

Mastering frozen colloid science

Synercore ingredient specialists navigate ice cream's complex colloid engineering, balancing physical chemistry whilst mastering sophisticated formulation challenges for optimal consumer experiences.

For many of us in the South African dairy sector, ice cream is a nostalgic summer staple, a "lekker" treat enjoyed at any occasion. However, for the ingredient specialist it represents "just about the most complex food colloid of all" and one of the most sophisticated challenges in food science. Achieving the perfect eating experience requires a precise balance of physical chemistry, rheology, and material science. Ice cream is a marvel of food engineering that exists in three states of matter, i.e., a solid (ice crystals and fat droplets), liquid (a concentrated sugar solution known as the matrix), and gas (air bubbles). These factors simultaneously make ice cream an emulsion, a solution and a foam.

ESSENTIAL COMPONENTS: FATS, SUGARS, AND PROTEINS

The microstructure is where the magic happens. A typical scoop contains air bubbles, ice crystals, and fat droplets ranging from 0.1 mm to 1 mm in size, all suspended in the viscous matrix. The amount of air incorporated, or overrun, is vital since a 100% overrun means the final volume is double that of the initial liquid mix. This air, stabilised by proteins and emulsifiers, is what gives ice cream its characteristic indulgent lightness.

The formulation of ice cream typically involves major components such as fat, proteins, sugars, and water.

- **Fats and oils:** Whether using dairy fat or vegetable fats like coconut or palm oil, the lipid component is responsible for the creamy texture and the flavour delivery. In general, dairy fat particularly has the most optimal melting profile. Being partially solid between -5°C and +5°C is ideal for structural development during freezing. In contrast, unsaturated fats like sunflower remain liquid

at low temperatures and fail to crystallise and stabilise the foam adequately during freezing.

- **Sugars:** Other than providing sweetness, sugars are the primary ingredient controlling the freezing point depression of the mix. By increasing the sugar content or using lower molecular weight sugars (like dextrose), manufacturers can reduce the ice content, resulting in a softer, more scoopable product on shelf.
- **Proteins:** Caseins and whey proteins (and some plant proteins) are essential surface-active agents. They stabilise the interface between the aqueous phase and the air bubbles in the mix, ensuring the foam doesn't collapse before it reaches the consumer.

THE UNSUNG HEROES

In the competitive food market, "minor" ingredients like stabilisers and emulsifiers play a major role in shelf-life and sensory appeal. Stabilisers, typically polysaccharides like Locust Bean Gum, Guar Gum, Carboxymethyl cellulose or Carrageenan, function by increasing the viscosity of the mix. This prevents "moisture migration", improves melt down resistance, and controls the presence

"In the competitive food market, 'minor' ingredients like stabilisers and emulsifiers play a major role in shelf-life and sensory appeal"



of large ice crystals that can make the product feel "icy" or grainy. Carrageenan, specifically, is used at very low levels to prevent "wheying off," or phase separation of the ice cream mix. The transition from a liquid mix to a frozen foam involves the processes of supercooling and nucleation in a continuous freezer. To create a smooth texture, ice cream manufacturers aim for rapid freezing, which produces many tiny ice nuclei rather than a few large crystals. If the freezing is too slow, or if the cold chain is disrupted during transport, a common challenge in the South African climate, the ice crystals undergo recrystallisation (coarsening), leading to a gritty unpleasant texture. Understanding ice cream is about managing all the fundamentals of a complex suspension. From the behaviour of the mix during processing to the intricate balance of the sugar matrix, every ingredient has a functional purpose.

FAST FACT

Ice cream exists simultaneously in three states of matter: solid (ice crystals and fat droplets), liquid (concentrated sugar solution), and gas (air bubbles). A 100% overrun means the final volume is double the initial liquid mix.

Synercore - www.synercore.co.za