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The Role of Emulsifiers and Stabilisers in Producing Ice Cream with High Overrun

Ice cream may be one of the most delicious frozen products available. It is usually made from dairy products, such as skimmed milk powder or butter, often combined with sucrose, stabilisers, emulsifiers, colourings and flavourings (Shanmugam & Marimuthu, 2017), and assembled in a solid foam, which is made by the dispersion of gas bubbles in a solid continuous phase (Rizzo, 2016).

The amount of air incorporated into the making of ice cream is termed as 'overrun', which gives the ratio between the volume of gas and the volume of continuous phase in percentage (Rizzo, 2016). The percent of the expansion of ice cream is achieved from the incorporated air (Sekarigenge et al., 2015). The amount of air incorporated depends upon the composition of the mix and is regulated to a certain percentage of overrun that will give the proper body, texture, and palatability necessary for a good quality

ice cream (Arbuckle, 2013). Ice cream would be a densely packed solid mass if insufficient air is put in the mix reducing its 'scoopability' properties (Warren & Hartel, n. d.).

Ice cream mix is an oil-in-water emulsion. Emulsifiers are used to stabilise the emulsion and prevent the fat globules from agglomerating in the mix. Mono- and diglycerides, sucrose, esters, and polysorbates are emulsifiers that are commonly used in ice cream (Miller, 2016). The presence of emulsifiers in ice cream leads to smoother texture and better shape retention while improving the ability of the mix to incorporate air (Deosarkar et al., 2016).

When the mix is churned into ice cream, the emulsifiers function to destabilise the natural milk protein film that surrounds the surface of milk fat globules which promotes partial coalescence between fat droplets and air bubbles to form a network of partially coalesced fat that stabilises the foam. If this does not happen, the air bubbles will merge, increase in dimension and exit the matrix (Miller, 2016; Rizzo, 2016). Other primary purposes of emulsifiers added into ice cream are to shorten the freezing time, improve whipping properties and produce a dry, stiff texture that melts slowly (Miller, 2016).

Stabiliser is used to stabilise the structure of ice cream. The commonly used stabilisers in ice cream are a group of ingredients (polysaccharides) such as guar, locust bean gum, carboxymethylcellulose and xanthan (Deosarkar et al., 2016). It was found that the overrun of ice cream increases with the increase of stabilisers (Mahdian & Karazhian, 2013, Cakmakci & Dagdemir, 2013) where it facilitates air incorporation and stabilise air cell distribution in ice cream (Bahramparvar & Mazaheri Tehrani, 2011).

The basic role of a stabiliser in ice cream is to reduce the amount of free water in the ice cream mix by binding it as "water of hydration" (Soad et al., 2014). For its ability to absorb and hold large amounts of bound water, stabilisers in ice cream increase mix viscosity, enhance overall mouthfeel and smoothness in body and texture, stabilise the protein in the mix to avoid wheying-off, aid in suspension of liquid flavours, prevent ice and lactose crystal growth during storage and improves melting properties (Bahramparvar & Mazaheri Tehrani, 2011; Abbas Syed, 2016; Shanmugam & Marimuthu, 2017).

Overall, producing ice cream with high overrun will decrease the mean ice crystal and air cell size and increase the extent of fat destabilisation (VanWees et al., 2019; Wu et al., 2019). Smaller air cells with a narrow size distribution improve the rheological properties of ice cream and have a positive influence on creaminess and mouthfeel (Park et al., 2015).

High overrun in ice cream significantly reduces meltdown rate and producing ice cream with better melting resistance (Warren & Hartel, 2018; Wu et al., 2019). Air is acting as an important insulator that prevents heat penetration into the ice cream during the meltdown process (Goff & Hartel, 2013). Meltdown properties of ice cream are not just significant for perceived sensation during consumption but also essential during transportation through temperature fluctuation that may occur (Goff & Hartel, 2013).

Stabiliser-emulsifier blend is one of the important ingredients in ice-cream preparation (Shanmugam & Marimuthu, 2017). By choosing the right emulsifiers and stabilisers it is possible to manufacture an ice cream with high overrun which will still be perceived as a high-quality ice cream (Palsgaard, n. d.).

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