OVERVIEW

The following technical data sheets provide basic guidelines for composition, physical and chemical aspects, and applications of different whey products.

Whey is a natural dairy product. Just as variations exist in fluid and other dairy products from supplier to supplier, variations also exist in non-standardized whey products. Differences in raw material as well as differences in the processing systems can result in variations in the functional and nutritional properties of whey products. The manufacturing process used and the brand become more important as the protein content is increased and as processing variables are modified to enhance certain properties.

For high-end products, direct communication with the supplier is necessary to ensure exact product specifications, thereby reducing unwanted product variations for high-protein WPCs and WPIs. However, for sweet- and acid-type whey powders, reduced-lactose whey, demineralized whey and WPC34, variations in products are less of a concern to most end-users. The processing techniques most commonly used to manufacture each of the products are summarized in the Figures 4.1, 4.3, 4.4, 4.5, 4.11 and 4.12 in this section.

Most U.S. suppliers will provide technical specifications for their products.

4.1 SWEET WHEY POWDER

Product Definition

Sweet whey powder is obtained by drying fresh whey (derived from the manufacture of cheeses such as Cheddar, Mozzarella and Swiss) that has been pasteurized and to which no preservatives have been added. Sweet whey powder contains all the constituents of fresh whey, except water, in the same relative proportion.

Storage

Store and ship in a cool, dry environment at temperatures of less than 27°C and relative humidity less than 65%. Use within 6-12 months.

Typical Composition*

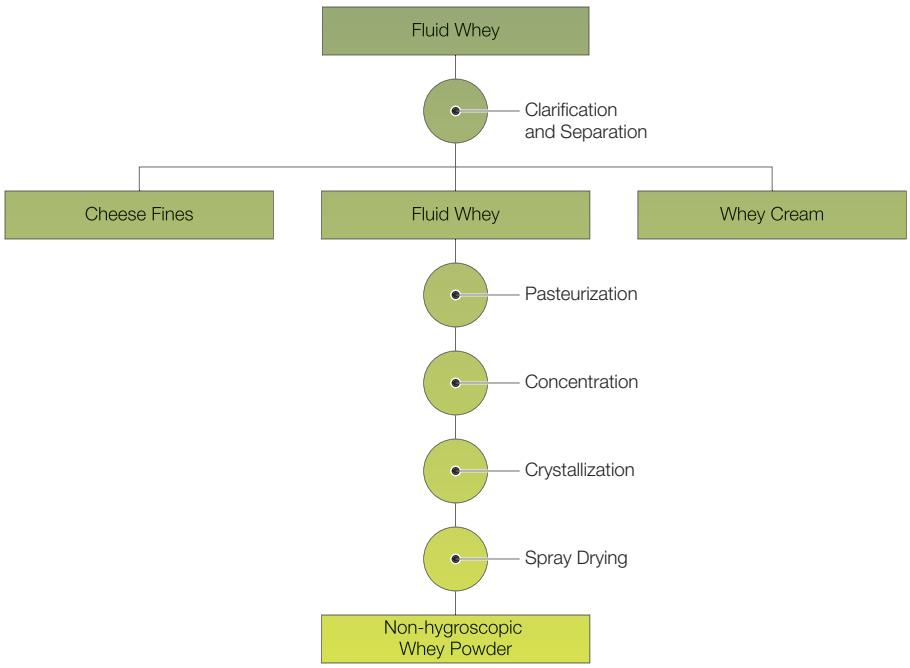
Protein	11.0%–14.5%
Lactose	63.0%–75.0%
Fat	1.0%–1.5%
Ash	8.2%–8.8%
Moisture	3.5%–5.0%

Physical and Chemical Aspects*

Typical microbiological analysis	
Standard Plate Count	≤30,000/g
Coliform	≤10/g
E. coli	Negative/g
Salmonella	Negative/100 g
Listeria	Negative
Coagulase-positive Staphylococci	Negative
Other characteristics	
Scorched particle content	7.5–15.0 mg
Titratable acidity	0.10%–0.15%
Color	Off-white to cream
Flavor	Normal whey flavor

*Please consult your U.S. supplier for detailed product specifications.

Figure 4.1
Processing of Whey Powder



4.2 ACID WHEY POWDER

Product Definition

Acid whey powder is obtained by drying fresh whey (derived from the manufacture of cheeses such as cottage, cream cheese, and ricotta) that has been pasteurized and to which no preservatives have been added. Acid whey powder contains all the constituents of the original acid whey, except water, in the same relative proportion.

