

Choosing a Dairy Protein Ingredient

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A growing consumer interest in high-protein diets has led to a significant increase in the development of new dairy ingredients in the U.S. The popularity of dairy protein ingredients is deeply rooted in dairy protein nutrition research, which has shown that dairy proteins support muscle recovery, weight management and satiety. This research is part of the reason we've seen such strong growth in Greek yogurt, protein drinks and protein in breakfast foods.

Overall, the dairy protein ingredient market has grown exponentially over the past few years, leading the way for many new high-protein, dairy-based products. With so many choices of dairy ingredients, however, food manufacturers can often feel unsure about which ingredient is right for their product. The outline below has been provided to assist companies in better understanding dairy ingredients and which one best fits their needs. This also includes a section on food applications along with a simple case study of the Wisconsin Center for Dairy Research (CDR) dairy ingredient work. As always, if you have specific questions about dairy ingredients, you are encouraged to contact CDR directly.



Whey Protein and Milk Proteins

The dairy protein ingredient options can be broken up into two basic categories: whey protein ingredients and milk protein ingredients. The whey protein ingredients include whey protein concentrates (WPC) and isolates (WPI), which range in protein from 34 to 89% for a WPC to a minimum of 90% for a WPI. Whey protein ingredients have a standard of identity, which can be found in the Code of Regulations 21CFR 184.197(c)(a).

The milk protein ingredients include milk protein concentrates (MPC) and isolates (MPI) with similar ranges in protein as whey protein ingredients. Milk protein concentrates and isolates do not currently have a standard of identity but a GRAS (Generally Recognized as Safe) notification has been submitted to and reviewed by the Food and Drug Administration for these ingredients. The GRAS notification includes milk protein ingredients that are manufactured by processing nonfat milk by ultrafiltration to remove a portion of the nonprotein constituents followed by evaporation and spray-drying. Milk protein ingredients are relatively new to the U.S. dairy ingredient world, with the first MPC manufactured in 2000. The U.S. has now at least 10 manufacturers of milk protein ingredients.

Whether you are a manufacturer or an end user of these ingredients, it is important to understand the differences in functionality before you start recommending or choosing an MPC or a WPC. Although both ingredients offer products with similar protein levels, such as MPC 80 or WPC 80, you will get a different set of functional properties with each ingredient, so it is important to note those differences when making a decision about which ingredient to use. The differences in functional properties are due to the type of protein that is most prevalent in each ingredient. MPC contains the typical 80% casein and 20% whey protein found in milk, whereas the protein in a WPC is all whey protein. If you know the basic chemical and functional properties of casein and whey protein, it makes selecting the right ingredient for your application much easier.

Functional Properties of Milk Proteins	
Caseins	Whey Proteins
Fat emulsification	Gelation
Foaming	Foaming
Soluble at pH >6	Soluble at any pH
Water binding	Heat sensitive
Precipitation by Ca ⁺⁺	
Precipitation by chymosin	
Heat stable	

Early, 1992. The Technology of Dairy Products

Understanding Functionality Differences

As noted above, MPC contains casein and whey proteins while WPC contains solely whey proteins. Casein and whey proteins react very differently under various conditions, so it is important to understand how each protein will react in your application.

Caseins are generally good at fat emulsification, foaming and water binding and have good heat stability as long as the pH of the application they are used in is above 6. When the pH decreases below 6, caseins will form acid gels, which is essentially the process that happens during the fermentation of milk into yogurt and cheese.

Whey proteins are known for their foaming ability, gelling properties, high solubility over a wide pH range and their heat sensitivity. Unlike casein, whey proteins will denature upon heating starting at about 145°F, and the proteins will eventually form a gel at a high enough concentration (about 7% protein). Whey proteins do not form acid gels like caseins, which is a key difference to consider when choosing a dairy protein ingredient for a yogurt application. Following are some examples of differences in functional properties of milk proteins and whey proteins.

Food Applications

Once you understand the chemistry behind each protein, it is also important to understand how the gelling, solubility and other characteristics will affect your food application.

When it comes to all food applications, knowing the pH of the food and understanding how the dairy protein will behave in those pH conditions is critical to choosing the right ingredient. Beverages are a good example of an application where the pH is important. Protein beverages can be found ranging in pH from 3.0 to 7.0, so knowing the properties of each protein and how they react to pH will make your choice much easier. If you are making a protein beverage in the high acid range, pH 3.0 to 4.5, where you will typically use a hot fill process, you will automatically pick a whey protein ingredient because milk protein will have poor solubility and will precipitate. If you are making a beverage in the low acid range, pH 6.5 to 7.0, then you would pick a milk protein ingredient for its heat stability because a UHT (ultra-high temperature) process will be necessary to make a shelf-stable product. You also could use a portion of the protein from a whey protein ingredient, because the casein ingredient will act like a chaperone and provide some added heat stability to the whey protein ingredient.


Another major difference between milk and whey protein ingredients is their hydration characteristics. Good hydration is key to achieving optimum functionality from a dairy protein ingredient. For fluid applications such as beverages, it is always recommended to add dairy protein powders and mix them with a high-speed mixer to fully dissolve the product in water. Whey proteins are very susceptible to denaturation from high shear, so overmixing will create a lot of foaming and can denature the protein, which in turn will decrease its solubility in acid conditions. Once the proteins are dissolved, it is recommended to use slow agitation for the remaining hydration time. Whey proteins will hydrate quickly, so a minimum of 30 minutes (with ambient temperature water) is necessary to achieve good hydration for a beverage application. By comparison, milk protein ingredients are very slow to hydrate. It is not unusual for milk protein ingredients with 70% protein or higher to take up to two hours. You can shorten the hydration time by increasing the water temperature to 120 to 140°F. Other applications where pH and hydration are important for good dairy protein ingredient performance are soups, sauces, yogurt and confections, such as caramel.

Case Study

An example of an application where pH is not critical would be in a bakery dough. A recent experience we had at CDR was in the development of a protein-enhanced dough for an Asian dumpling prototype (**formulation available on ThinkUSAdairy.org**).

We developed the dough with 10% protein (11 grams) per serving using a WPC 80 and then were asked to change the formula and use an MPC 80 instead. Due to the higher water-binding ability of the MPC compared with the WPC, we could not do a one-to-one replacement without other changes to the formula. The MPC formula required a higher level of water addition to result in a similar dough texture. The MPC formula also required more MPC in order to achieve the 10% protein as the additional water diluted the amount of protein. The comparison of the formulas is at right.

Ingredient	Dumpling Dough with WPC	Dumpling Dough with MPC
Flour	61.05	52.95
Water	33.11	40.66
WPC 80	5.84	-----
MPC 80	-----	6.39
Total	100.00	100.00



Conclusion

Dairy protein ingredients have many great functional and nutritional properties. Once you understand the basic differences in the chemistry between casein and whey proteins, you have a better chance of successfully developing a protein-enhanced food that has the flavor, texture and appearance consumers will enjoy.

For more information on dairy protein ingredients and formulations, visit ThinkUSAdairy.org.



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