Paper No.: 13

Paper Title: Food Additives

Module – 13: Foaming and Anti-foaming agents

13.1 Introduction

Foaming and Anti-foaming agents are important part of food industry not only for manufacturing of products but also for processing of various food products. In these module different foaming and anti-foaming agents are discussed with their appropriate application in food products.

13.2 Foaming Agents

Foaming agent also known as aerating agent. A foaming agent is additives that facilitates formation of foam and make it possible to form or maintain a uniform dispersion of a gaseous phase in liquid or solid food.

These compounds have been suggested for use in the preparation of certain toppings, cakes and cake mixes, coffee whiteners, whipped creams, beverages and soft drinks.

13.2.1 Propylene glycol esters of fatty acids

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.

Widely used in Cake batters, Margarine, Shortening, Powdered desserts, Toppings, Synthetic cream etc.

13.2.2 Glycyrrhizin

Glycyrrhizin is a foaming agent also acts as sweetener and nutrient.

It is widely used in 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) and Other (i.e. tobacco, chocolate, vanilla, medicines, gelatin, pudding, chewing gum).

Alternative forms include Calcium glycyrrhizinate, Disodium glycyrrhizinate, Monoammonium glycyrrhizinate, Potassium glycyrrhizinate, Magnesium glycyrrhizinate, Ammonium glycyrrhizinate pentahydrate.

13.2.2.1 Ammoniated glycyrrhizin

Widely used in Baked goods, Beverages (alcoholic), Beverages (non-alcoholic), Candy (hard), Candy (soft), Chewing gum, Herbs/ Plant protein products, Seasonings, Vitamin or mineral dietary supplements, Pharmaceuticals.

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.

13.2.3 Alginic Acid

Alginates are the principal structural polysaccharide component of brown seaweeds. Alginic acid swells in water, but does not dissolve, and its main applications are in pharmaceutical tablets.

In the food industry, it is rarely added directly to food compositions. However, it is produced in situ when sodium alginate is used in acidic food stuffs. In such situations it will form a gel, skin or fibre as a result of its insolubility in water. Alginic acid is used in some formulated alginate products for stabilising ice cream and whipped dairy cream.

13.2.4 Polysorbates

Polyoxyethylene sorbitan monolaurate (Polysorbate 20)

Polyoxyethylene sorbitan monopalmitate (Polysorbate 40)

Polyoxyethylene sorbitan monostearate (Polysorbate 60)

Polysorbate (20, 40 & 60) is widely used within the food industry as a surfactant, for forming oil-in-water emulsions such as dressings, sauces and margarines. The surfactant properties also lead to uses in improving the volume and texture of cakes, the dispersion of coffee whiteners, and the aeration, dryness and texture of whipped cream. It is used to stabilize sauces and dressings and in bakery margarine to improve aeration, cake volume and texture.

Typical Products includes cakes and cake mixes, coffee whiteners, whipped creams based on dairy and vegetable fat, margarine, salad dressings and sauces.

13.2.5 Lactic acid esters of mono- and diglycerides of fatty acids (Lactems)

Lactems are used in combination with other emulsifiers in whipped topping concentrates, and as aerating and emulsifying agents for cakes and sponges to produce a narrow pore size distribution in the crumb. In mousses these combinations of emulsifiers are used to produce consistent aeration and to maximize volume. Lactems are also used in baking margarines.

Typical Products include cakes and whipped toppings.

13.2.6 Quillaia Extract

Used in Beverage bases; Beverage mixes; Soft drinks.

13.2.7 Saponin

Saponin is also used in Beverage bases; Beverage mixes; Soft drinks.

13.2.8 Sodium Bicarbonate

Used in various unstandardized confectionery.

13.2.9 Others

Apart from above additives, following additives are also known for functioning as foaming agent.

Ammonium alginate, Calcium alginate, Calcium stearoyl lactylate, Hydroxypropyl cellulose, Methyl ethyl cellulose, Microcrystalline cellulose (Cellulose gel), Nitrous

oxide, Potassium alginate, Propylene glycol alginate, Sodium alginate, Sodium stearoyl lactylate, Xanthan gum

13.3 Anti-foaming Agents

Also known as defoaming agents. These agents are substances used to reduce foaming caused by proteins or gases that may be interfere with processing. Foaming may be largely suppressed or completely eliminated by the use of small quantities, generally 10 ppm.

These compounds have been suggested for use in the preparation of certain comminuted meat products, bakery products, confections, dairy products, vegetable oils, alcoholic and nonalcoholic beverages, jams and jellies, molasses, soups, starches, syrups and pickles.

13.3.1 Polyoxyethylene stearate

Polyoxyethylene stearate is made by reacting stearic acid with polyoxyethylene, a polymer of ethylene oxide.

Polyoxyethylene stearate is permitted only in wine that has been imported from certain countries, where it is used to inhibit foam formation during fermentation.

13.3.2 Polyoxyethylene sorbitan tristearate (Polysorbate 65)

Polysorbate 65 is a tan colour solid produced from a mixture of partial stearate esters of sorbitol and its anhydrides, condensed with ethylene oxide.

Polysorbate 65 is used as a surfactant, often in combination with other emulsifiers for forming oil-in-water emulsions. It is used to hold the fat in ice cream to give dry eating characteristics and to retard the development of fat bloom in chocolate products. It is used to reduce foam formation during food processing. Polysorbate 65 has a waxy, somewhat bitter taste.