Storage

Store and ship in a cool, dry environment at temperatures of less than 27°C and relative humidity less than 65%. Use within 6-12 months.

Typical Composition*

Protein	11.0%–13.5%
Lactose	61.0%–70.0%
Fat	0.5%–1.5%
Ash	9.8%–12.3%
Moisture	3.5%–5.0%

Physical and Chemical Aspects*

Typical microbiological analysis	
Standard Plate Count	≤30,000/g
Coliform	≤10/g
E. coli	Negative/g
Salmonella	Negative/100 g
Listeria	Negative
Coagulase-positive Staphylococci	Negative
Other characteristics	
Scorched particle content	7.5–15.0 mg
Titratable acidity	0.35%–0.44%
Color	Off-white to cream
Flavor	Normal whey flavor, slight acid

*Please consult your U.S. supplier for detailed product specifications.

4.3 REDUCED LACTOSE WHEY

Product Definition

Reduced lactose whey is obtained by the selective removal or hydrolysis of lactose from whey. The lactose content of the dry product may not exceed 60%. Reduction of lactose is accomplished by physical separation techniques such as precipitation or filtration or by enzymatic hydrolysis of lactose to glucose and galactose. The acidity of reduced lactose whey may be adjusted by the addition of safe and suitable ingredients.

Storage

Store and ship in a cool, dry environment at temperatures of less than 27°C and relative humidity less than 65%. Use within 6-9 months.

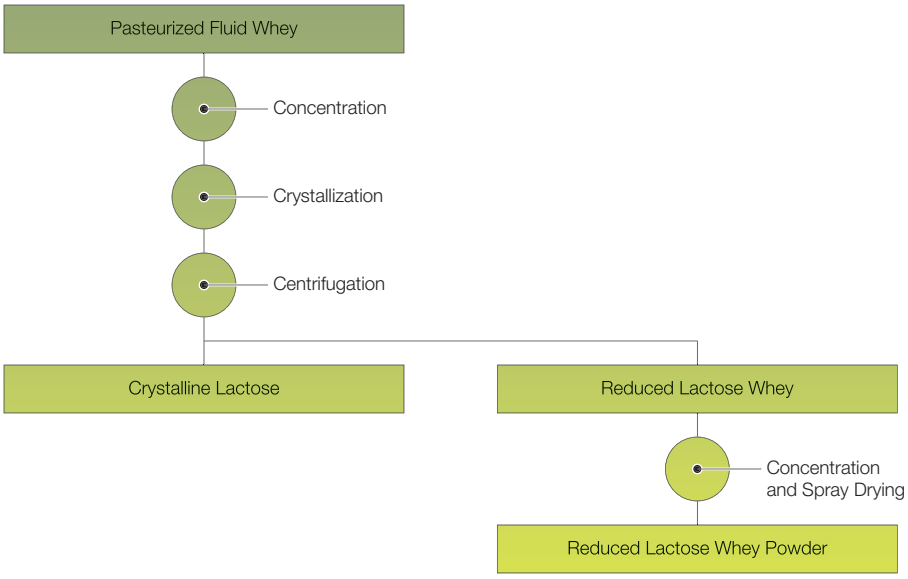
Typical Composition*

Protein	18.0%–24.0%
Lactose	52.0%–58.0%
Fat	1.0%–4.0%
Ash	11.0%–22.0%
Moisture	3.0%–4.0%

Physical and Chemical Aspects*

Typical microbiological analysis	
Standard Plate Count	≤30,000/g
Coliform	≤10/g
E. coli	Negative/g
Salmonella	Negative/100 g
Listeria	Negative
Coagulase-positive Staphylococci	Negative
Other characteristics	
Scorched particle content	7.5–15.0 mg
Color	Cream to dark cream
Flavor	Normal whey flavor

Figure 4.3
Processing of Reduced Lactose Whey



4.4 DEMINERALIZED WHEY

Product Definition

Demineralized whey (also called reduced-minerals whey) is obtained by removing a portion of the minerals from pasteurized whey. Typical levels of demineralization are 25%, 50%, and 90%. The dry product may not exceed 7% ash. Demineralized whey is produced by separation techniques such as ion exchange, diafiltration or electrodialysis. The acidity of demineralized whey may be adjusted by the addition of safe and suitable ingredients.

