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Stabilizer Blends and their importance in Ice cream Industry – A Review

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ABSTRACT

Ice cream and frozen desserts are stabilized or textured with more than one hydrocolloid. Manufacturer/Formulator requires to know a lot about a variety of hydrocolloids to work out the combination that will deliver the characteristics required in ice cream. In view of this, information has been compiled on various hydrocolloids, their properties and compatibility with each other as a blend for manufacturing better quality ice cream and frozen desserts.

INTRODUCTION

Ice cream and related products are generally classified as frozen desserts which include ice cream, frozen custard, frozen confectionaries, ice milk, ice lollies, sherbets etc., which are popular among all age group of people. Ice cream is a frozen dairy product made by freezing a mix with agitation to incorporate air and ensure uniformity of consistency (Arbuckle, 1986). The complex physical structure of ice cream presents a challenge for Food Chemists. Simply stated, overall goal of designing the ice cream is to incorporate several different insolubles (air bubbles, ice crystals and fat globules) into an aqueous phase in the smallest sizes and in the greatest numbers possible.

The basic role of a stabilizer is to reduce the amount of free water in the ice cream mix by binding it as “water of hydration”, or by immobilizing it within a gel structure. Also it is the ability of small percentage of stabilizer to absorb and hold large amounts of bound water, which produces good body, smooth texture, slow melt down and heat shock in the resultant product (Keeney, 1982).

Stabilizers maintain homogeneity and control ice crystal growth during the freezing/aeration process. During storage, stabilizers play crucial role in resisting structural changes during “heat shock” (the inevitable temperature during storage and distribution that creates ice crystal growth and other types of deterioration, leading to structural changes). During serving and consumption, stabilizers contribute to uniform meltdown, mouth feel and texture of ice cream. A stabilized ice cream is one that resists or retards structural changes in a dynamic environment (Goff, 1997).

FORMULATION OF DIFFERENT STABILIZER BLENDS

In ice cream manufacturing, it is always difficult to get all the properties of ice cream using a single stabilizer. Today Dairy/Food Technologists have found a new technique of blending these stabilizers in different proportions to get excellent properties in ice cream.

Most ice cream stabilizers based on polysaccharides influence the rheological properties of the continuous phase. Some stabilizers form a complex with ice cream constituents, example, carrageenan complexes with casein and prevents whey separation during mixing. However, when used alone, stabilizers including locust bean gum (LBG), guar gum, carboxymethyl cellulose (CMC) and xanthan gum promote whey separation, due to their tendency to precipitate proteins during heating at neutral pH. Ice cream stabilized with locust bean gum and carrageenan contains significantly smaller ice crystals than ice cream made under identical conditions without stabilizers (www.foodsci.uoguelph.ca).

Though alike in many ways, these stabilizers also have many differences with respect to their property and compatibility. Knowing the characteristics of each allows product designers to incorporate the correct ingredient or ingredient blend in a particular application. The choices require consideration of the entire product spectrum from mixing and processing, through finished product attributes, storage and end use.

GELATIN

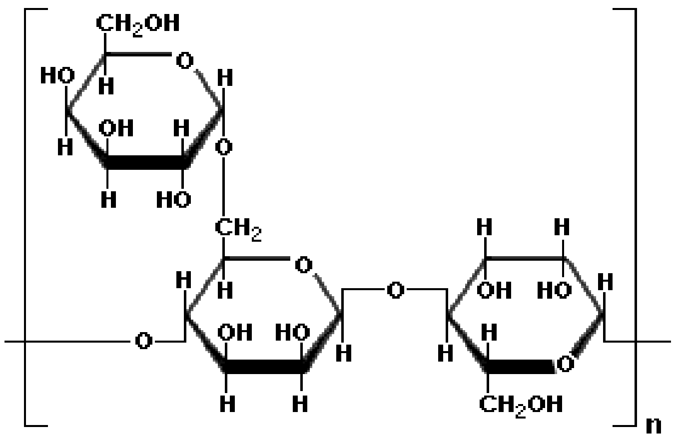
A high molecular weight polypeptide, gelatin consists of chains of 300 to 4,000 amino acids (primarily glycine and proline/hydroxyproline). It is derived from animal collagen, mainly pork or beef, but other sources are available, most notably fish. Boiling hydrolyzes the collagen, and converts it into gelatin. Two processes are used, an acid process gives type A gelatin and an alkaline process gives type B gelatin. Their properties are similar, but type A can negatively interact with other anionic polymers, such as carrageenan. A thermo reversible gel starts to form when a hot gelatin solution is cooled to below 30º to 35 ºC. At refrigeration temperatures (5ºC), gelatin takes 5 to 8 hours to reach maximum gel strength (measured in Bloom). Because the gels dissolve at low temperature, they "melt in the mouth" with good flavor release. Levels for a 250 Bloom gelatin are between 0.25% and 0.50% of the mix.

In ice cream industry gelatin forms a gel in the mix as well as during ageing, preventing large ice crystals formation during freezing. But today its use as stabilizer has decreased or stopped due to availability of alternatives and also due to vegetarian sentiment of the consumers (Arbuckle, 1986).

