TEXTURIZING TOOLS

More Protein, More Problems? Stabilizing High-Protein Dairy

The right hydrocolloids can help ice cream and yogurt formulators strike the perfect balance between protein content and creamy texture

By Nesha Zalesny



› Tamarind seed gum is particularly suited for high-protein ice creams due to its ability to manage water without building the same viscosity as LBG or guar gum.

› Key takeaways

- **Protein Alters the Structure**: Adding protein powders increases water binding and can introduce residual ingredients like minerals and lactose. Excess lactose can encourage a sandy texture, while minerals impact protein interactions and heat stability.
- **Blends Beyond the Usual Gums**: Tamarind seed gum has the special ability to manage water in high-protein ice cream with less added mix viscosity. Blended with locust bean gum, it has also been shown to slow melting.
- **Tailoring Texture in Yogurts**: High-protein yogurt is often thick enough already, so adding more texturizers can make it worse. The stabilizer should address the defect at hand: whey separation, graininess after stirring, or an overly sticky texture.

High-protein dairy has moved well beyond the bodybuilder niche. Protein claims now appear on yogurt, frozen desserts, drinkable dairy products, and products that sit somewhere between a snack and a meal. Consumers expect all of that protein to arrive with the same creamy texture and clean flavor they associate with conventional dairy. Unfortunately, adding protein is usually a balancing act between consumer expectations and the formulator's reality.

Protein is a structural ingredient, but it is also a reactive one. The protein source, the ratio of casein to whey, mineral balance, heat treatment, homogenization, pH, and total solids all affect the finished texture. A formula can move from thin to pleasantly full-bodied and then to pasty, grainy, or rubbery with a surprisingly small change in protein or process. This is where hydrocolloids earn their place. The goal is not simply to make the product thicker. It is to manage water, support the protein structure, and keep the texture pleasant over shelf life.

High-Protein Ice Cream: Solids Are Not the Whole Story

Ice cream is a complex system of ice crystals, air cells, fat globules, and a concentrated unfrozen serum. Conventional ice cream is already a balancing act. Increasing protein, often while reducing sugar or fat, removes several of the formulator's usual manipulation tools. Milk protein concentrate, whey protein concentrate, and whey protein isolate can improve nutritional content and add body. They can also increase mix viscosity, alter whipping and overrun, bind water, contribute cooked or dairy flavors, and create chalky or powdery notes. Whey proteins are particularly sensitive to heat. Once denatured, they can associate with one another and with casein. This may be helpful at a controlled level, but can become aggregation or graininess when the system is out of balance.

Protein powders bring more than protein. Depending on the ingredient, they can also bring lactose and minerals. Lactose can contribute to freezing-point depression, but too much lactose, or poor control of the unfrozen phase, raises the risk of lactose crystallization and the familiar sandy defect. Minerals influence protein interactions and heat stability. Two protein ingredients with the same protein declaration may therefore behave quite differently.

There is also an important distinction between freezing point and frozen texture. Hydrocolloids are large molecules used at low levels, so they do not substantially depress the equilibrium freezing point the way sugars, salts, lactose, and other small dissolved molecules do. What they do extremely well is bind or immobilize water, increase viscosity in the unfrozen phase, and slow ice recrystallization during storage and temperature cycling. In the real world, where a pint may travel from factory freezer to distribution center, grocery freezer, car, and home freezer, water management can make or break the consumer experience.

The Galactomannans & Beyond

Locust bean gum (LBG), guar gum, and tara gum are all part of the galactomannan family and are traditional favorites for ice cream formulators. They are often used interchangeably, but not on a one-for-one basis. Locust bean gum, increasingly labeled carob bean gum, is the traditional favorite in premium ice cream. It is hot soluble. This is ideal for dairy processing,

as LBG builds viscosity only after pasteurization. It produces a creamy, cohesive body and helps control ice-crystal growth without an obviously gummy texture. Its relatively low galactose substitution allows smooth regions of the chain to associate with other polymers. This characteristic also makes it synergistic with carrageenan.

