



## Differences Between Milk Protein and Whey Protein Ingredients

The U.S. has spent a lot of time and research developing processing, functionality, application and nutrition information on whey protein ingredients such as whey protein concentrate (WPC) and whey protein isolate (WPI). All of this research has contributed to the success of whey protein ingredients and expanded their uses in food. Now that the U.S. is a significant manufacturer of milk protein ingredients, such as milk protein concentrate (MPC), milk protein isolate (MPI), and even Micellar casein, we are still in the process of collecting similar information to share. Both milk protein and whey protein ingredients are available at the same protein concentrations, such as whey protein concentrate with 80% protein (WPC80) and MPC80, or WPI and MPI. Though you can buy either ingredient and get the same amount of protein, this is where the similarities end. Though it may be tempting for product developers to substitute one or the other based on which one is lower in cost, they will find that in many cases it is not an easy substitution. The source of the differences starts with the basic structural differences between caseins and whey proteins.

### **Protein characteristics:**

Caseins are the most predominant proteins in milk making up about 80% of the total protein. They are large proteins with a complex random coil configuration that includes calcium as an intricate part of the structure and is typically referred to as a casein micelle. The whey proteins make up the other 20% of the protein in milk of which  $\beta$ -lactoglobulin is the most predominant, followed by glycomacropeptide,  $\beta$ -lactalbumin, bovine serum proteins, immunoglobulins, and others.<sup>1</sup> Whey proteins are smaller than caseins and have a globular structure. By definition, they are the group of proteins that remain soluble at pH 4.6, (the isoelectric point of casein) while the caseins will precipitate under these conditions, such as in cheesemaking. MPC ingredients range in protein from 42-89% protein while MPI contains a minimum of 90% protein but still have the same ratio of casein to whey protein (80:20) found in milk. WPC and WPI ingredients are made similar levels of protein as the milk protein ingredients but they contain no casein.

**Functional Properties:** Milk and whey proteins have many functional properties which include, emulsification, foaming, water binding, viscosity, solubility, heat stability, and gelation. These functional properties can be measured using different methods when the ingredients are made into solutions. Measuring these properties provides a way to compare ingredients and characterize their performance. Measuring functional

ity can also be a way to help select a specific ingredient for an application. When comparing milk protein and whey protein ingredients, there will be differences in many of the functional properties. In general, milk protein ingredients are better at emulsification and water binding, will develop higher viscosities, have better heat stability, poor solubility below pH 6 but will primarily gel only with slow acidification (ie. cheese or yogurt manufacture). Whey proteins are generally better at foaming, are less heat stable (will denature or unfold with heat) and will gel with heat but have good solubility at a wide pH range from pH 2-10.<sup>2,3</sup> These differences in functionality are important for choosing the right ingredient for a specific application.

**Applications:** Both types of protein ingredients are used in many different applications from dairy products, baked products, nutrition bars, confections, soups, sauces, beverages, processed meats and even desserts. Many product developers today use milk and whey protein ingredients to add protein to foods where they may have target protein levels of up to 10% or more. It is at these high levels that you will find big differences in performance between milk and whey protein ingredients. One example would be in the beverage category. It is popular to develop high protein beverages and often those beverages will have protein levels in the range of 4-8% protein. You will find beverages that are in the pH range of 6.8-7.0 which are considered low acid beverages. You will also find beverages that are pH 3-4.5 and these are considered high acid beverages.<sup>4</sup> If your desire is to make a shelf stable beverage, then the heat processing requirements are different for these two types of beverages. The low acid beverage will need to be retort or UHT (ultra-high temperature) processed which involves temperatures above 250F. The high acid beverage would require hot fill processing conditions or temperatures about 180F. This difference in pH and processing temperature will help in the selection of the appropriate protein ingredient. Since milk protein ingredients are more heat stable and have good solubility above pH 6, an MPC, MPI or micellar casein ingredient would be the best choice for the low acid beverage. Whey proteins can be used in the low acid product but they should be used in combination with a milk protein ingredient. For the best heat stability and to avoid unnecessary aggregation of the proteins, it is best to have more casein than whey protein in a low acid high protein drink. The choice for a high acid beverage is more related to the pH conditions. Whey proteins will have the best solubility below pH 4.6 and they can handle the heat processing needed for a high acid beverage.

**Formulation tips:** The hydration of milk and whey protein ingredients is key to their optimal performance especially in applications such as beverages, yogurt, soups, sauces, and other applications that are high in moisture. Both types of ingredients should be dissolved in water or milk with high shear and allowed to hydrate with slow agitation. For whey protein ingredients, the temperature of the water should be less than 65C to avoid denaturation during the hydration process and 30 minutes is typically a sufficient holding time. The amount of shear should also be minimized for whey proteins because they will also denature when exposed to high shear. Milk protein ingredients don't have the same limitations when it comes to temperature or shear but the MPC ingredients at 70% protein and higher are very slow to hydrate at cold or even ambient temperatures. Many researchers have studied the hydration characteristics of milk protein ingredients.<sup>5-9</sup> It is recommended to hydrate milk protein ingredients in warm water or milk at 50C and hold for at least 1 hour for the best performance. Poor hydration of milk protein ingredients will lead to a chalky or grainy texture in products like beverages, soups, sauces, or yogurt and could lead to settling over time in a beverage.

Development of a high quality food product that contains milk or whey protein ingredients is important to the success of the dairy protein ingredients. Understanding how to choose the right dairy protein for the application will help the product developer achieve their goals and deliver a product that consumers will enjoy while also benefitting from the nutrition of dairy proteins.

#### References:

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