Milk Protein Products - What Are They and What Role Do They Play in Lactose Reduced (Low "Carb") Foods?

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Low "Carb" Dairy Foods and Ingredients.

The popularity of low-carb diets (for example, Atkins diet) has focused the attention of the American consumer on the carbohydrate content of their diet and of individual foods. Obesity, and being over weight, has been identified as a major health problem for the American public. Many consumers are looking for dietary strategies to control their weight. The low carbohydrate approach of the Atkins diet was very popular and the food industry is responding by producing foods that support this and related dietary weight control strategies. The major carbohydrate in milk is lactose, sometimes called milk sugar. Approximately, 40% of the solids in milk as it leaves the farm is lactose (carbohydrate). Lactose is one molecule of glucose and galactose connected together. Some people cannot digest lactose (i.e., lactose intolerance) because they do not have sufficient activity of an enzyme (lactase) in their digestive system to digest lactose. Thus, consumption of milk causes stomach upset in these individuals. These individuals usually stop consuming dairy products. The dairy industry has offered "lactose-reduced" milks to lactose intolerant consumers for many years, but these products are <u>not</u> reduced in carbohydrate content. Lactose-reduced milk has had the lactose broken (into its two simple sugars, usually 70 or 100%) by adding the enzyme lactase (at the factory). Lactose reduced milk can be consumed by lactose intolerant consumers and allows them to maintain their dietary intake of milk protein and calcium. Consumers can also buy lactase and add it directly to their foods at home.

Low "carb" dairy foods are distinctly different from lactose-reduced dairy foods in that the lactose has been partially or totally <u>removed</u> from the dairy product or dairy ingredient. At the same time there has been interest in low "carb" dairy foods and ingredients, the positive role and function of both milk proteins and calcium in the diet is being more completely understood. Consumption of calcium and milk protein has been associated with reduced accumulation of body fat and reduced blood pressure. Removal of lactose from milk is most commonly done by a physical filtration process called ultrafiltration (UF). This process can be used to produce both low "carb" dairy foods and low "carb" milk protein concentrates (MPC) that provide milk proteins and milk calcium in dairy and other formulated food products (for example, sports nutrition products, protein and calcium fortified beverages, etc.). When low "carb" milk-based ingredients are used in other foods it expands the consumption of milk protein and calcium. In fact, UF on the farm, or in a factory, to a 3X (three times) concentration factor produces milk that is reduced in carbohydrate content by about 65 to 70%. Thus, both liquid and dry milk ingredients with two thirds or more of the lactose removed will become increasingly important ingredients in food manufacturing.

Are Milk Protein Products Safe?

The traditional milk protein products (e.g., nonfat dry milk powder, whey powder, whey protein concentrate, whey protein isolates, caseins, and caseinates) produced in the USA and imported from other countries have a long history of safe use in human foods. All milk and milk products in USA are produced under conditions of Good Food Manufacturing Practice and in compliance with Grade A and/or human food grade food production regulations.

All of the newer milk protein products produced by filtration processes (e.g., milk protein concentrates, milk casein concentrates, milk soluble protein concentrates) that are physical separation technologies. No chemicals or additives are used in the process of manufacturing these milk protein concentrate products. Therefore, the safety of these milk protein products comes back to the same quality and safety standards for milk that the regulatory agencies require for manufacture of all other dairy foods. Once milk meets these standards, then the processing, cleaning, and sanitation procedures must conform to all Federal and State Regulatory standards for safe production of all other dairy foods.

If milk protein concentrates are used as an ingredient in dairy products and particularly other foods that may, or may not, normally contain dairy ingredients, then these foods are required to be properly labeled to indicate that a milk derived ingredient has been used. In this case, the individuals in the consumer population that may have an allergy to milk protein are informed that milk proteins are present in the food product and they can choose to avoid consumption of that particular food.

Milk components and separation processes:

Can fat and protein be separated from each other in milk?

Yes. A centrifugal cream separator is used to remove cream (about 36 to 40% fat) from milk and produce skim milk as a by-product.

What are the components of skim milk?

Skim milk contains protein (3.2%), lactose (5.0%), and minerals (0.7%).

Can the components of skim milk be separated from each other?

Yes. An ultrafiltration unit can separate lactose from protein in skim milk, like a cream separator separates fat from skim milk.

Are there different types of proteins in milk?

Yes. There are two major types of proteins in milk: caseins (these stay with the cheese) and soluble proteins (beta-lactoglobulin and alpha-lactalbumin) that go out with the whey in cheese making. Of the true protein in milk about 82% is casein and 18% is soluble proteins.

Can the different types of protein in milk be separated from each other?

Yes. A microfiltration unit can separate milk casein from milk soluble proteins in skim milk with out addition of any chemicals.

What products can be made with separation processes?

Cream separator:

From milk: cream, skim milk, condensed skim milk, nonfat dry milk powder.
From whey: whey cream, liquid whey, condensed whey, whey powder.

Ultrafiltration system:

Lactose reduced milk and whey products. Lactose is a by-product. Currently, the ultrafiltration is technological basis for "low-carb" milk based beverages. Milk protein concentrates are made using ultrafiltration.

Microfiltration system:

Soluble protein and lactose reduced milk protein products (that is, native casein concentrates). Lactose and milk soluble proteins are by-products. Microfiltration is a very exciting new technology that has not been commercialized on milk in the US yet, but will open up many new possibilities for uses of milk proteins as ingredients in foods. For example, milk soluble proteins can be separated from caseins and used to protein fortify clear fruit-flavored beverages. Protein fortification of non-dairy beverages with fresh liquid milk soluble protein concentrates is a very large new market for milk protein and has the potential to greatly expand the consumption of milk protein in the US. The milk casein concentrates, or "micellar" casein concentrates (MCC) as they are sometimes called, have much better flavor and heat stability than imported dried rennet and acid casein products. The products of milk filtration technology open up a new opportunity for expanding the consumption of milk proteins in the US.