Guar gum is cold-water soluble and is generally the most economical of the three. It builds viscosity efficiently and gives excellent water control. The drawback is that too much guar can produce a thick, slightly sticky or gummy melt. In a high-protein mix that is already viscous, the useful level may be lower than expected. Guar is often most successful as part of a system rather than as the entire stabilizer system.

Structurally, tara gum falls between guar and LBG. It has more galactose substitution than LBG and less than guar. It partially hydrates in cold water or milk. It is generally used at around 75%–85% of LBG in ice cream. It provides good body, has useful synergism with carrageenan, and can offer a smoother texture than an all-guar or all-LBG system.

Tamarind Seed Gum Reins in Viscosity

High-protein ice cream presents a practical processing dilemma. Protein raises mix viscosity, and adding a conventional galactomannan on top of that structure can push the mix beyond the efficient operating range of plate heat exchangers and homogenizers. Excessive viscosity can increase residence time, production line pressure, and line fouling. Removing the hydrocolloid is rarely a viable commercial solution, however, because the unfrozen serum still needs enough water control to resist ice-crystal growth during storage and temperature cycling.

One option that may be under the formulator's radar is tamarind seed gum. Its principal polymer is xyloglucan: a neutral, cellulose-like backbone carrying xylose and galactose side chains. These branches prevent the chains from packing like cellulose and allow the polymer to hydrate and hold water. Tamarind seed gum is useful in high-protein dairy because it manages water and supports a weak serum-phase network without building the same mix viscosity as an equivalent stabilizing dose of guar or locust bean gum. Dilute solutions may show relatively smooth, near-Newtonian flow, while higher concentrations and finished dairy systems can become shear-thinning. The practical benefit is lower processing viscosity and a less gummy mouthfeel. Tamarind seed gum, when blended with LBG, has been shown to slow melt time.

Microcrystalline cellulose (MCC) offers another way to add structure without relying entirely on dissolved-phase viscosity. Food-grade MCC is commonly co-processed with a small amount of carboxymethyl cellulose to help the insoluble cellulose particles disperse. Unlike tamarind seed gum, MCC does not dissolve and hydrate as individual polymer chains. It must be thoroughly wetted, dispersed, and mechanically activated, typically with adequate high shear, so the crystallites separate and form a three-dimensional particulate network. Homogenization, a common practice for ice cream mix production, is sufficient for activation.

Once activated, the MCC network can suspend protein and other insoluble material, limit serum separation, and contribute body with less dependence on high viscosity. The crystalline

particles also support finer ice-crystal structure. Cellulose gel is the common label name for MCC, while cellulose gum refers to carboxymethyl cellulose carrier. The terminology should be familiar to consumers who see these listed on protein shakes and other reduced-fat frozen systems.

Blends of galactomannans and tamarind seed gum, MCC, or acacia allow a formulator to tune hydration, viscosity, creaminess, and cost. A blend gives better balance than pushing any one gum to its limit. Typical total stabilizer systems for ice cream are measured in tenths of a percent, but a high-protein formula should be optimized from the base upward. More protein usually means more inherent viscosity and water binding, not an automatic need for more gum.

Carrageenan: A Little Protein Reactivity Goes a Long Way

Carrageenan is especially useful in dairy because it interacts with kappa-casein at the surface of the casein micelle. At very low levels, carrageenan helps keep the mix homogeneous, limits phase separation, and works synergistically with galactomannans to improve body and melt. It can also reduce the risk that protein-rich material settles or separates during aging before the mix reaches the freezer.

This protein interaction is also the reason carrageenan must be handled carefully in a high-protein system. The amount that works beautifully in standard ice cream may be too much when the casein concentration is high. Excess carrageenan can contribute to an over-structured, brittle, or gelled mix, particularly when potassium, calcium, other minerals, and the selected carrageenan type favor gel formation. The answer is not to remove carrageenan automatically, but to start low and evaluate it in the actual protein and mineral system.

A traditional blend based on LBG, tara gum, or guar gum with a very small amount of carrageenan remains a sensible first bench trial. The galactomannan manages viscosity and the unfrozen water phase; carrageenan supports the dairy protein network, and the galactomannan contributes to the synergy. The correct balance should survive heat treatment, age without becoming pudding, whip to the desired overrun, and melt cleanly rather than turning gummy.

