, half-cystine, serine, aspartic acid, proline, arginine, phenylalanine, lysine, asparagine, valine, leucine, iso-leucine, tyrosine, glutamic acid, glutamine, tryptophan, methionine.

100 000 times as sweet as sucrose on a molar basis.

Marketed by Tate & Lyle in UK and Hayes Ingredients in US, selling it as a thaumatin-aluminium product under the name Talin.

Listed in the *Guinness Book of World Records* as the sweetest substance known.

Primarily sold in Japan.

Manufactured and distributed by Kaden BioChems; Research Organix.

NAME:	Trehalose		
CATEGORY:	Sweetener		
FOOD USE:	Stabiliser/Thickener/Flavour enhancer in honey, breads, beer, seafood/Cryopreservation		
SYNONYMS:	Ergot sugar/α-D-Glucopyranosyl-α-D-glucopyranoside/Mycose/Natural trehalose/α-Trehalose/α,α-Trehalose/D-(+)-Trehalose/Trehalose, dehydrate/Mushroom Sugar/CAS 99-20-7/EINECS/ELINCS 202-739-6		
FORMULA:	$C_{12}H_{22}O_{11}$		
MOLECULAR MASS:	342.30		
PROPERTIES AND APPEARANCE:	Off-white to white crystal powder, odourless; about 0.36 times as sweet as sucrose; fermented by yeast; specific gravity 1.54		
MELTING RANGE IN °C:	97		
FOOD SAFETY ISSUES:	Toxicology studies, as well as absorption, metabolism and tolerability testing of trehalose in humans, indicate that trehalose consumption at levels expected for use as food ingredient are not of toxicological concern. Evaluation by the Joint Food and Agriculture Organisation/World Health Organisation Expert Committee on Food Additives (JECFA, 2001) granted trehalose at an acceptable daily intake (ADI) of 'not specified'. There are no safety or nutritional concerns associated with trehalose.		
LEGISLATION:	**USA:** GRAS; approved for use as sweetener	**UK and EUROPE:** EU: approved for use as sweetener	**CANADA:** Canadian Provisional Domestic Substance Listed
REFERENCES:	Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York. Novel Foods Information: Trehalose. Health Canada, Ontario, Canada. Available at: http://www.hc-sc.gc.ca. Accessed February 27 2010. Shmuel, Y. (ed.) (2004) *Dictionary of Food Compounds with CD-ROM: Additives, Flavors and Ingredients*. Chapman & Hall/CRC, USA.		
ANY OTHER RELEVANT INFORMATION:	Manufacturer/Distributor: British Sugar plc; Cargill Foods; Hayashibara Trade names: Ascend™, Trehalose		

NAME:	Xylitol
CATEGORY:	Sweetener/Nutritive additive/Humectant/Bulking agent
FOOD USE:	Sugars, sugar preserves and confectionery (confections, icings, chocolate products, fondants, mints, caramels)/ Baked goods (dry mixes, cream fillings)/Other (dietary supplement, diabetic foods, dietetic foods, pharmaceuticals, anti-caries products, oral and intravenous nutrients, chewing gum, children's chewable vitamins)
SYNONYMS:	CFSAN Xylitol/CAS 87-99-0/EINECS 201-788-0/INS967; E967/Xylite/Xylit/Eutrit/Kannit/Klinit/Kylit/ Newtol/Torch/Xyliton/Xylitol C/Xylo-pentane-1,2,3,4,5-pentol/Xylisorb/1,2,3,4,5 – Pentahydroxypentane/ Pentahydric alcohol
FORMULA:	$C_5H_{12}O_5$
MOLECULAR MASS IN Daltons:	152.15
PROPERTIES AND APPEARANCE:	White crystal or crystalline powder; practically odourless. Sweet taste with cooling sensation; same sweetness as sucrose; no aftertaste. Soluble in water; slightly soluble in alcohol.
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.52 (stable form)
MELTING RANGE IN °C:	Stable form 93–94.5; metastable form 61–61.5
PURITY %:	98.5 to 110 assay
SOLUBILITY % AT VARIOUS TEMPERATURE/pH COMBINATIONS:	
in water:	**@ 20°C** 62.7 g/100 g solution **@ 50°C** 80 g/100 g solution
in ethanol solution (100%):	Sparingly soluble in ethanol (1.2 g/100 g solution at 25°C)
FUNCTION IN FOODS:	Add texture and mouthfeel (bulking agent). Reduced tendency to crystallise. Sweetener (sweetness 1.0 relative to sucrose); humectant; non-fermentable. In baking, results in: reduced fermentability; increased resistance to non-enzymic browning reactions; decreased tendency to crystallise; increased hygroscopicity. Dietary supplement; sugar substitute; humectant; stabiliser; emulsifier; thickener.

