Milk Protein Concentrate in Yogurt

Replacing starches and thickeners in Greek style yogurt

By Philip Connolly

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Yogurt is becoming an increasingly popular dairy product with consumers around the world. While the regulations covering yogurt composition and manufacture may vary from country to country, the product, itself, is pretty standard around the globe. There are three basic types of yogurt. What most consumers would call "regular" yogurt can be separated into two categories: set-in-cup yogurt (Set yogurt) and stirred curd yogurt (or Swiss style yogurt). Currently, the fastest growing yogurt segment in the U.S. is Greek style yogurt, otherwise known as Mediterranean style yogurt. Greek style yogurt differs from "regular" yogurt in that it contains a much higher protein content (usually at least 2 times the protein of regular yogurt) and a corresponding decrease in lactose. This article looks at the benefits of adding Milk Protein Concentrate (MPC) to all types of yogurt to provide texture improvement, reduce syneresis, extend shelf life, improve flavor versus use of stabilizing gums and starches, and to enrich protein.

"Regular" Yogurt Basics

Yogurt is a fermented milk food that results from the culturing of milk with bacterial organisms. Most legal definitions of yogurt include the phrasing that the yogurt must be fermented from milk via culturing/growth of *L. bulgaricus* and *S. thermophilus*. It is these two organisms that contribute the characteristic, traditional flavor notes to yogurt. Other organisms can also be added to yogurt, such as probiotic organism's *bifidus* and *L. casei*.

Because yogurt composition regulations vary from country to country, this article will concentrate on U.S. regulations as specified in the U.S. Code of Federal Regulations (CFR) in sections 21 CFR 131.200, 203, and 206 for full fat yogurt, low fat yogurt, and nonfat yogurt, respectively. In the U.S., all yogurts must contain a minimum of 8.25% solids not fat. Full fat yogurt must contain not less than 3.25% milk fat, while low fat yogurt can contain 2.0% milk fat maximum, and nonfat yogurt must be less than 0.5% milk fat. 21 CFR sections 131.2 also allow for additions of Vitamins, Optional Dairy Ingredients, Nutritive Carbohydrate Sweeteners (except Table Syrup), Flavoring Ingredients, Color Additives, and Stabilizers.

The two most common styles of yogurt are the set-in-cup (Set) yogurt and stirred curd yogurt. Set Yogurt is the type of yogurt that is packaged with fruit-on-the-bottom and yogurt on top. Stirred Curd Yogurt is packaged with the fruit blended into the yogurt and suspended in the yogurt until consumed. The two types of yogurt are basically manufactured in the manner as befits their names. In simple terms, Set Yogurt is manufactured by mixing all desired ingredients into milk (base), homogenizing the base, pasteurizing the base (at least 90°C for 8 minutes), cooling the base to 42°C, inoculating the base with the yogurt culture, placing the inoculated mix into the final yogurt package cup (the fruit and flavors are added to the bottom of the cup and the inoculated milk is poured over the top), and allowing the base to ferment at 42°C for a number of hours in the package cup before cooling to below 7°C to stop fermentation and refrigerating.

In the manufacture of Stirred Curd Yogurt, all ingredients are added to the milk, the milk is homogenized, the base is pasteurized (at least 90°C for 8 minutes), the base is cooled to culturing temperature of 42°C, yogurt culture is added, and the base is fermented for a few hours. When desired pH is reached and the base has formed a soft gel, the yogurt is cooled to below 7°C to stop the fermentation process. Fruit and flavors are added to the yogurt via agitation/stirring. The result is a smooth, viscous, homogenous product.

Most of the yogurt sold today is the Stirred Curd type. It is the preferred type among consumers because of the homogenous nature and the smooth mouth feel of the curd. Since, over the storage period, Set Yogurt generally exhibits some syneresis on top of the yogurt gel, when consumers open the packaging, they can visibly detect a pool of whey on top of the yogurt curd. Many consumers consider that pool of whey to be undesirable. Stirred Curd Yogurt typically contains more stabilizer ingredients than Set Yogurt, because the Stirred Curd Yogurt gel must be of sufficient viscosity to keep the fruit suspended in the curd throughout storage. Due to the higher usage level of stabilizers, Stirred Curd Yogurt is far less likely to exhibit syneresis, and it provides a more appetizing consumer experience.