Storage

Store and ship in a cool, dry environment at temperatures of less than 27°C and relative humidity less than 65%. Use within 9-12 months.

Typical Composition*

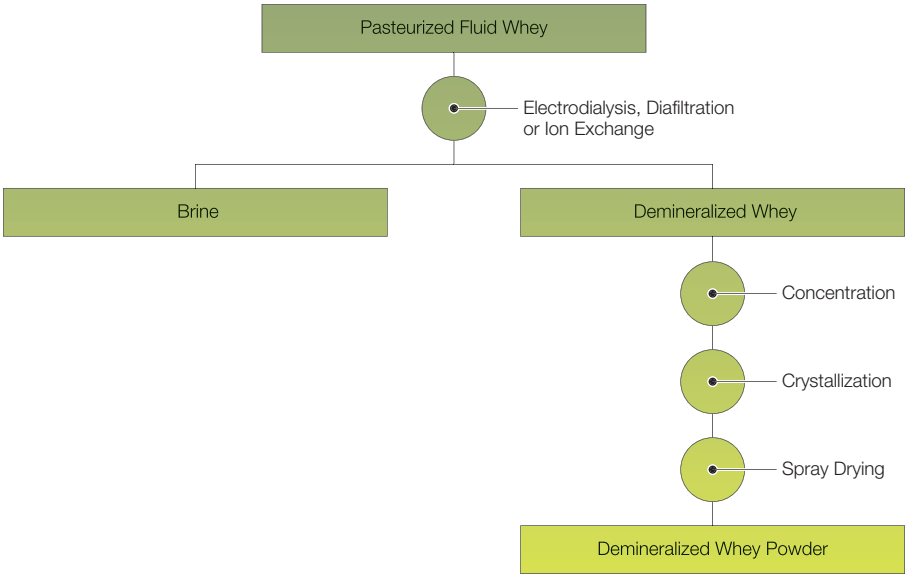
Protein	11.0%–15.0%
Lactose	70.0%–80.0%
Fat	0.5%–1.8%
Ash	1.0%–7.0%
Moisture	3.0%–4.0%

Physical and Chemical Aspects*

Typical microbiological analysis	
Standard Plate Count	≤30,000/g
Coliform	≤10/g
E. coli	Negative/g
Salmonella	Negative/100 g
Listeria	Negative
Coagulase-positive Staphylococci	Negative
Other characteristics	
Scorched particle content	7.5–15.0 mg
pH	6.2–7.0
Color	Cream to dark cream
Flavor	Less salty whey flavor

*Please consult your U.S. supplier for detailed product specifications.

Figure 4.4
Processing of Demineralized Whey



4.5 WHEY PROTEIN CONCENTRATE 34% PROTEIN (WPC34)

Product Definition

Whey protein concentrate is obtained by removing sufficient non-protein constituents from pasteurized whey so that the finished dry product contains not less than 34% protein. WPC34 is produced by membrane separation processes. Acidity may be adjusted by the addition of safe and suitable ingredients.

Storage

Store and ship in a cool, dry environment at temperatures of less than 27°C and relative humidity less than 65%. Use within 9-12 months.

Typical Composition*

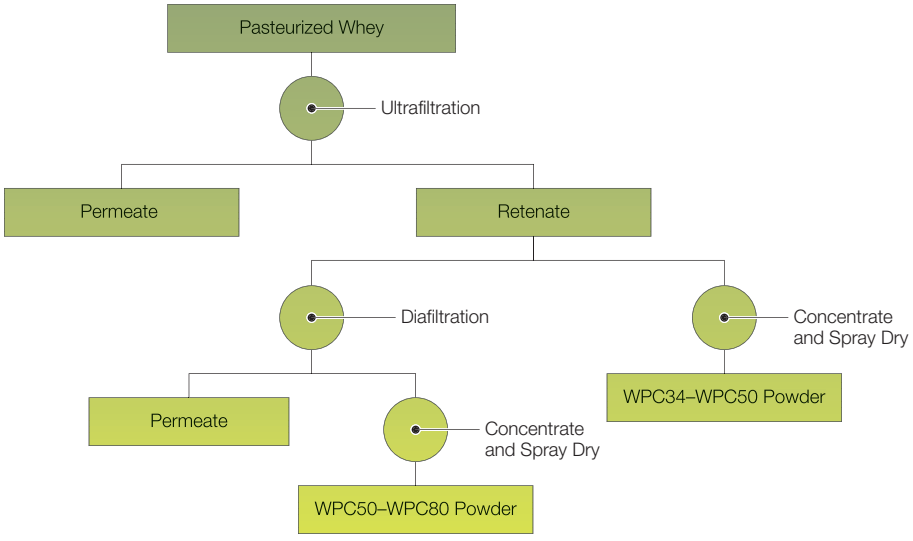
Protein	34.0%–36.0%
Lactose	48.0%–52.0%
Fat	3.0%–4.5%
Ash	6.5%–8.0%
Moisture	3.0%–4.5%

