FROZEN DESSERTS OF THE FUTURE— EMULSIFIERS HYDROCOLLOIDS IN FROZEN DELIGHTS

Despite the wide variety of ice-creams and frozen desserts, the one critical functional ingredient that must be present is a texturising system—a combination of emulsifiers and hydrocolloids. By Dr. LaiYee, Lee—Futura Ingredients.

Ice-creams and frozen desserts are perennial favourites with consumers, be it in the heat of summer or during winter. These frozen delights often provide a sense of comfort and simple indulgence which consumers gravitate towards. It is this reason that during the pandemic lockdown, consumers increased their consumption of frozen delights at home—especially good quality ice-creams—as a form of escapism and reward. And with most consumer food items, the trend to a better-for-you product is all the rage which also applies to frozen delights.

Nutritionally, protein content in ice-creams is generally similar to standard dairy milk: approximately 3 percent. It could be designed to be higher—even up to 10 percent—by using the appropriate protein concentrates.

A typical dairy full cream milk contains about 3 percent fat and lactose in the range of 4-5 percent. A good standard dairy ice-cream mix contains about 8—10 percent fat, and sugar (including lactose) between 12-20 percent; these numbers are reduced by half with a 100 percent overrun, making an ice-cream with 4-5 percent fat and 6-10 percent sugar. It is the higher content of fat and sugar together with emulsifiers and hydrocolloids, as well as processing that creates the unique characteristics of ice-cream, imparting creaminess and allowing freezing to take place. As a matter of fact, ice-creams are often recommended by medical professionals as the nutritional alternative for patients refusing normal diet.

CARBOHYDRATES IN ICE-CREAM

One of the key aspects in ice-cream formulation design is the overall sugar profile. The two fundamental terms are the relative sweetness and freezing point depression factor (FPDF), or some know it better as the anti-freezing power (AFP). Relative sweetness is the sweetness index, with value ranges between 14 to 17 in typical ice-creams, disregarding lactose. Freezing point of pure water is at 0 deg C, and this is lowered with the presence of sugar and salt, or polyols and alcohols, in the formulations which enable ice-creams to remain scoopable even though frozen. FPDF takes into consideration the impact to the freezing point of the water content. Both relative sweetness and FPDF use sucrose as reference. The correct combination of carbohydrates—sugar and/or sugar alternatives—are essential to achieve the needed relative sweetness and at the same time creates a product that has FPDF just right with acceptable texture, scoopability and melting profile.

VEGAN ICE-CREAM

Some commercial products have claimed itself as "vegan ice-creams" when there is no fat or protein in it—true that it is vegan, but these products are better described as a sorbet and not an ice-cream. There are several routes to the design of vegan ice-creams—(1) from scratch by combining relevant plant based ingredients from the start of the formulation design process; or (2) by converting the composition of a dairy-based ice-cream to vegan version with ingredient substitution. Either way, a balanced formulation composition is critical to achieve a good quality vegan ice-cream with desired shelf-life stability.

With dairy protein substitution to a plant-based source, the lactose and minerals in dairy proteins are eliminated from the formulation. Assuming there is 10 percent skim milk powder in the formulation, this would contribute to approximately 5.6 percent lactose, which is a significant contribution to the total carbohydrate of the ice-cream—1.1 relative sweetness; 5.6 FPDF. This lactose content will only be higher if whey protein is used. The sweetness from milk solids non-fat (MSNF) is probably negligible, but not the FPDF which must be compensated in a vegan formulation design.