Typical Products include ice cream and frozen desserts, sugar confectionery, cakes and cake mixes, coffee whiteners and whipped creams based on dairy and vegetable fat.

13.3.3 Sodium, potassium, magnesium and calcium salts of fatty acids

The salts of fatty acids are made by reacting the acids with the appropriate hydroxide. The acids used are principally stearic, palmitic and oleic. The salts can be used singly or in mixtures.

The salts of fatty acids have a range of uses, usually derived from their fatty acid component. Thus they are defoaming agents, anti-caking and free-flow agents.

Magnesium stearate is used to help powders flow during tableting. Other fatty acid salts are used to decrease foam during the processing of beet sugar, chewing gum, and as a yeast activity promoter.

13.3.4 Acetic acid esters of mono- and diglycerides of fatty acids (Acetems)

Acetems are made by reacting mono- and diglycerides of fatty acids with acetic acid in various proportions.

In the preparation of jams and marmalades, acetems are used as antifoam to aid filling and present a neat, unbubbled surface. Acetems are also used to manipulate the melting point and plasticity of fats.

13.3.5 Sorbitan esters

[Sorbitan monostearate, Sorbitan tristearate, Sorbitan monolaurate, Sorbitan monooleate, Sorbitan monopalmitate]

The sorbitan esters are produced by the reaction of the appropriate fatty acid with hexitol anhydride, which is itself derived from sorbitol.

They are used as antifoaming agents in the production of beet sugar, boiled sweets and preserves, and to modify fat crystal structure in chocolate to inhibit the development of the storage defect known as “bloom”.

13.3.6 Fatty acids

The fatty acids include stearic, palmitic and oleic acids. They are made by fractionation of natural fats such as tallow followed by acidification. They can be used alone or in mixtures.

Fatty acids have a number of functions, including plasticizers for chewing gum and anti-foaming agents for jams.

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

Dimethyl polysiloxane is made from silica and oil-derived chemicals. Dimethyl polysiloxane is a surfactant. In foams it occupies the air-water interface and can act in two ways. At low concentration it is a foam stabiliser and at higher concentrations it causes foams to collapse.

Dimethyl polysiloxane is mainly used as an antifoaming agent but is also used to stop hot liquids from sticking to equipment. It is useful in products such as jam, preventing frothing when boiling, and in carbonated drinks, which tend to froth when being filled into bottles or cans.

Dimethyl polysiloxane formulations used as an anti-foaming agent in Apple, Fig, Pineapple marmalade Jam and Jelly; Reconstituted lemon juice; Reconstituted lime juice; Shortening; Skim milk powder and Wine.

13.3.8 Propan-1,2-diol (propylene glycol)

Propane-1,2-diol, also known as propylene glycol, is produced by heating glycerol with sodium hydroxide, or by treating propylene with chlorinated water to form the chlorohydrin, followed by a further treatment with sodium carbonate solution to form the glycol.

It can be used as an anticaking agent, antifoaming agent, emulsifier, flour treatment agent, humectant, stabiliser, thickener, adjuvant and carrier solvent. Polyethylene glycol (molecular weight 3000-9000) is widely used in soft drinks.

13.4 Use of Anti-foaming agents permitted in Food Products in India (FSSAI)

Food Products	Dimethyl polysiloxane	Mono and diglycerides of fatty acids and edible oils
Jam/ Jellies/ Fruit Cheese	10 ppm max	GMP
Fruit Marmalades	10 ppm max	GMP
Culinary Paste/ Other Sauces	10 ppm max	10 ppm max
Concentrated Fruit/ Veg. Juice/ Pulp/ Puree	10 ppm max	10 ppm max
Chutney Fruits and / or Vegetable/ Mango Chutney	10 ppm max	10 ppm max
Green Chilli Paste, Ginger Paste, Garlic Paste, Onion Paste, Whole Chilli Paste	GMP	GMP
Tallow	10 ppm max	-
Lard Edible	10 ppm max	-
Vegetable oils and fats	10 ppm max	-
Thermally Processed Fruits - Pineapple	10 ppm max	

13.5 Toxicological Aspect

Very limited information is available on toxicological aspects of foaming and anti-foaming agents. Toxicological effects of individual ingredients are discussed bellow.

For foaming Agent i.e. Lactic acid esters, if lactic acid is derived from milk products or by using lactic acid starter cultures that are obtained from milk products, there may be a slight risk for individuals who suffer from milk allergies or lactose intolerance. Patients with

a sodium-restricted diet shouldn't abuse sodium bicarbonate. Sodium bicarbonate may cause edema and alkalosis. It can also cause congestive heart failure, hypernatremia, sodium levels higher the normal in blood, and hypertension. In patients with a high calcium diet, the intake of high amounts of sodium bicarbonate may lead to a milk-alkali syndrome, metastatic calcification, kidney stones and renal failure.

For anti-foaming i.e. Dimethyl polysiloxane is non-toxic but will irritate the skin and eyes along with being a danger if inhaled or swallowed in its raw form. Further studies are needed to explore the potential dangers and side-effects of Dimethyl polysiloxane. Propylene glycol in large doses can lead to liver, heart and nervous system disorders as it can damage human cells. Propylene glycol can even disrupt the body's chemical balance, leading to excessive acid production that can cause metabolic problems. After prolonged contact with skin or eyes, it can cause irritation. In high doses, polysorbate 65 can cause cancer if it is contaminated with 1,4- dioaxne, which is readily absorbed by the skin. It is also known to decrease fertility. Polysorbate 65 is also known to be toxic to human organs.