Physical and Chemical Aspects*

Typical microbiological analysis	
Standard Plate Count	≤30,000/g
Coliform	≤10/g
E. coli	Negative/g
Salmonella	Negative/100 g
Listeria	Negative
Coagulase-positive Staphylococci	Negative
Other characteristics	
Scorched particle content	7.5–15.0 mg
pH	6.0–6.7
Color	White to light cream
Flavor	Bland, clean

*Please consult your U.S. supplier for detailed product specifications.

Figure 4.5
Processing of Whey Protein Concentrates



Heat Stability of Whey Protein Concentrates

By DR. A. HUGUNIN
Consultant,
Pleasanton, CA

The heat stability of whey protein concentrates in food systems is influenced by a variety of factors such as pH, duration and intensity of the heat treatment, amount of calcium and presence of other ingredients.

Specifically, the following factors influence heat stability:

- Temperature >75°C
- Acidity, pH 3.5-6.0
- Protein concentration >5%
- Calcium and magnesium
- Lactose, sugar and fat concentration

In UHT-treated beverages, whey proteins can be denatured and flocculate if the process is not controlled and the formula adapted as needed. Manufacturers can also modify the production process to increase the heat-stability of whey proteins.

A typical heat stability test for heat-resistant whey protein concentrates included preparing a 100 ml solution of an 8% solution of WPC, heating to 70°C, cooling down to room temperature, autoclaving at 125°C for 10 minutes, cooling to room temperature, filtering the solution and measuring solids in the filtrate. The ingredient is considered heat-stable if over 95% of the solids pass through the filter (measured as % solids in filtrate/original solids).

Test method courtesy of Glanbia Nutritionals USA.

4.6 WHEY PROTEIN CONCENTRATE 50% PROTEIN (WPC50)

Product Definition

Whey protein concentrate is obtained by removing sufficient non-protein constituents from pasteurized whey so that the finished dry product contains not less than 50% protein. WPC50 is produced by membrane separation processes. Acidity may be adjusted by the addition of safe and suitable ingredients.

Storage

Store and ship in a cool, dry environment at temperatures of less than 27°C and relative humidity less than 65%. Use within 9-12 months.

Typical Composition*

Protein	50.0%–52.0%
Lactose	33.0%–37.0%
Fat	5.0%–6.0%
Ash	4.5%–5.5%
Moisture	3.5%–4.5%

Physical and Chemical Aspects*

Typical microbiological analysis	
Standard Plate Count	≤30,000/g
Coliform	≤10/g
E. coli	Negative/g
Salmonella	Negative/100 g
Listeria	Negative
Coagulase-positive Staphylococci	Negative
Other characteristics	
Scorched particle content	7.5–15.0 mg
pH	6.0–6.7
Color	White to light cream
Flavor	Bland, clean

4.7 WHEY PROTEIN CONCENTRATE 60% PROTEIN (WPC60)

Product Definition

Whey protein concentrate is obtained by removing sufficient non-protein constituents from pasteurized whey so that the finished dry product contains not less than 60% protein. WPC60 is produced by membrane separation processes. Acidity may be adjusted by the addition of safe and suitable ingredients.

Storage

Store and ship in a cool, dry environment at temperatures of less than 27°C and relative humidity less than 65%. Use within 9-12 months.