GUAR GUM

Derived from guar (*Cyamopsis tetragonolobus*) seeds, this long, rigid, linear molecule of beta-1,4-D-galactomannans with alpha 1,6-linked D-galactose has a molecular weight of approximately 1,000,000, giving it a high viscosity in solution. Guar gum is an economical thickener and stabilizer. It hydrates fairly rapidly in cold water to give highly viscous pseudoplastic solutions of generally greater low shear viscosity when compared with other hydrocolloids and much greater than that of locust bean gum. High concentrations (~ 1%) are very pseudo plastic but lower concentrations (~ 0.3%) are far less so. Guar gum is more soluble than locust bean gum and a better emulsifier as it has more galactose branch points. Unlike locust bean gum, it does not form gels but does show good stability to freeze-thaw cycles. Guar gum shows high low shear viscosity but is strongly shear thinning in nature. Being non ionic, it is not affected by ionic strength or pH but will degrade at pH extremes at temperature (*e.g.* pH 3 at 50°C). It shows viscosity synergy with xanthan gum. Levels used are up to 0.20%, and depend on the usage level of other added gums (www.lsbu.ac.uk/water/hyloc.html).

Today guar gum is widely used as ice cream stabilizer. Guar is preferred for its relatively low cost and the body it contributes to the product. It hydrates well in cold water, and often used in combination with carrageenan and locust bean gum to impart excellent properties to ice cream.

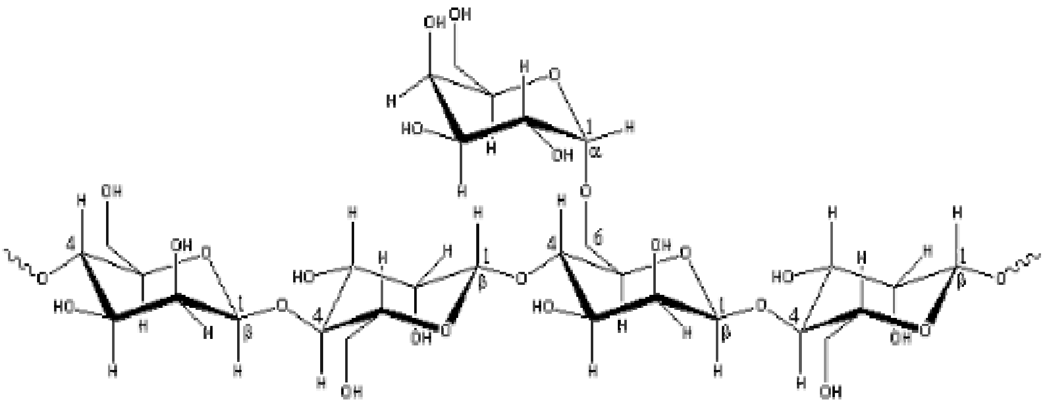


Chemical Structure of Guar Gum

LOCUST BEAN GUM

Also called carob gum, as it is derived from carob *(Ceratonia siliqua*) seeds. Locust bean gum (LBG) has an irregularly shaped molecule with branched beta-1,4-D-galactomannan units. This neutral polymer is only slightly soluble in cold water and requires heat to achieve full hydration and maximum viscosity. LBG does not form a gel, and creates a less gummy texture than guar. It requires heating to 170°F for full hydration, usually achieved during pasteurization. LBG is inert to acid and calcium.

Locust bean gum enhances aeration, and imparts good body to ice cream. Used alone, it can cause whey-off during processing, so it is usually used in combination with carrageenan and guar gum. LBG can act synergistically with kappa-carrageenan and xanthan gum. Usage levels are similar to guar, again depending on which other gums are used in conjunction with it (www.foodproductdesign.com).



Chemical Structure of Locust Bean Gum

CARRAGEENAN

Extracted from Irish moss and other species of red seaweed of the class rhodophyceae, carrageenan is a sulfated linear polysaccharide, which reacts with casein by forming ionic linkages between sulfate groups and charged amino acids.

Carrageenan is available in several types, the most common of which are kappa, iota and lambda. For low fat and soft serve ice cream compositions, kappa often is used for its gel forming functionality and its reactivity with casein, which prevents whey separation. It's mandatory to add carrageenan if an aging step exists in the manufacturing process. A kappa-iota blend is sometimes preferred, to keep kappa from forming a brittle gel. Lambda blends can be used for ice creams with sufficient fat to stabilize without gelling. Kappa and iota solutions require heating for proper hydration. Carrageenan levels can be used up to 0.05% of the blend (www.lsbu.ac.uk/water/hyloc.html).