ALTERNATIVES: Sorbitol (less sweet)

TECHNOLOGY OF USE IN FOODS:

An affinity for water without altering sweetening power. Functionally similar to sucrose; sweetening power twice sorbitol and glucose syrup. pH 5–7 in aqueous solution. Chemically stable.

Storage: 1-year stability in original sealed package; store below 25°C and $< 65\%$ relative humidity.

High hygroscopicity: 6.0 g/100 g methanol; 1.2 g/100 g ethanol; 62.2 g/100 g water.

Sweetness varies slightly with temperature, pH and concentration.

Used alone, with other polyols, or with polydextrose in sugarless confectionery products. Polydextrose is a bulking agent with low laxative properties, low calorific value (1 kcal/g) and is tolerated by diabetics, but is not very sweet.

Primarily used as a sweetener in sugarless chewing gum.

In 50/50 combination with sorbitol in milled, blended or compressed form may have potential for use in mints and children's chewable vitamin tablets. There are problems of poor flow properties. Direct compression of xylitol with no more than 4% sorbitol preferable.

Good choice for replacement of sucrose in chocolate.

Conching can take place at temperatures up to 55°C.

Can be combined with sorbitol to provide syrup phase of fondants, and with mint and chocolate flavours. Can also be used in pectin and gelatin jellies, but extra gelling agent is required as xylitol reduces gel strength.

No browning (Maillard) reaction; resistant to heat; does not react with amino acids.

Solubility in water:

10°C	58 g/100 g solution
20°C	62.7 g/100 g solution
30°C	68.5 g/100 g solution
40°C	74.5 g/100 g solution
50°C	80 g/100 g solution
60°C	86 g/100 g solution

FOOD SAFETY ISSUES:

LD_{50} of 22 g/kg (25.7 g/kg orally; 3.77 g/kg intravenous). Moderately toxic by intravenous route; mildly toxic by ingestion.

Low cariogenicity; several studies have demonstrated its caries-inhibiting ability; is not metabolised by cariogenic bacteria.

Is slowly but completely absorbed in the intestine.

Laxative effect at high doses (50–70 g/day), so warning labels are required in some countries.

Has been proven to have no adverse health effects, but abnormalities arise when exceptionally large quantities are taken.

Suitable for diabetic products because metabolism results in no significant change in blood glucose.

ADI not specified.

On heating to decomposition, emits acrid smoke and irritating fumes.

TSCA (Toxic Substance Control Act) listed.

Cariostatic.

LEGISLATION:

USA:

FDA clearance in 1978 for sweetening of Special Dietary Foods

CFR 21

PART 172 – Food Additives Permitted for Direct Addition to Food for Human Consumption

Subpart D – Special Dietary and Nutritional Additives

172.395 – Xylitol.

Xylitol may be safely used in foods for special dietary uses, provided the amount used is not greater than that required to produce its intended effect.