Typical Composition*

Protein	60.0%–62.0%
Lactose	25.0%–30.0%
Fat	1.0%–7.0%
Ash	4.0%–6.0%
Moisture	3.0%–5.0%

Physical and Chemical Aspects*

Typical microbiological analysis	
Standard Plate Count	≤30,000/g
Coliform	≤10/g
E. coli	Negative/g
Salmonella	Negative/100 g
Listeria	Negative
Coagulase-positive Staphylococci	Negative
Other characteristics	
Scorched particle content	7.5–15.0 mg
pH	6.0–6.7
Color	White to light cream
Flavor	Bland, clean

4.8 WHEY PROTEIN CONCENTRATE 75% PROTEIN (WPC75)

Product Definition

Whey protein concentrate is obtained by removing sufficient non-protein constituents from pasteurized whey so that the finished dry product contains not less than 75% protein. WPC75 is produced by membrane separation processes. Acidity may be adjusted by the addition of safe and suitable ingredients.

Storage

Store and ship in a cool, dry environment at temperatures of less than 27°C and relative humidity less than 65%. Use within 9-12 months.

Typical Composition*

Protein	75.0%–78.0%
Lactose	10.0%–15.0%
Fat	4.0%–9.0%
Ash	4.0%–6.0%
Moisture	3.0%–5.0%

Physical and Chemical Aspects*

Typical microbiological analysis	
Standard Plate Count	≤30,000/g
Coliform	≤10/g
E. coli	Negative/g
Salmonella	Negative/100 g
Listeria	Negative
Coagulase-positive Staphylococci	Negative
Other characteristics	
Scorched particle content	7.5–15.0 mg
pH	6.0–6.7
Color	White to light cream
Flavor	Bland, clean

*Please consult your U.S. supplier for detailed product specifications.

4.9 WHEY PROTEIN CONCENTRATE 80% PROTEIN (WPC80)

Product Definition

Whey protein concentrate is obtained by removing sufficient non-protein constituents from pasteurized whey so that the finished dry product contains not less than 80% protein. WPC80 is produced by membrane separation processes.

Storage

Store and ship in a cool, dry environment at temperatures of less than 27°C and relative humidity less than 65%. Use within 9-12 months.

Typical Composition*

Protein	80.0%–82.0%
Lactose	4.0%–8.0%
Fat	4.0%–8.0 %
Ash	3.0%–4.0%
Moisture	3.5%–4.5%

Physical and Chemical Aspects*

Typical microbiological analysis	
Standard Plate Count	≤30,000/g
Coliform	≤10/g
E. coli	Negative/g
Salmonella	Negative/100 g
Listeria	Negative
Coagulase-positive Staphylococci	Negative
Other characteristics	
Scorched particle content	7.5–15.0 mg
pH	6.0–6.7
Color	White to light cream
Flavor	Bland, clean

*Please consult your U.S. supplier for detailed product specifications.

4.10 WHEY PROTEIN ISOLATE (WPI)

Product Definition

Whey protein isolate is obtained by removing sufficient non-protein constituents from whey so that the finished dry product contains not less than 90% protein. WPI is produced by membrane separation processes or ion exchange.

Storage

Store and ship in a cool, dry environment at temperatures of less than 27°C and relative humidity less than 65%. Use within 9-12 months.