The shelf life of yogurt is usually determined by how long the yogurt gel will maintain strength and stability. At some point in the life of yogurt, the soft yogurt gel will lose viscosity and the gel will fall apart, exhibiting significant syneresis, resulting in curds and whey. Obviously, curds and whey are not desirable to yogurt consumers, so manufacturers limit their product shelf life to a period of time in which the gel maintains viscosity and stability, and will not synerese to an undesirable degree. Addition of stabilizers to a yogurt formula can help to extend yogurt shelf life by maintaining gel viscosity over a longer period of time.

Typical stabilizers of yogurt are usually gums, thickeners, or food starches. Such as; carageenans, gelatins, locust bean gum, guar gum, pectins, and starches. The amount of stabilizer allowed to be added to yogurt will vary in different countries around the world. Yogurt manufacturers have found, however, that adding too much stabilizing agent will usually detract from the yogurt flavor. For higher quality yogurts, manufacturers try to keep stabilizer additions to a minimum. Side by side sensory evaluations of yogurt with low or no levels of stabilizers versus yogurt containing higher levels of stabilizers shows that stabilizer levels of 1.5% (w/w of the yogurt) will detract from overall flavor and may require additions of extra flavoring agents.

The flavor of yogurt is determined by the ingredients in the yogurt base as well as the compounds that are produced as the base is fermented. The acidity developed by the yogurt culture multiplication and growth complements the flavor compounds that are added to the yogurt. When additional ingredients are added to a yogurt base, the resultant flavor profile of the finished yogurt will be modified. Addition of higher levels of stabilizers to a yogurt base has been found to mute the natural flavor of yogurt as well as any added flavors such as fruit or vanilla. The manufacturer is then required to add extra flavors to the yogurt base to compensate for flavor masking induced by the stabilizers.

Milk Protein Concentrate in Yogurt in Replacement of Stabilizers

Instead of adding additional flavor-altering stabilizers, yogurt manufacturers can produce a stable viscous gel and extend product shelf life by adding Milk Protein Concentrate (MPC) as a partial replacement of stabilizers. MPC contains casein and whey proteins in the same, unaltered ratio as is found in fluid skim milk. The proteins in MPC are in the same ratio as is found in unfortified yogurt . This ratio of proteins is a significant determinant in forming the typical, traditional yogurt gel. Adding MPC to yogurt also results in increased water binding, increased viscosity, and a stronger yogurt gel. The addition of MPC to a yogurt formula at usage levels of 1% (w/w) will allow a yogurt manufacturer to decrease stabilizers by 0.75% (w/w) to 1.0% (w/w) without sacrificing yogurt quality.

The appearance and texture of yogurt is dependent on the total solids of the yogurt, protein content of the yogurt, and the amount of stabilizers added to the formula. Total solids and protein content play a significant role in determination of yogurt texture and stability. When yogurt milk is heated for pasteurization, a high heat treatment is used to completely denature the whey proteins in the milk.

Denatured beta-lactoglobulin from the whey protein fraction will react with alpha-casein from the casein micelle to form an insoluble complex. That complex contributes to yogurt texture (*Yogurt, Science and Technology, 1st Edition*, 1985). In the yogurt manufacturing process, as milk is being cultured and the pH of the product decreases, the casein micelles in the milk form matrices.

The type of matrix formed by the casein micelles is dependent on the concentration of other proteins present in the yogurt mix. When extra whey proteins are added to the yogurt mix, fine protein floccules can be observed in the yogurt. When milk protein concentrates are added to the protein mix, no protein floccules are observed in the yogurt (*Journal of Dairy Science*, 1983; 66: 430-437). Fortification of yogurt milk with MPC results in a thicker, more viscous gel consistency. In addition, fortification with MPC will ensure that the resultant yogurt gel will form with similar casein micelle matrices to those found in unfortified yogurt. This results in a more realistic yogurt gel structure, plus a more stable gel, due to the higher viscosity of the mix. The resultant gel is less likely to synerese over storage time and the shelf life of the yogurt can be extended.

Use of MPC in replacement of gums, pectins, and starches will also improve yogurt flavor profiles. Unlike stabilizers, MPC will not mute the natural yogurt flavors, or mask the intensity of added flavors. Yogurt manufacturers will notice increased flavor strength from their yogurt when they replace a portion of their stabilizer mix with MPC in their yogurt base. When MPC is used to help stabilize yogurt, replacing starches or other thickening agents, an improvement in overall yogurt flavor profile can help manufacturers reduce costs by decreasing flavor addition levels.

