Yogurt Manufacturing

Dispersion, hydration and solubility of milk proteins in milk when manufacturing yogurt

By Philip Connolly

Milk Proteins in Yogurt Manufacturing

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How Milk Protein Dispersion, Hydration, and Solubility Affect Yogurt Manufacture

Milk protein powder is finding an increasing role as a functional ingredient in yogurt manufacture. To optimize the use of milk protein powder in yogurt applications, it is important to properly disperse the powder into the milk, properly hydrate the powder in the milk, and maximize solubility of the powder in the milk. Failure to properly execute one or more of these steps will result in yogurt with undesirable physical and organoleptic properties.

Dispersing Milk Protein Powder into Milk:
For purposes of this discussion, we will assume that the milk protein powder is going to be dispersed in 40°F (4°C) milk. A commonly used inline mixer in the dairy industry is a Tri-Blender®. Tri-Blender®s work well to disperse protein-containing powders into fluid milk. They have a high-speed, high-shear mixing chamber and do a good job of evenly dispersing powder into fluid milk without lumps. If the yogurt factory does not have a Tri-Blender® available, a Likwifier type of mixer will also function well to mix milk protein powder into milk. The goal when mixing milk protein powder into milk is to produce a dispersion wherein the powder is evenly distributed throughout the milk. High-speed, high-shear mixers work best for protein powder dispersion into liquids.

Failure to disperse the milk protein powder into a homogenous milk/protein powder blend will result in the formation of milk protein lumps in the milk. Once these lumps form, they are extremely difficult, if not impossible, to break up. The lumps will contain dry milk protein powder in the center. If lumps do form in the milk as a result of poor dispersion actions, the following will occur:

- Yogurt will contain lumps that are uncharacteristic in a smooth yogurt gel.
- The lumps may settle to the bottom of the yogurt container during shipping and storage (this is especially true for set-type yogurt).
- The yogurt gel won't have as much strength and stability as was expected due to the milk protein entrapped in the lumps not being available to join the gel matrix as a stabilizing and strengthening factor.
- Shelf life could be unexpectedly shortened.

Hydration of Milk Protein in Milk:
The most common method for adding milk protein powder into milk is to mix the powder into the milk at refrigeration temperatures, 40°F (4°C). At such low temperatures, hydration (the action wherein water from the milk penetrates the spray-dried protein particles) proceeds very slowly. Because many yogurt factories are in a hurry to begin making yogurt immediately after they add the milk protein powder to the milk, they typically blend the milk protein powder into cold milk and then immediately proceed to pasteurize the mixture at high temperatures, usually above 190°F (88°C) for hold times as long as 10 minutes (except in the case of Greek style yogurts that contain high levels of whey proteins). It is possible that a problem could occur because at such low powder mixing temperatures with no time allowed in between, the milk protein powder is not hydrated and may actually suffer a loss of solubility by reacting with the milk minerals when quickly exposed to such high pasteurization temperatures and being held for so long at that temperature.

In addition, part of the reason for using such high pasteurizing temperatures in yogurt manufacture is to promote an interaction between the casein micelles in the milk and beta-lactoglobulin, a whey protein fraction, to promote proper gel structure.

If the milk protein powder is not fully hydrated, some of the micelles in the powder may not interact with beta-lactoglobulin as desired during the pasteurizing step. This could result in an inferior yogurt gel structure.

The best hydration results are obtained when yogurt factories mix the milk protein powder into milk at cold temperatures and then store the dispersion at refrigerated temperatures, with good agitation, for 6 to 12 hours (overnight) before pasteurizing the milk/milk protein powder blend and going through the yogurt making process. Failure to properly hydrate the milk protein powder in the milk may result in the following:

- Modified gel structure.
- The yogurt gel could possess a grainy texture.
- The yogurt gel won't have as much strength and stability as was expected.
- Shelf life could be shortened.
- The yogurt could possess a powdery off flavor note.

Maximizing Milk Protein Solubility in Milk:
Once the factory has properly dispersed the milk protein powder into the milk by making use of high-speed, high-shear mixers and has allowed sufficient time for the powder to hydrate in the milk, obtaining maximum protein solubility should not be a problem. Solubility is a function of time and energy in the system. At higher temperatures, solvation occurs faster and at lower temperatures; solvation proceeds more slowly. At standard HTST pasteurization temperatures, a well dispersed and well hydrated milk/milk protein powder mixture should reach maximum solubility within 5 minutes. At standard yogurt milk pasteurization temperatures and hold times, the protein powder will reach maximum solubility within minutes. Therefore, by the time the yogurt mix has been pasteurized and held at an elevated temperature to sterilize the mix and promote protein interactions, the powder should be solubilized to the maximum possible.

Maximizing milk protein solubility in the yogurt milk will ensure the desired yogurt gel structure and extend yogurt shelf life.

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