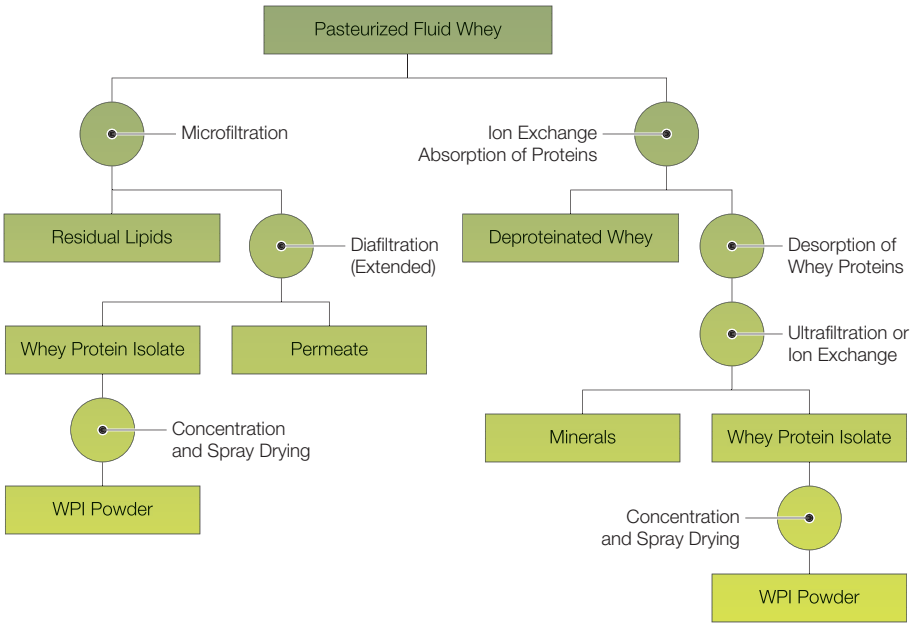
Typical Composition*

Protein	90.0%–92.0%
Lactose	0.5%–1.0%
Fat	0.5%–1.0%
Ash	2.0%–3.0%
Moisture	4.5%

Physical and Chemical Aspects*

Typical microbiological analysis	
Standard Plate Count	≤10–30,000/g
Coliform	≤10/g
E. coli	Negative/g
Salmonella	Negative/100 g
Listeria	Negative
Coagulase-positive Staphylococci	Negative
Other characteristics	
Scorched particle content	7.5–15.0 mg
Color	Cream
Flavor	Bland, clean

Figure 4.10
Processing of Whey Protein Isolate



4.11 LACTOFERRIN

Product Definition

Lactoferrin is a 78 kilodalton glycoprotein consisting of single polypeptide chain linked to two glycans by N-glycosidic linkages. Its average concentration in cow's milk is 10 mg/l but lactoferrin is found in higher concentration in whey protein products: 30-100 mg/l of sweet whey. Lactoferrin is now produced commercially using cation exchange cross-flow membranes. It can also be isolated by chromatography and other methods. Lactoferrin is not only a source of amino acids but also a regulatory factor with broad biological roles that have been well documented.

Typical Composition*

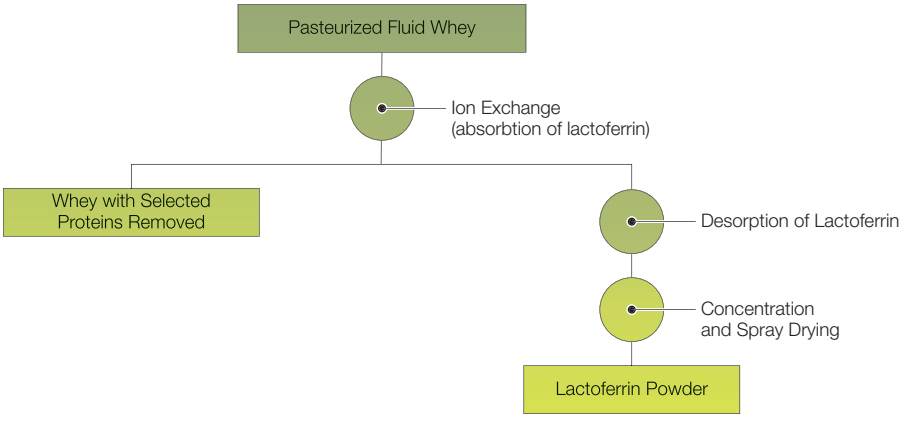
Protein content	>90%
Lactoferrin purity	>90%
Moisture	<5%
Ash	<1.5%
Iron saturation	
Low	<10 mg/100 g of protein
Medium	35 mg/100 g of protein
High	>100 mg/100 g of protein

Physical and Other Characteristics*

Form	Powder
pH	6–7
Solubility	>99%
Iron binding capacity	>85%
Standard Plate Count	<1000 cfu/g
Coliform	<10 cfu/g
Salmonella	0 cfu/g

*Please consult your U.S. supplier for detailed product specifications.

Figure 4.11
Processing of Lactoferrin



Functions and Benefits of Lactoferrin

Antibacterial Properties of Lactoferrin

Bactericidal and bacteriostatic activities have been attributed to the iron-scavenging properties of lactoferrin. Lactoferrin binds iron very strongly and makes this essential component unavailable to bacteria. Evidence from a number of studies, however, indicates that the antimicrobial mechanism of lactoferrin is more complex than simple nutritional deprivation. Other bacterial inhibitory effects have been ascribed to the binding of lactoferrin to enterocyte lactoferrin receptors. It was also found that bovine milk-derived lactoferrin was more potent than human lactoferrin against various Gram-negative and Gram-positive bacteria at concentrations between 0.3 µM and 3.0 µM. In another study on animals, lactoferrin appeared to protect against septic shock, an often fatal complication of bloodstream infections. Those who are particularly vulnerable to septic shock include the elderly, surgical patients and people with AIDS or other conditions that disable the immune system. Antiviral effects of lactoferrin against several types of human viruses have also been reported.

