

Paper No.: 13

Paper Title: FOOD ADDITIVES

Module – 14 Firming agents, Humectants and Propellants

14.1 Introduction

Each category of food additives has distinct application. In these module important Firming agents, Humectants and Propellants are discussed with their probable applications in food industry.

14.2 Firming Agents

Firming agents are substance added to precipitate residual pectin, thus strengthening the supporting tissue and preventing its collapse during processing. Fruits and vegetables contain pectin components that are relatively insoluble and form a firm gel around the fibrous tissues of the fruit and prevent its collapse. Addition of calcium salts causes the formation of calcium pectate gel, which supports the tissues and affords protection against softening during processing. The calcium salt is sometimes added to the canned vegetable in the form of a tablet containing both sodium chloride and calcium chloride.

Canned vegetables, canned apples, frozen apples, and tomatoes are sometimes treated during processing with calcium chloride, calcium citrate, monocalcium dihydrogen phosphate, calcium lactate or calcium sulphate to prevent them from becoming soft and disintegrating. Suggested level of use of these calcium salts is 0.02%, calculated as calcium in the final food product. In canned potatoes, calcium chloride and calcium citrate at a level of 0.5% (calculated as calcium) are used.

Acidic aluminum salts, such as aluminum sulfate, ammonium aluminum sulphate, potassium aluminum sulphate and sodium aluminum sulfate are used as firming agents in pickles and relishes. A more recently introduced firming agent is aluminum sulfate for canned crabmeat, lobster, salmon, shrimp, and tuna.

Important firming agents are discussed below.

14.2.1 Calcium chloride

As a firming agent calcium chloride is used in canned vegetables, in firming soy bean curds into tofu and in producing a caviar substitute from vegetable or fruit juices.

It helps to maintain firmness of fruits and vegetables or interacts with gelling agents to strengthen food structure. Calcium chloride acts as a firming agent in cheddar and cottage cheese.

Calcium chloride may impart stomach irritant in sensitive people.

14.2.2 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 is used as a source of calcium to improve the structure from low-gluten flours, and to increase the firmness of canned vegetables such as carrots and tomatoes.

14.2.3 Konjac

Konjac gum and konjac glucomannan, also known as konjac flour, yam flour, konnyaku glucomannan and glucomannan gum, are extracted from the tuber of the *Amorphophallus konjac* plant.

In table dessert gels and aspics, 0.6% of a konjac gum-kappa-carrageenan blend gives firm cohesive textures. The thermally stable glucomannan gel is used in coarse-ground sausage and meat analogues as a texture modifier and water binder.

Typical products include aspics, surimi, frozen desserts, sauces and batters.

14.2.4 Calcium sulphate

Calcium sulphate is a naturally occurring mineral, also known as Plaster of Paris. Calcium sulphate is used in the preparation of water for brewing to provide both calcium and sulphate ions, which are present in naturally hard water.

In canned fruit and vegetables, it is also used to provide calcium ions for reaction with natural cell-wall pectin to maintain the firmness of the pieces. In baking, it helps bubble stability and cell strength.

Table 14.1: Important firming agent with their food applications.

Firming Agent	Application in food
Aluminum Sulphate	Canned crabmeat, lobster, salmon, shrimp and tuna; Pickles and relishes.
Ammonium Aluminum Sulphate	Pickles and relishes
Calcium Chloride	Canned apples, Canned grapefruit, Cheddar cheese, Cottage cheese, Glaze for frozen fish, Olives, Pickles and relishes, Canned vegetable; Tomatoes, Canned apricots, Frozen apples
Calcium Citrate	Canned vegetables; Tomatoes, Canned apples, Frozen apples; Frozen sliced apples
Calcium Gluconate	Unstandardized foods
Calcium Lactate	Canned grapefruit, Canned peas
Calcium Phosphate, dibasic	Unstandardized foods
Calcium Phosphate, monobasic	Canned vegetables; Tomatoes, Canned apples, Frozen apples
Calcium Sulphate	Canned vegetables; Tomatoes, Canned apples, Frozen apples
Potassium Aluminum Sulphate	Pickles and relishes, Sea urchin roe
Sodium Aluminum Sulphate	Pickles and relishes

14.3 Humectants

Humectants are hygroscopic substances incorporated in food to promote retention of moisture. It prevents food from drying out by counteracting the effect of a wetting agent atmosphere having low degree of humidity.

In certain foods, it is necessary to control the amount of water that enters or exits the product. It is for this purpose that humectants are employed. Polyhydric alcohols (polyols), which include propylene glycol, glycerol, sorbitol, and mannitol, contain numerous hydroxyl groups. Their structure makes them hydrophilic and enables them to bind water in foods. Examples of products that use humectants include shredded coconut, cookies, glazed and dried fruit, gelatin products, and cakes. High dosages of polyhydric alcohols may cause a laxative effect and usage is somewhat limited as a result.

Humectants are also known as moisture/ water retention agent or wetting agent. Important humectants are discussed below.

