

# Cheese Manufacturing

Dispersion, hydration, and solubility of  
milk proteins in cheese manufacturing

By Philip Connolly



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## How Milk Protein Dispersion, Hydration, and Solubility Affect Cheese Manufacture

Many of the problems encountered when using milk protein to supplement milk solids when manufacturing cheese can be attributed to improper dispersion of the milk protein powder in the milk, and/or improper hydration of the protein powder in the milk, and the resultant poor solubility of the milk protein powder in the milk. To ensure optimum cheese quality, cheese manufacturers need to properly disperse and hydrate milk protein powder into their cheese milk before they start to manufacture cheese. Failure to do so can result in cheese with fish eyes, powder specs, ragged slice and shred, poor melt, undesirable organoleptic qualities, and wasted protein powder.

Standard practices in countries that allow for inclusion of milk protein in cheese manufacture is to mix milk protein powder into available cheese milk using the milk protein powder as part of cheese milk standardizing prior to cheesemaking. Many cheese factories do not possess high-speed, high-shear mixers that are necessary to mix protein powder into milk. The lack of proper mixing equipment leads to poor dispersion of the milk protein powder in the cheese milk. In addition, cheese factories typically do not allow sufficient time for the milk protein powder to properly hydrate in the cheese milk before they start to manufacture cheese. Many of these factories will pasteurize the milk/milk protein mixture immediately after adding the powder to the milk without allowing sufficient time for hydration of the powder prior to heating the mixture to pasteurizing temperatures. This can lead to unwanted reactions between milk minerals and the milk protein powder that can decrease milk protein powder solubility in the milk. Milk protein powder is not as readily soluble in milk as it is in water, mainly because of the minerals in milk that interfere with milk protein solubility. Cheese factories must ensure that the milk protein powder is completely dispersed into the cheese milk and that sufficient time has been allowed for the powder to hydrate in the milk prior to pasteurization. Otherwise, the milk protein powder will display poor solubility in milk and this will affect the physical, analytical, and organoleptic properties of the cheese.

### 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 cheese 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 mixture. 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 cheese milk as a result of poor dispersion actions:

- The lumps will precipitate out with the cheese curds when the cheese curd is formed.
- The lumps will become a part of the cheese, sometimes evident to the naked eye on the outer surface of the cheese but certainly evident to the naked eye when one cuts into the cheese. The lumps may appear as “fish eyes” if the lump was partially solubilized before the curding process was begun, or they may appear as spots of white powder in the cheese. Either way, the lumps will detract from the pleasing appearance of the cheese for the consumer.
- A cheese with undispersed protein lumps may not analyze correctly for fat and protein content as was desired. While the block of cheese, overall, may contain the desired fat to protein ratio, if the sample taken from the block does not have a good representation of the cheese and lumps in the proper ratio, analysis of the sample will produce a result with incorrect fat to protein content.
- Undispersed protein powder lumps will not possess the same organoleptic properties as the surrounding cheese. They will likely possess a powdery flavor and a granular texture.
- When cheese containing these lumps is shredded or grated, the lumps will be broken apart in the process but they will show up as shred fines, not the desired smooth cheese shreds that a consumer expects.
- When cheese containing these lumps is melted, the lumps will not melt but will be readily apparent as “lumps” in the melted cheese.

To produce a cheese with pleasing physical and organoleptic properties, it is imperative that the cheesemaker thoroughly disperse the milk protein powder into the milk so that a homogenous, evenly distributed mixture is achieved.

#### **Hydration of Milk Protein in Cheese Milk:**

The most common method for adding milk protein powder into milk in a cheese factory 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 cheese factories are in a hurry to begin making cheese, they typically blend the milk protein powder into cold milk and then immediately proceed to pasteurize the milk right after mixing the protein powder into the milk. It is possible that a problem could occur because at such low 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 high pasteurization temperatures. The best hydration results are obtained when cheese 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 blend and going through the cheesemaking process. Failure to properly hydrate the milk protein powder in the milk may result in the following:

- Grainy cheese texture, slice and shred.
- Undesirable melt qualities. Excess free oil. Excess melt spread.
- Grainy mouthfeel.
- Possibility of powdery note off flavors in the cheese.
- Noticeable sedimented powder deposits on the bottom of the milk silo and/or cheese vat.

#### **Maximizing Milk Protein Solubility in Milk:**

Once the factory has properly dispersed the milk protein powder into the cheese milk by making use of high-speed, high-shear mixers and has allowed sufficient time for the powder to hydrate in the milk, the factory should still allow for sufficient time at elevated temperature to maximize solvation of the protein powder into the milk.

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. Cheesemaking presents an interesting challenge to protein solubilization as the cheesemaker does not wish to expose the cheese milk to high temperatures for too long so as to avoid denaturation of the whey proteins in the milk and subsequent inclusion of the denatured whey proteins in the cheese curd, which will affect cheese texture and melt. At standard HTST pasteurization temperatures, a well dispersed and well hydrated milk/milk protein mixture should reach maximum solubility within 5 minutes. It is not desirable, however, to hold cheese milk for that long at those temperatures. Therefore, cheesemakers cool the pasteurized milk down to the proper culturing temperature, usually 100°F (38°C) to 105°F (41°C), immediately following HTST pasteurizing. It would be helpful for maximizing solubility of the milk protein if the pasteurized and cooled dispersion could be allowed to sit, with agitation, for 20 to 30 minutes at culturing temperature (105°F) in the cheese vat prior to starting the cheesemaking process. If the factory cannot tolerate such hold times due to production limitations, any amount of hold time would be better than no hold time at all.

Maximizing milk protein solubility in the cheese milk will ensure the smoothest slice, shred and mouthfeel as well as result in consistent texture and melt properties.

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