Paper No.: 13

Paper Title: FOOD ADDITIVES

Module – 21 : Raising agents, Glazing agents and Sequesterants for the food industry

21.1 Introduction

Raising agents, Glazing agents and Sequesterants have their distinct role in various food products. Important raising or leavening agents, glazing agents and sequestering agents used for the food industry are discussed in this module.

21.2 Raising agents for the food industry

Raising agent or Leavening Agent is a substance used to produce or stimulate production of carbon dioxide in baked goods in order to impart a light texture, including yeast, yeast foods, and calcium salts. It is a substance or combination of substances which liberate gas and there by increased volume of a dough.

Different raising agents are discussed below:

21.2.1 Calcium carbonate

Calcium carbonate is a naturally occurring mineral (chalk or limestone), but the food-grade material is made by reaction of calcium hydroxide with carbon dioxide, followed by purification by flotation. It is used as a colour, a source of carbon dioxide in raising agents, an anti-caking agent, a source of calcium and a texturising agent in chewing gum.

Calcium carbonate is used in chewing gum and in bread.

21.2.2 Calcium phosphates

The calcium phosphates are manufactured by the reaction of hydrated lime and phosphoric acid under conditions controlled to maximize the yield of the required product.

Monocalcium phosphate

Monocalcium phosphate is used as a raising agent when rapid reaction with sodium bicarbonate is required.

Dicalcium phosphate

Dicalcium phosphate is available in both dihydrate and anhydrous forms. The dihydrate is used as a raising agent in combination with other phosphates and sodium bicarbonate. It is used in products that require a baking time in excess of 30 minutes and in combination with faster-acting raising agents when it provides last-minute expansion of the cake batter just before the batter sets.

21.2.3 Magnesium phosphates

The phosphates are prepared by reaction of magnesium oxide with phosphoric acid under conditions controlled to maximise the yield of the required product. Magnesium phosphates are used as acidulants in raising agents in dough of Bakery goods.

21.2.4 Ethyl cellulose

Ethyl cellulose is the ethyl ether of cellulose, prepared from wood pulp or cotton by treatment with alkali and ethylation of the alkali cellulose with ethyl chloride. It can be used as bulking agent and raising agent.

Ethyl cellulose polymers bring binding, film forming and flavour fixative benefits to food products, helping flavours last longer. It is used in food supplements and encapsulated flavourings.

21.2.5 Sodium carbonates (Sodium carbonate and bi carbonate)

Sodium bicarbonate is made industrially from brine and limestone using the ammonia soda process. It is purified by repeated crystallisation. Sodium bicarbonate does decompose thermally and can be used alone as a raising agent. The bicarbonate is generating carbon dioxide by the action of heat at temperatures as low as 60 °C. Sodium carbonate is used as a raising agent in cakes, in combination with, for example, sodium aluminium phosphate.

The carbonates are used in a wide range of baked goods including pastries, cakes, waffles, cookies and scones.

Sodium bicarbonate is well known as Baking Soda and is sold in grocery stores under the name bicarbonate of soda. Baking Soda liberates carbon dioxide, but in the process, a residue of washing soda remains in the cake which imparts a dark color and unpleasant taste to the cake. To counteract this, an edible acid ingredient is normally added which reacts with the soda and produces an edible, pleasant tasting residue.

Baking Powder

It is the leavening agent produced by mixing baking soda and acid salt. Flour or starch is added to stabilize the mixture and to standardize it such that at least 12% carbon dioxide is released upon heating.

21.2.6 Potassium carbonates

Both potassium carbonate and bicarbonate are prepared by passing carbon dioxide into potassium hydroxide. Potassium bicarbonate can also be used in baking powder to generate carbon dioxide by mixing it with an acidic material such as tartaric acid or disodium diphosphate. The tricarbonate is also used alone, generating carbon dioxide by the action of heat at temperatures as low as 60 °C.

The potassium carbonates are used as raising agents, where it is necessary to restrict the amount of sodium or enhance the potassium in the product. Potassium carbonate is more soluble than sodium carbonate. Potassium carbonate releases carbon dioxide only when used in conjunction with an acid. It is thus less convenient to use than sodium carbonate. When used in excess, potassium bicarbonate can leave a soapy taste in the product. Potassium bicarbonate is more expensive and requires higher usage rates than sodium bicarbonate.

It is used in low-sodium crackers or biscuits and energy bars. Potassium carbonate is also used in the treatment of hops, in cocoa powder used for baking or chocolate drinks, and in ginger bread.