14.3.1 Sorbitol

Sorbitol is widely present in nature, particularly as a constituent of many fruits and berries. Sorbitol syrup is 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. Excessive consumption of sorbitol can produce a laxative effect.

14.3.2 Glycerol

Glycerol is made by the hydrolysis of fats. It can be obtained from both animal and vegetable fats, and material from both sources is readily available. Glycerol is liquid at room temperature. It is used as a humectant, to keep foodstuffs moist to the palate without the risk of mould or bacterial growth. It is also used to retard staling and to improve texture by plasticising the food.

In products where sugar crystallises after manufacture, glycerol is used to inhibit crystallisation, thus maintaining more sugar in solution, which itself has a humectant effect.

Glycerol is also less volatile than water, which means that it is better at maintaining moistness over the shelf-life of the product.

It does have the particular taste effect of leaving a slight burning sensation in the throat, which limits the quantities that can be used in a product. Glycerol is used in cakes and confectionery.

14.3.3 Xylitol

Xylitol is produced by the catalytic hydrogenation of xylose (wood sugar), which can be obtained from the xylan-rich hemicellulose portion of trees and plants. Xylitol is principally used as a non-fermentable bulk sweetener in foods and oral hygiene products. In addition to its use as a sweetener, xylitol is also used as a humectant, as a masking agent for other ingredients, and as an energy source in intravenous products.

Xylitol is well tolerated but, as with other polyols, excessive consumption can cause laxative effects. Xylitol is used in chewing gum, mints and gum-arabic pastilles, and other confectionery. It is also used in toothpaste, mouthwash and other dental speciality products, and as an excipient in pharmaceutical products.

14.3.4 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. Erythritol has a laxative effect, but at a higher dose than other polyols.

Typical Products includes confectionery, desserts, food supplements, liqueurs.

14.3.5 Polydextrose

Polydextrose is prepared by a vacuum melt process involving polycondensation of glucose in the presence of small amounts of sorbitol and an acid.

Polydextrose functions as a humectant and retards the loss of moisture in baked goods, which helps protect against staling. Polydextrose is used in no-added-sugar, energy-reduced or dietetic products, including chocolate, hard candy, frozen dairy desserts, baked goods, fruit spreads and fillings, surimi, and beverages. In pharmaceutical preparations, solutions of polydextrose can be used as binders in wet granulation processes.

Polydextrose may also be used in conjunction with other materials as a film and tablet-coating agent.

14.3.6 Propane-1,2-diol

Propane-1,2-diol, also known as propylene glycol, It can be used as an anticaking agent, antifoaming agent, emulsifier, flour treatment agent, humectant, stabiliser, thickener, adjuvant and carrier solvent.

14.4 Propellants

Propellants help propel food from a container. They are pressurized gases used to expel food from its container. Propellants are also used to reduce the amount of oxygen in contact with the food in packaging.

Pressurized aerosol containers are used to dispense fluid food products in the form of a liquid, foam or spray. The use of propellants provides the necessary pressure to force the fluid food out of the aerosol container. The most commonly used propellants include nitrogen, nitrous oxide and carbon dioxide. The latter propellants are generally used to dispense foam and spray type products, such as whipped creams, cheese and mustard. This is because nitrous oxide and carbon dioxide tend to dissolve in the fluid food and expand during its release from the container, causing the formation of a spray or foam. Nitrogen does not exhibit such properties and thus is used to dispense foods that are required in a liquid form, e.g. oils and syrups.

Important propellants are discussed below.

14.4.1 Nitrous oxide

Nitrous oxide is most commonly obtained by the thermal decomposition of ammonium nitrate.

In modified-atmosphere packaging, nitrous oxide is a permitted packaging gas, but is not used for general food-packaging applications. It is used in the dairy industry for several applications, where it has the property of being able to reduce the oxidation of lipids by any residual air. It is used in whipping creams and mousses and as a propellant in aerosol creams.

Nitrous oxide is a very reactive gas, requiring safety measures.

Shelf-life in packaged dairy products can be extended by the use of nitrous oxide, where oxidative rancidity can be avoided.

Typical Product includes ready-to-serve whipped cream. N_2O has excellent performance as a propellant of food aerosol products. Whipped cream by N_2O has higher foaming stability. Most importantly, the taste of N_2O -containing whipped cream is similar to air-whipped cream.

14.4.2 Butane and Iso-butane

Butane (also known as n-butane) and iso-butane are obtained from natural gas by fractionation. They are colourless, odourless, flammable gases at normal temperatures and pressures. They are readily liquefied under pressure at room temperature and are stored and shipped as liquids.

Butane and iso-butane can be used as propellants in vegetable oil pan sprays and water-based emulsion sprays.

14.4.3 Propane

Propane (also known as dimethylmethane) is obtained from natural gas by fractionation. It is a colourless, odourless, flammable gas at normal temperatures and pressures, which is easily liquefied under pressure at room temperature. Propane is stored and shipped in the liquid state.

Propane can be used as a propellant in vegetable oil pan sprays and water-based emulsion sprays.