UK and EUROPE:

Permissible for use in UK, EEC, Scandinavia. One of 12 sweeteners listed as permissible for use in the UK as of 1983

CANADA:

Canada FDR s. 67.31B – Table IX – Food additives that may be used as Sweeteners – Item X.1 (September 12, 2009)

Permitted in or on unstandardised foods at maximum level of use specified by Good Manufacturing Practice

1996 Addition: Page 67–29 of Canadian FDR – Table IX

Permitted for use as a sweetener in chewing gum at a maximum level specified by Good Manufacturing Practice

OTHER COUNTRIES:

WHO/FAO clearance (1978) for sweetening of Special Dietary Foods

Not GRAS approved

Permitted for use in more than 40 countries as of 1991 including EEC, North America and Scandinavia

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Wong, D.W.S. (1989) *Mechanism and Theory in Food Chemistry.* Van Nostrand Reinhold, New York.

ANY OTHER RELEVANT INFORMATION:

Pentahydric alcohol or sugar alcohol; hydrogenated form of xylose; naturally occurring in raspberries, strawberries, plums, some vegetables, mushrooms, greengages and cauliflowers.

Manufacturers: American Roland, American Xyrofin, Automergic Chemicals, F. R. Benson, Cerestar International, Food Additives & Ingredients, Forum Chemicals, Fruitsource, Melida, Penta Manufacturing, Raquette U.K., Scanchem Xyratin.

Marketed under trade names of C*Xylides; Xylisorb®; Xylitab®; Xylitol C.

Developed in the 1970s; relatively expensive, but appealing due to other beneficial qualities. Produced commercially by enzymatic or microbial conversion of xylose-rich precursors such as birchwood chips.

Xylisorb® meets requirements of USPXXII, NF XVII, Japanese Ph XI, and DAC 90.

Strongly negative heat of solution combined with high solubility at body temperature results in refreshingly cool effect to the taste. Heat of solution −34.8 cal/g versus water −4.3 cal/g. Cooling effect (150 g powder/50 mL water at 37°C): −20 versus −9 for sugar.

NAME:	Xylose, D(+)
CATEGORY:	Sweetener
FOOD USE:	Sweetener in diabetic food/Savoury flavour reducing sugar/Source of ethanol/Flavouring ingredient
SYNONYMS:	2,3,4,5-Tetrahydroxy-pentanal/Wood sugar/D-Xylopyranose/(D)-Xylose/Xylose, D-/Losan/Xylomed/Xylo-Pfan/Pentose sugar/CAS 58-86-6/EINECS/ELINCS 200-400-7/FEMA 3606
FORMULA:	$C_5H_{10}O_5$
MOLECULAR MASS:	150.13
PROPERTIES AND APPEARANCE:	White crystal powder; soluble in water, alcohol; present in straw, corncobs and pecan shells; 40% the sweetness of sugar
MELTING RANGE IN °C:	156–158
DENSITY AT 20°C (AND OTHER TEMPERATURES) IN g/L:	1.525
FOOD SAFETY ISSUES:	Combustible. When heated to decomposition will emit acrid smoke and irritating vapours. Toxic Substance Control Act listed.
LEGISLATION:	**USA:** FEMA, GRAS **CANADA:** Canadian Provisional Domestic Substance Listed
REFERENCES:	Ash, M. and Ash, I. (2006) *Handbook of Flavors and Fragrances*. Synapse Information Resources Inc., New York. Shmuel, Y. (ed.) (2004) *Dictionary of Food Compounds with CD-ROM: Additives, Flavors and Ingredients*. Chapman & Hall/CRC, USA.
ANY OTHER RELEVANT INFORMATION:	Manufacturer/Distributor: AMERSCO, Adept Sol'ns, Asiamerica Int'l, Bioth China, CarboMer, Danisco Cultor, Danisco Sweeteners, Penta Mfg, Ruger, Sigma, Sinochen Tianjin, Spectrum Quality Prods, Universal Preserv-A-Chem, VWR Int'l, Voigt Global Distrib Trade names: D-Xylose CL; D-Xylose CT; D-Xylose CTR

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Food Additives Data Book, Second Edition. Edited by Jim Smith and Lily Hong-Shum.

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WILEY-BLACKWELL

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