21.2.7 Ammonium carbonates

Either ammonium carbonate or ammonium bicarbonate is used to a small extent as a leavening agent. Ammonium bicarbonate is prepared by passing carbon dioxide into ammonia solution. The ammonium carbonates are particularly useful because they break up on heating to only 60 °C, generating both carbon dioxide and ammonia, and leaving no residue in the product. They are both readily soluble in water. Its use is primarily limited to certain types of cookies and cream puffs.

The ammonium carbonates are now used as raising agents in the manufacture of biscuits and crackers, and in sugar confectionery.

21.2.8 Sodium sulphates

Sodium sulphate is produced as a by-product of a number of processes using sulphuric acid. Sodium sulphate is used in colours to standardise the colour strength of the powder. Sodium bisulphate is also used as an acid in raising agents.

21.2.9 Potassium sulphates

Potassium bisulphate is used as an acidic material in raising agents. It is used as a replacement for sodium sulphate in products where it is required to reduce the sodium level.

21.2.10 Sodium aluminium phosphate

Sodium aluminium phosphate is a white, odourless powder made by the reaction of sodium hydroxide, aluminium oxide and phosphoric acid.

Sodium aluminium phosphate is an acidic product used as a raising agent with a carbon dioxide generator such as sodium bicarbonate. It provides slow release of carbon dioxide and is used in commercial doughs and batters, where the dough is made up and is held refrigerated before cooking. Typically, about 20% of available carbon dioxide is released from the bicarbonate during mixing and the remainder is released during cooking. It is also used in a mixture with monocalcium phosphate to provide release of carbon dioxide both before and during cooking.

Its particular benefit is the low level of carbon dioxide released during refrigerated storage. Widely used in Scones and sponges.

21.2.11 Yeast

Yeast is commonly used as raising agent in bakery industry especially in bread and cake making. Yeast is a single-celled plant that reproduces by budding and is capable of converting sugar to alcohol and carbon dioxide in a process known as fermentation. The production of carbon dioxide causes the flour mixture to rise.

Forms of Yeast: Dry or Granular, Cake, Compressed of Fresh

Role of Yeast in Bread making:

The formation and migration of carbon dioxide culmination in a network of cellular compartments, to lighten or raise the dough, thereby improving its ultimate palatability. The simultaneous production and concentration of alcohols, aldehydes, ketones and acids and ultimately contributing to bread aroma and flavor.

21.3 Glazing agents for the food industry

A glazing agent is a natural or synthetic substance that provides a waxy, homogeneous, coating to prevent water loss and provide other surface protection for the substance. Substance which, when applied to the external surface of a foodstuff, imparts a shiny appearance or provides a protective coating.

Different glazing agents are discussed below:

21.3.1 Agar

Agar is obtained from red seaweeds of the *Gelidium* and *Gracilaria* species collected from the coasts. Agar is used in jams and marmalades, toppings and fillings for bakery products such as doughnut glaze. Agar gels are used in gelled meats worldwide.

21.3.2 Karaya gum

Karaya gum is a natural tree exudate collected from *Sterculia urens* (Roxburgh) and other species of *Sterculia* and *Cochlospermum* following manmade incisions in the bark of the tree.

Karaya gum is used as a thickener (cold make-up) and as a coating and glazing agent. Karaya particles do not normally dissolve but swell in a similar fashion to starch, although karaya generally thickens at a lower concentration than starch, forming a thick paste at 3% w/w in water.

21.3.3 Pectins

Pectins are found in most land plants, especially in fruits and other nonwoody issues. Commercial pectins are currently extracted from fruit solids remaining after juice extraction – in particular, from apple pomace and citrus peel.

Pectins are used as gelling and thickening agents in a range of mainly acidic foods, most typically fruit products (jams, jellies, industrial fruit preparations for bakery and dairy products, sugar confectionery) but also increasingly in glazes and sauces for savoury products.

21.3.4 Dimethyl polysiloxane (silicone, silicone oil, dimethyl silicone)

Dimethyl polysiloxane is made from silica and oil-derived chemicals.

It is used as a carrier of glazing agents for fruit. Dimethyl polysiloxane is permitted in a limited range of products, such as jam, soups, frying oils, drinks, canned and bottled fruit and in chewing gum.

21.3.5 Beeswax

Beeswax is purified from naturally produced honeycomb.

Beeswax is permitted only as a glazing agent in a range of snacks, confectionery and bakery items, and food supplements, and on the surface of some fresh fruit. Generally used in Small confectionery items such as jellies and gums, and tablets.