Greek Style Yogurt

This type of yogurt gained its name from the geographical region where it has been commonly manufactured. It is also referred to as Mediterranean Style Yogurt because this yogurt type has been manufactured all over the Mediterranean coastal countries from Greece, through the Middle East, and even across Northern Africa. Traditionally, Greek yogurt has been manufactured by a process resembling regular yogurt manufacture in the rest of the world. Historically, however, refrigeration had been scarce along the Mediterranean coast so yogurt manufacturers in that region would typically bundle the yogurt gel in cheesecloth, or some other porous material, and suspend the yogurt gel for days at time in the porous cloth. As the yogurt gel was suspended, it would synerese whey. The whey would drip away from the yogurt gel, thereby resulting in a yogurt gel with lower whey solids (lactose, soluble minerals), higher total solids, and higher protein content. Because of the higher solids and protein content, Greek yogurt gels tend to be much more solid than regular yogurt gels. One boutique Greek style yogurt manufacturer has stated that his customers prefer a yogurt gel so strong that they can walk on the yogurt. It is the higher protein content of Greek style yogurt that has appealed to a new generation of yogurt consumers and contributed to the soaring popularity of the product today.

Obviously, one cannot expect to manufacture a consistent quality Greek style yogurt in large quantities by suspending yogurt gels in cheesecloth for a few days. In order meet the needs of the modern marketplace, it is necessary to find more modern means of increasing total solids and protein content of the yogurt. Adding a blend of MPC and some Whey Protein Concentrate (WPC) to yogurt milk is one way to achieve higher total solids and higher protein content, without decreasing the ratio of protein to nonfat solids or decreasing the Protein Efficiency Ratio (PER) of the yogurt, as is required for all yogurt products in the 21 CFR 131.2 sections.

Plain nonfat Greek style yogurts currently commercially available typically contain 4.0% to 8.0% carbohydrate (almost the same as for regular nonfat yogurt) and 8.2% to 11.0% protein (roughly 2 to 2.25 times the protein of regular yogurt). In order to produce a Greek yogurt through protein

fortification with a blend of WPC and MPC, it would be necessary to fortify nonfat milk with 5.5% to 7.3% (w/w, based on weight of the milk) MPC (80% protein content) and WPC (80% protein content). Greek style manufacturers have found that yogurts fortified with MPC will often exhibit a firm gel, but will also exhibit progressively grainy texture as the protein content increases. Greek style yogurts fortified with whey proteins tend to exhibit smooth texture, but whey proteins do not contribute to a realistic yogurt gel texture or create a firm enough gel when used at high levels. The solution is to use a blend of both types of dairy proteins to achieve a firm, Greek style yogurt gel that also exhibits a smooth texture.

My own personal laboratory experiments with nonfat Greek style yogurt have shown that a blend containing in the range 50% to 70% casein and 30% to 40% whey proteins yields a firm yogurt gel with smooth texture in Greek style yogurt applications. The resultant gel has the desired firmness of Greek style gels and the smooth texture of a high quality yogurt. Blends comprised of the casein to whey protein ratios described above would consist of 60% to 85% MPC 80 and 15% to 40% WPC 80. The exact ratio of casein to whey protein should be chosen based on desired total yogurt protein content. If a high protein Greek style yogurt is desired (10% protein and above), a blend that contains higher amounts of whey proteins would be required in order to maintain a smooth gel texture with the increased protein content. At lower yogurt protein levels, a blend that is higher in casein content would be required in order to maintain desired gel firmness with lower solids content. Of course, the addition of small amounts of stabilizer ingredients would also help to achieve gel firmness and texture, but many Greek style yogurt brands want to offer all natural ingredients to the consumer.

Conclusion

MPC can be added to yogurt milk to replace starches and other thickeners that might otherwise be added to yogurt. When MPC is used to help stabilize yogurt, the gels are firmer, the gels will have less tendency to synerese, shelf life is extended, and flavor improves compared to yogurts manufactured from bases comprised of milk and high levels of stabilizers. Blends of MPC and WPC can be used in Greek style yogurt applications to yield high protein, firm yogurt gels with a smooth texture.

About the Author:

Owner and President of Commercial Proteins, Philip Connolly is a leading expert in protein development, manufacture, and marketing of milk and vegetable proteins to the food, nutraceutical, and pharmaceutical industries. Mr. Connolly has more than 35 years' experience in development and application of proteins including; over 20 U.S. and Worldwide Patents covering protein manufacture and applications, 13+ years in R&D for the manufacture and application of proteins in food, 3 years as Senior Research Scientist for the New Zealand Dairy Board, and numerous formulations for sports nutrition companies, including EAS and Weider Nutrition.

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