Inhibition of Free Radicals

Another biological function ascribed to lactoferrin is the protection against oxidative damage, by scavenging excess iron that catalyzes the undesired formation of free radicals. The excess formation of free radicals such as superoxides or hydroxyl radicals are among the main causes of the skin damage characterized by the appearance of wrinkles and other aging symptoms.

Iron Transport

Although considerable attention has been paid to many functions of lactoferrin, its primary nutritional contribution is presumed to be related to its iron-binding characteristics. Several studies have demonstrated that iron-saturated lactoferrin is an effective form of transport for iron in the diet. Lactoferrin is used in infant formulas to improve iron balance. Iron-saturated lactoferrin is a good source of readily bioavailable supplemental iron that can be used in dietary supplements, sports drinks and bars, and foods formulated specially for women. An additional advantage is that lactoferrin does not induce constipation as some inorganic iron supplements may. In Japan, new patents have focused on using iron-saturated lactoferrin to enrich foods such as fats and oils.

Milk and Dairy Products in Cancer Prevention: Focus on Lactoferrin

Milk and dairy products constitute an important part of the Western style diet. A large number of epidemiological studies have been conducted to determine effects of consumption on cancer development. It has been proposed that, whereas fats in general could promote tumor development, individual milk fats like conjugated linoleic acid could exert inhibitory effects. There is also considerable evidence that calcium in milk products protects against colon cancer. According to recent research reports, whey proteins may also be beneficial, as shown in human and animal studies. Experimental data have demonstrated that bovine lactoferrin inhibits colon carcinogenesis in the post initiation stage in animal studies. Results of other animal models have provided further indication that lactoferrin might find applications as a natural ingredient of milk with potential for chemoprevention of colon and other cancers.

Tsuda, U. et al. Milk and dairy products in cancer prevention: focus on bovine lactoferrin. Mutat. Res. 2000. (4)462:227-33.

Promotion of Cell Growth, Stimulation of Immunity

Lactoferrin has been shown to have beneficial effects on cell growth at the intestinal level. Lactoferrin ingestion may lead to more rapid restoration of normal digestive functions.

Recently, a few studies indicated that lactoferrin can stimulate a variety of cells of the immune defense system. Lactoferrin may present benefits as a supplement for the elderly or individuals with compromised immunity.

Antioxidant

Lactoferrin has the ability to bind and transport free iron and other divalent metal ions that catalyze the formation of superoxide radicals. This ability makes lactoferrin a potential inhibitor of oxidative processes that are metal-ion catalyzed. In that respect, lactoferrin has antioxidant properties. A Japanese patent describes a functional food product containing oils and fats fortified with iron in the form of iron-lactoferrin. The iron-lactoferrin acts both as a source of iron and as an antioxidant for the oil and fat in the food.

Stimulation of Bifidobacteria

Lactoferrin has been reported to stimulate the growth of Bifidobacteria. The importance of lactoferrin as a potent growth promoter of some strains of Bifidobacteria has been confirmed in recent studies. For this reason and the ones listed above, lactoferrin appears to be a health enhancing ingredient that offers benefits in dairy foods and other nutraceuticals formulated with probiotic cultures. Studies on infants have shown that supplementation with lactoferrin (100 mg/100 ml of formula) resulted in increased concentrations of Bifidobacterium species after three months of feeding.

Current Applications for Lactoferrin

Increased demand for natural antibiotics and for components to supplement infant formula and other specialty foods has stimulated interest in the isolation and effective utilization of lactoferrin. Lactoferrin is available commercially with different levels of iron saturation, ranging from <10 mg/10 g to over 100 mg/100 g of protein (see specification table). Products with a high level of iron can provide iron supplementation, while lactoferrin with low saturation is used for its bactericidal and bacteriostatic properties.

The major use for lactoferrin to date is infant formula. The addition of lactoferrin enriches the formulas, making them more similar to human milk, which naturally contains 20 more times lactoferrin. Iron-saturated lactoferrin is also utilized to enhance the absorption of iron.

Non-food uses of lactoferrin have developed in recent years. For example, the antibacterial activity of lactoferrin is utilized in toothpaste and mouthwash. An antibacterial mouthwash, for example, contains a combination of lactoferrin, lactoperoxidase and lysozyme.