21.3.6 Candelilla wax

Candelilla wax is a natural wax extracted from the leaves of the candelilla plant, *Euphorbia antisyphilitica* Zucc.

Candelilla wax is permitted only as a glazing agent in a range of snacks, confectionery and bakery items and food supplements, and on the surface of some fresh fruit. Typical Products include Chewing gum and small pieces of confectionery.

21.3.7 Carnauba wax

Carnauba wax is a natural material extracted from the fronds of the Brazilian wax palm, *Copernicia prunifera*. Carnauba wax works well where pressure can be applied to produce the shine. This makes it inappropriate for delicate products.

Carnauba wax is permitted only as a glazing agent in a range of snacks, confectionery and bakery items and food supplements, and on the surface of some fresh fruit up to specified limits. Carnauba wax is used to glaze small pieces of chocolate confectionery, gums, jellies and chewing gum.

21.3.8 Shellac

Shellac is purified and refined from a resinous secretion of an Indian scale insect, *Laccifer lacca*. Shellac has a number of uses. It is used to provide a polished surface on products, to prevent sticky items from sticking together, and to reduce the moisture loss of fresh fruit. Shellac is insoluble but dispersible in water and provides high gloss without the need for pressure. It can be used in combination with other glazing agents.

Shellac is permitted only as a glazing agent in a range of snacks, confectionery and bakery items, food supplements, and on the surface of fresh fruit. No limits are set for the applications. Shellac is used on small coated pieces, such as chocolate and flavoured coated confectionery, biscuits, and gums.

21.3.9 Hydrogenated poly-1-decene

Hydrogenated poly-1-decene is prepared by the hydrogenation of mixtures of trimers, tetramers, pentamers and hexamers of 1-decenes. Pure 1-decene is itself made from ethylene.

It is a permitted as a glazing agent for use in a limited number of foodstuffs, namely sugar confectionery and dried fruits.

21.3.10 Oxidised polyethylene wax

Oxidised polyethylene wax is prepared by the mild air oxidation of polyethylene. Oxidised polyethylene wax is used to provide a protective coating to fresh fruit to reduce moisture loss during storage.

During the washing process, fruit tends to lose some of its natural wax, and glazing agents such as oxidised polyethylene wax are used to replace it. The wax is sprayed on as a very small droplet size emulsion.

21.3.11 Pullulan

Pullulan is a linear, neutral glucan which consists primarily of maltotriose units connected by α-1-6 glycosidic bonds. It is produced by fermentation from a food grade hydrolysed starch using a non-toxin producing strain of the fungus *Aureobasidium pullulans*.

Use as glazing agent for coating of food supplements that are in capsule/tablet form and breathe freshening micro sweets in film form.

21.4 Sequesterants for the food industry

Sequestering agents, also called chelates, combine with polyvalent metal ions to form a soluble metal complex to improve the quality and stability of products as free metallic ions promote oxidation of food. They are used in various aspects of food production and processing chiefly to obviate undesirable properties of metal ions without the necessity of precipitating or removing these ions from solutions.

Different sequestering agents are discussed below:

21.4.1 Citric acid

Citric acid is a key intermediate in the human metabolic cycle. It occurs vary widely in nature, most notably in citrus fruits. Its primary functions in food are as an acid, acidity regulator, antioxidant and sequestrant. It has antioxidant properties, protecting sensitive flavours, and it is a powerful sequestering agent, binding metal ions that are responsible for the onset of rancidity.

In dilute solution, citric acid reduces the discoloration and spoilage of cut fruits, vegetables and shellfish. It helps prevent rancidity in fats and aids the degumming of vegetable oils. Citric acid is one of the most widely used of all food additives. Its clean, tart taste has found wide application in soft drinks (carbonates, squashes, nectars and powdered beverages), sugar confectionery, jams, jellies, preserves, soups and sauces.

21.4.2 Phosphoric acid

Manufactured commercially by the addition of sulphuric acid to phosphate rock, followed by additional steps to remove impurities. The dimetalphosphates are used for their ability to enhance water binding in meat and dairy products, preventing water loss and shrinkage during cooking and storage. They are also used to stabilise milk products, such as evaporated milk, against protein coagulation and gelling but also to increase the rate of gelling in instant puddings and cheesecakes. They are powerful sequestrants of calcium in water and are used as such to prevent flocculation of milk proteins during rehydration in hard water of milk-based powders.