ALGINATES

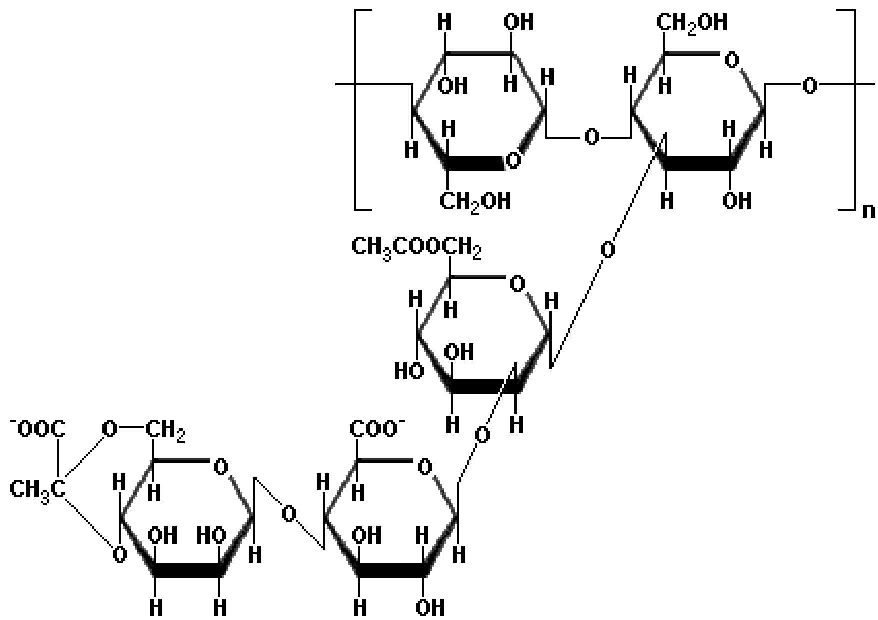
Alginates add a type of body and texture to ice cream that other gums don't easily duplicate. Extracted from ocean kelp, this natural gum dissolves best at 155° to 160°F. Combined with sodium or phosphate salts, it forms gels at levels from 0.18% to 0.25%. Because it binds calcium, it will reduce the amount of free calcium in the mix.

Precipitation of sodium alginate will occur at high calcium levels, making it difficult to hydrate without adding sequesterant.

XANTHAN GUM

A product of bacterial fermentation, this giant glucomannan polymer (2 million daltons) makes an excellent emulsion/stabilizer because its suspending properties keep emulsions dispersed. It's a popular ingredient in low fat compositions.

It can be dispersed by blending with skim milk, corn syrups or nonfat milk solids. Xanthan is cold water soluble, hydrates quickly once dispersed and provides water binding. It is always used in combination with other gums. It is synergistic with locust bean gum, which reduces the levels of locust bean gum and guar required. Xanthan gum is heat and pH resistant and also has a cleaner flavor when compared to other gums. It possesses pseudoplastic properties and exhibit shear thinning, a useful property for pumping and extrusion in soft serve ice creams. Overuse can cause excessive gelation, an overly viscous mix, and a chewy ice cream. Usage levels range from 0.015 to 0.040%. However, its cost limits its usage.



Chemical Structure of Xanthan Gum

RELATIONSHIP BETWEEN ICE CREAM COMPOSITION AND STABILIZER CONCENTRATION

The quantity of stabilizer and emulsifier required for different variety of ice cream differs based on the total solids, fat content, desired over run etc. As the fat level decreases, the amount of stabilizer/emulsifier concentration increases. The reason is mainly attributed to decreased total solids content resulting in increased water concentration in the formulation. As a result to attract water molecules in more number and to decrease bigger ice crystal formation, stabilizer/emulsifier are added in more quantity (Arbuckle, 1986). Examples of the approximate composition of some typical ice creams.

Product	**Milk Fat (%)**	**Solids not Fat (%)**	**Sweeteners (%)**	**Stabilizers and Emulsifiers (%)**	**Total Solids (%)**
Non fat Ice cream (hard)	< 0.8	12 - 14	18 - 22	**1.0**	35 – 37
Low fat ice cream (hard)	2 - 4	12 - 14	18 - 21	**0.8**	35 – 38
Light Ice cream (hard)	5 - 6	11 - 12	18 - 20	**0.6**	35 – 38
Economy Ice cream	10 - 12	10 - 11	15	**0.5**	35 – 37
Frozen yoghurt	3 - 6	8 - 13	15 - 17	**0.5**	30 – 33
Soft serve ice cream	3 - 4	12 - 14	13 - 16	**0.4**	29 - 31

Source: www.foodproductdesign.com

CONCLUSION

Stabilizers afford functionalities that include increased stiffness; provide a slower and more uniform meltdown; enhance whippability during aeration; prevent lactose crystallization; prevent shrinkage during storage; stabilize the emulsion; contribute to body, texture and creaminess. Since all these properties cannot be met by a single hydrocolloid, it is always necessary for a stabilizer manufacturer to go for a blend which can meet the needs of ice cream manufacturer.

In view of growing demand, quality consciousness among people and increased competitiveness in the market, ice cream manufacturers are relying more on the stabilizer manufacturer for excellent stabilizer blends to prepare better quality product to increase their market share. Stabilizer manufacturers to cater the needs of these ice cream manufacturers have now started setting up their own in-house R & D/Application centers to develop various combinations of these stabilizer blends. As a result today the ice cream manufacturers have the option to go for a different stabilizer blend or a combination of stabilizer/emulsifier blend which is best suited for their style of ice cream manufacturing.

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