NO ADDED SUGAR ICE-CREAM

Lactose is present by default in an ice-cream if MSNF is present, unless its vegan. It is important to note that with the "no added sugar" claim, this lactose remains—hence, not zero sugar. The elimination of added sugar needs to be compensated with its alternatives to fill both the body and functionalities. Sugar alcohol, or polyols, are often used for its freezing point depression capabilities. Some examples are sorbitol, xylitol, mannitol and maltitol. These are nutritive sweeteners as they do contribute calories. The one to highlight is erythritol, a much favourable polyol option in recent years for its exceptionally low, or basically zero calorie content. Erythritol has 70 percent sweetness of sucrose with 2.8 FPDF, and used especially in low calorie and other trendy ice-creams especially ice-creams with a more health-conscious slant. Intense sweeteners are often added along with polyols to impart the sweetness required. There are two types generally, artificial sweeteners such as aspartame and sucralose, and the more favourable natural sweeteners such as stevia. In such formulations, there are also usually bulking agents like maltodextrins and fibres to increase total solids of the ice-cream.

EMULSIFIERS & HYDROCOLLOIDS IN ICE-CREAMS

Despite the wide variety of ice-creams and frozen desserts, the one critical functional ingredient that must be present is a texturising system—a combination of emulsifiers and hydrocolloids. Each ingredient carries unique and fundamental functionalities in enhancing quality of ice-creams and frozen desserts. The texturising system is added in the ice-cream mix which forms the base of different varieties of ice-cream products. This enables the emulsifier in the system to help lower interfacial tension thus create fat globules that are fine and more uniform during homogenisation (usually between 100 and 200 bar, depending on formulations). Emulsifiers also act as a layer of grease to reduce fouling on the heat exchange system.

Ageing, one of the most critical steps in ice-cream making, allows partial crystallisation of fat globules to take place, which happens at a higher rate when emulsifiers such as mono- and diglycerides (MDG) are present. The hydrophobicity of fat globules surfaces change as partial crystallisation occurs and this helps with emulsion destabilisation where MDG displaces part of the milk proteins from the fat globules surfaces at a higher rate. Polysorbate 80 is more potent in protein displacement, yet it does not promote fat crystallisation, and is therefore often used alongside MDG. Nonetheless, the use of Polysorbate 80 has been gradually replaced by partially unsaturated MDG for its more functional protein displacement properties and at the same time contribute to a desirable partial fat crystallisation. Both partial fat crystallisation and protein displacement are crucial and often influence the rate of fat aggregate formation during freezing in the scrap surface heat exchange system. Meantime, hydrocolloids are better hydrated during the ageing process. This helps to unfold its capabilities in imparting body, giving some degree of mix viscosity to help with air incorporation and entrapment during freezing.

At the time of freezing, the fat globules collide and areas exposed from protein displacement earlier would now partially coalesce forming fat aggregate network. This fat network then surrounds and protects air cells incorporated simultaneously. The fat aggregate network form varies following the type of emulsifiers used—unsaturated MDG tends to create a more structured network of fat aggregates that holds the ice-cream better hence imparting slower melting. Hardening, the static freezing process, ensures more water are converted into ice crystals—where the water cling onto the existing ice crystals formed during dynamic freezing—with no new ice crystals are formed during this stage. This ideally happens within the shortest time to preserve the microstructure of ice-creams. Hydrocolloids, such as guar gum and sodium carboxymethyl cellulose, regulate water mobility during storage, minimising ice crystal growth. Locust bean gum (LBG) is used in ice-creams for its irreplaceable cryo-gelation effect in protecting ice-cream microstructure, imparting excellent melting resistance. Carrageenan, another typical hydrocolloid used in ice-creams, helps prevent serum separation during ageing and melting of ice-creams.

Both dairy and plant-based ice-cream formulations, and other varieties of ice-creams and frozen desserts often use similar sources of texturising systems. And it is ideal and possible for the same texturising system to be deployed in different ice-cream variants within the manufacturing site. Futura Ingredients has solid technical competences in supporting ice-cream and frozen desserts applications in the form of product development, innovation, improvement and troubleshooting.

Reach out to Futura Ingredients to expand the dialogue on our Ekömul KREM 500 series, texturising systems custom designed for ice-creams and frozen desserts, along with Ekölite VITA Protein, plant protein series, and many more.

ENQUIRY No. 4301 Enquire at page 71 or log on to apfoodonline.com/contact