The dimetalphosphates are the most important emulsifying salts in processed cheese, because they provide the required body and melting performance without fat separation. They are often used in combination with the trimetal phosphates and occasionally with the mono-metal phosphates.

Typical products include processed cheese, cooked ham, desserts and evaporated milk.

21.4.3 Metatartaric acid

Metatartaric acid is manufactured from glucose. It is also known as glucaric acid. Metatartaric acid is used as a sequestrant to prevent deposition of cream of tartar (monopotassium tartrate) and calcium tartrate in wine during storage.

Metatartaric acid is permitted only in wine and made wine up to 100 mg/litre. It is deliquescent and should be kept in tightly closed packages.

21.4.4 EDTA

Ethylene diamine tetra-acetic acid (EDTA) is the most commonly used sequestering, or metal-complexing, agent used in the food industry. This compound, as well as the disodium or calcium disodium salts of tetraacetic acid retards discoloration of dried bananas, beans, chickpeas, canned clams, pecan pie filling, frozen potatoes, and canned shrimp. Also, these compounds improve flavour retention in canned carbonated beverages, salad dressings, mayonnaise, margarine, and sauces; retard struvite formation in canned crabmeat and shrimp; and protect against rancidity in dressings, mayonnaise, sauces, and sandwich spreads.

Calcium disodium EDTA

Calcium disodium EDTA is the mixed salt of EDTA made by reacting the acid with a mixture of calcium and sodium hydroxides. EDTA itself is made by a multistage process starting from ethylene glycol. Calcium disodium EDTA is a sequestrant, both binding metal ions and exchanging its calcium for metal ions.

Calcium disodium EDTA is used to sequester small quantities of metal ions present in raw materials or process water. These metals tend to catalyse degradation reactions such as those

leading to rancidity, and their removal increases the stability of products during storage and extends shelf-life. By a similar mechanism, it stabilises vitamin C and oil-soluble vitamins.

It is used in spreadable fats as a synergist for the antioxidant vitamins, having the advantage over citric acid or polyphosphate that it imparts no flavour. The salt is used because it is more stable than the acid. Calcium disodium EDTA is permitted only in a number of canned and bottled products, in spreadable fats and in emulsified sauces with individual maxima specified in each case. Widely applicable in catering sauces and salad dressings.

21.4.5 Sorbitol

Sorbitol is widely present in nature, particularly as a constituent of many fruits and berries. Commercial products are manufactured by hydrogenation of dextrose and dextrose/glucose syrup, followed, for the crystalline sorbitol, by crystallisation.

Sorbitol syrup is also used as an efficient humectant, and as a sequestering and emulsifying agent in confectionery and bakery products, as well as in mayonnaise, creams and sauces.

Typical products include Sugar-free confectionery products such as chewing gum, compressed tablets, hard-boiled, soft and chewy candies and chocolate; bakery products; and fish and surimi products.

21.4.6 Erythritol

It can be used as a sweetener like the other currently permitted polyols. As well as use as a sweetener, it can act as a flavour enhancer, carrier, humectant, stabiliser, thickener, bulking agent, and sequestrant.

Typical products include confectionery, desserts, food supplements, liqueurs.

21.4.7 Triethyl citrate

Triethyl citrate is made by reacting citric acid with ethanol. It is an odourless and colourless oily liquid.

Triethyl citrate is used to increase the rate at which rehydrated egg white powder forms a stable foam. It can also be used as an antifoaming agent, sequestrant, stabiliser or as a carrier solvent.

21.5 Use of Food Additives permitted in Food Products in India (FSSAI)

21.5.1 Raising / Leavening agents

Sr. No.	Name	Bread	Biscuit	Cakes and Pastries
1	Baking powder	GMP	GMP	GMP
2	Ammonium bi-carbonate	GMP	GMP	GMP
3	Ammonium carbonate	5000 ppm max	5000 ppm max	500 ppm max

21.5.2 Glazing agents

Sr. No.	Name	Chocolates
1	Shellac	GMP
2	Beeswax (white and yellow)	GMP
3	Candelilla wax	GMP
4	Gum arabic	GMP
5	Pectin	GMP

21.5.3 Sequestering agents

Sr. No.	Name	Carbonated fruit beverages or fruit drink	Carbonated water, Cold drink	Nectars, Thermally processed fruit beverages	Fruit drinks/ready to serve fruit beverages
1	Sodium hexa meta phosphate	1000 ppm max	1000 ppm max	1000 ppm max	1000 ppm max