What are the typical milk protein products made by separation technologies?

Nonfat dry milk (NDM).

Whole milk is separated into cream and skim and the skim milk (ca. 8.6% dry matter) is concentrated by evaporation (condensed liquid skim) and spray dried to form a powder. The powder contains about 34 to 36% protein on dry basis and is about 97% dry matter. Condensed skim (ca. 35% dry mater) can be used as a fresh ingredient in dairy product and food manufacture. NDM can be stored and shipped long distances. These products have been common in the dairy industry for 75 years.

Whey powder (WP).

The whey from cheese making has the fat removed with a cream separator and then the liquid whey (ca. 6.2% dry matter) is concentrated using evaporation (condensed liquid whey) and spray dried to form a powder. Condensed whey (ca. 35% dry mater) can be used as a fresh

ingredient in dairy product and food manufacture. Whey powder contains about 11 to 13% protein on dry basis. The major proteins in whey powder are beta-lactoglobulin and alpha-lactalbumin.

Whey protein concentrate (WPC).

The whey from cheese making has the fat removed with a cream separator and then the liquid whey (ca. 6.2% dry matter) solids are fractionated using ultrafiltration, concentrated using evaporation (condensed liquid WPC) and spray dried to form a powder. The key thing is that proteins do not pass through the filter, they are concentrated, and lactose does pass through the filter. The WPC commodity powder contains about 34% protein (like nonfat dry milk). You can think of this as a whey powder with some of the lactose removed. The proteins are whey proteins (beta-lactoglobulin and alpha-lactalbumin) and the milk proteins called caseins formed the cheese. Currently, WPC powders of higher protein content (up to 80%) are being manufactured and sold as food ingredients.

Milk protein concentrate (MPC).

Whole milk is separated into cream and skim milk. The skim milk is fractionated using ultrafiltration to make a lactose-reduced skim concentrate. The skim concentrate can be concentrated further by evaporation and spray dried to form a powder. A typical MPC powder contains about 42% protein (can be made higher if desired) on dry basis and is about 97% dry matter. MPC made by filtration technology is a lactose-reduced nonfat dry milk.

What are some other current milk protein products?

Rennet and acid caseins.

These are precipitation of a casein curd from skim milk followed by washing and drying. The whey proteins are lost from this product. These technically can be manufactured in the US, but currently are not for economic reasons. They are approximately 90% protein on dry basis.

Co-precipitates.

These are prepared by adding calcium chloride or dilute acid to skim milk followed by a heating step to cause a curd formation that captures both the caseins and whey proteins. The products are approximately 90% protein. These technically can be manufactured in the US, but currently are not for economic reasons.

Caseinates.

These are made by treating the rennet or acid casein with alkali (sodium or calcium) and then drying. The products are sodium caseinate and calcium caseinate. The products are approximately 90% protein. This improves the solubility of the caseins for use as an ingredient in foods. These technically can be manufactured in the US, but currently are not for economic reasons.

Milk protein blends.

Combinations of dry milk derived products from whey, casein, co-precipitates, caseins, nonfat dry milk, etc. technically can be blended together to produce a milk protein concentrate look alike from a composition point of view. They can be blended to produce products with a wide

range of compositions for use as custom ingredients in food product manufacture. However, the functionality (i.e., solubility, flavor, etc.) may be very different than milk protein concentrate (MPC) prepared by UF of milk.

What are some new milk protein products that will have an impact in the future?

Micellar Casein Concentrates (MCC).

These are concentrates of the milk proteins that normally form the structure of cheese when milk is used for cheese making. Micellar Casein Concentrates are made by microfiltering milk. These are the larger proteins that do not pass through the microfilter. They are very heat stable and are able to carry a large amount of calcium. They could be used for cheese making, but the more exciting value added applications are in shelf-stable high-quality nutrition beverages. The fresh concentrates can be made to be lactose-free and are extremely heat stable and very bland in flavor. These characteristics makes them an ideal base to formulate nutritional beverages. The casein provide the mouth feel of a beverage that contains fat and these concentrates are ideal to make low-fat "shake" products that are low in fat and lactose-free. Adult nutritional concentrate beverages with greatly improved flavor quality can also be produced using micellar casein concentrates. The fresh liquid micellar casein concentrate as if comes off the filtration system contains about 3 times the protein concentration of skim milk and nearly 3 times the calcium content per serving. Liquid micellar casein concentrate has the whiteness and mouthfeel of a milk that contains about 1.5 to 2% fat.

Milk Soluble Protein Concentrates (MSPC)

These are concentrates of the milk proteins that normally are lost in whey during cheese making and are not retained in the cheese. Milk Soluble Protein Concentrates are made by microfiltering milk. These are the smaller proteins that pass through the microfilter. The fresh concentrates can be made to be lactose-free and are very bland in flavor. The milk soluble proteins are an ideal base to formulate shelf-stable fruit-flavored nutritional beverages and protein fortified juices and drinks. At the concentration of protein found in milk, a fruit drink fortified with milk soluble proteins does not look like or taste like milk. The mouthfeel of the beverage is hardly different from the fruit drink without the protein. As teenage girls decrease their consumption of milk, these milk protein beverages would provide and alternative to deliver nutritional value of milk proteins and calcium without the fat and lactose in a beverage format and presentation that is more attractive to the younger generation.