Yogurt Already Has a Gel. It Still May Need Help.

High-protein yogurt presents a different problem. As milk is fermented toward the isoelectric point of casein, casein micelles lose stability and form the acid gel that gives yogurt its body. More protein provides more material to build that network. This is why strained and concentrated yogurts can achieve impressive body without relying on a large amount of added stabilizer.

However, more gel is not always better gel. High-protein yogurt can become excessively firm, pasty, or adhesive. Stirring can break a strong gel into particles, creating a grainy texture rather than a smooth, spoonable product. Whey protein denaturation during heat treatment changes how the network forms. Protein source and concentration also influence fermentation time, water-holding capacity, syneresis, and flavor release. Structure-function rules developed for conventional yogurt do not always scale neatly into formulas with much higher protein.

Here, it is helpful to address the specific defects that need correcting. If the yogurt already has ample firmness but releases whey, the need is water management and network refinement. If it is sticky or pasty, adding a powerful thickener may make the defect worse. If the product is stirred or drinkable, post-fermentation shear and the broken gel's ability to recover become central.

Traditional options include starch for body and water binding, gelatin for a smooth thermoreversible gel, and pectin for serum control and a cleaner spoonable texture. Citrus fiber can add water binding and body, although its flavor, color, and processing tolerance must be evaluated in the actual base. Galactomannans can be useful in some stirred or indulgent yogurt systems, but they should not be treated as a universal answer. Blends of high- and low-acyl gellan gum can provide customized suspension and shear recovery without adding too much viscosity.

Building Systems Around Protein

The most efficient development program begins by characterizing the protein ingredient and the base before selecting the stabilizer. Protein percentage alone is not enough. Casein-to-whey ratio, lactose, minerals, pH, heat history, and powder dispersibility all matter. A useful bench screen holds the protein system and process constant, then compares several low-level stabilizer blends rather than one ingredient across an overly wide dosage range.

For ice cream, measure mix viscosity before and after aging, overrun, extrusion behavior, hardness at a defined temperature, meltdown, iciness after heat shock, and sensory coating. For yogurt, measure fermentation profile, firmness before and after shear, viscosity recovery, syneresis, and graininess over shelf life. A sample that looks wonderful the morning after production may tell a different story after three weeks in a cup or several temperature cycles in a freezer.

High protein contributes to body, nutrition, and consumer appeal. It also changes nearly every interaction in a dairy system. The traditional tools, particularly galactomannans and carrageenan in ice cream, remain excellent places to start. The trick, as usual, is using just enough. In hydrocolloids, restraint is often the difference between creamy and something that could stand up without the container.▼

Nesha Zalesny is a partner at IMR International, a trusted source of market intelligence and technical insight for the global hydrocolloid industry.

Hydrocolloids in Conventional and High-Protein Ice Cream

Ingredient	Conventional ice cream	High-protein ice cream
Locust bean gum (LBG)	Gives a creamy, cohesive body and helps control ice-crystal growth. Often blended with carrageenan.	Manages water, but its contribution to viscosity must be balanced against the protein-thickened mix.
Guar gum	Builds viscosity efficiently and provides water control.	The effective dose may be lower; too much can produce a sticky or gummy melt.
Tara gum	Adds body and can give a smoother texture than an all-guar or all-LBG system.	Can be used with a small amount of carrageenan in a stabilizer blend.
Tamarind seed gum	Limited ice recrystallization and improved cohesiveness in studied formulations, although melting was faster.	Manages water with less mix viscosity than an equivalent stabilizing dose of guar or LBG.
Microcrystalline cellulose (MCC)	Its suspended particles helped maintain finer ice crystals in a study of creamy ice cream.	Forms a particulate network that suspends insoluble material and limits serum separation; requires thorough dispersion and mechanical activation.
Carrageenan	Helps keep the dairy mix homogeneous and limits separation at low levels. Often blended with LBG.	Excess can over-structure or gel a mix with a high casein concentration.