4.12 LACTOPEROXIDASE

Product Definition

Lactoperoxidase is a glycoprotein with a molecular weight of 77.5 kilodaltons. It is an enzyme and natural anti-microbial agent present in sweet whey at a concentration of about 1-30 mg/l. Lactoperoxidase is part of a group of enzymes, which has antibacterial effects. Whey-based lactoperoxidase is relatively heat resistant.

Stability and Storage

Lactoperoxidase should be stored at 2-8°C. It is stable for over 6 months.

Typical Composition*

Protein	92%
Moisture	5%
Ash	3%

Physical and Other Characteristics*

Form	Green/brown powder
pH	6–7
Solubility (at <2% in water)	>99.9%
Standard Plate Count	<1000 cfu/g
Coliforms	<1/g
Staph. Aureus	Neg. in 1 g
Salmonella	Neg. in 5 g
Yeasts and mold	<10/g

*Please consult your U.S. supplier for detailed product specifications.

Function and Benefits of Lactoperoxidase

Antibacterial, Preservative Effects

Lactoperoxidase inactivates or kills a broad spectrum of microorganisms through an enzymatic reaction. The reaction involves two co-factors, hydrogen peroxide and thiocyanate ions, which, together with lactoperoxidase, constitute the lactoperoxidase system. Lactoperoxidase can inhibit certain Gram-negative bacteria (including E. coli and some strains of Salmonella) and is bacteriostatic against Gram-positive bacteria. The effectiveness of the lactoperoxidase system is dependent upon environmental conditions such as pH, temperature and cell density. In the presence of hydrogen peroxide and thiocyanate, the enzyme has an antibacterial effect against Gram-negative bacteria.

The lactoperoxidase system is a major part of the antibacterial activity in milk. The natural occurrence of lactoperoxidase can be used in the preservation of milk. Recently, lactoperoxidase has been added to yogurts to prevent additional acid production during storage.

Current Applications for Lactoperoxidase

Nutritional Products

Protection of intestinal flora, milk replacer or electrolyte additive to substitute for the use of antibiotics in the prevention of some neonatal infections.

Personal Care Products

Mouth care and skin care products, for the prevention of cavities and gingival infections, to prevent skin infections.

Based on clinical evidence, brushing teeth with toothpaste supplemented with lactoperoxidase reduces dental caries. Lactoperoxidase is also used in cosmetics and personal care items such as mouthwash, shampoos, and acne preparations.

Dairy Products

Preservation systems.

4.13 GMP (GLYCOMACROPEPTIDE)

Product Definition

Glycomacropeptides are isolated from fresh cheese whey using unique ion exchange and membrane technology. The powder is light colored, homogeneous, and free flowing. The flavor of the product is clean, and bland.

The glycosylated portion of caseino-macropeptide (CMP) is formed by rennin cleaving k-casein from the casein micelle. Rennin is used only with cheeses that produce sweet whey, therefore GMP will not be present in acid whey. Rennin is a protease secreted in the neonate's stomach, suggesting that glycomacropeptide normally accompanies whey proteins rather than caseins through the intestinal tract. Glycomacopeptide can suppress appetite via stimulation of pancreatic hormone cholecystokinin (CCK) release, alter pigment production in melanocytes, act as a prebiotic and has immunomodulatory actions. Physiologic activity of GMP depends upon its glycosylation.

Storage

Store at temperatures below 25°C, relative humidity below 65% and in an odor free environment.

Typical Composition*

Purity	97% ± 1%
Lactose	<1.0%
Fat	0.6% ± 0.2%
Ash	6.3% ± 0.2%
Moisture	6.0% ± 0.2%

Physical and Chemical Aspects*

Typical microbiological analysis	
Standard Plate Count	<2,500/g
Coliform	<10/g
E. coli	Negative
Salmonella	Negative
Listeria	Negative
Coagulase-positive Staphylococci	Negative
Other characteristics	
Color	Light colored
Flavor	Clean, bland

4.14 DAIRY PRODUCTS SOLIDS (PERMEATE)

Product Definition

This term is used to designate a "family" of products which have common specifications: 59% minimum lactose; 10% maximum protein and; 27% maximum ash. Examples of products meeting these specifications are permeate and de-proteinized whey, as well as other products which are often marketed under a brand name.

Manufacturers in the United States can use the term "dairy products solids," "de-proteinized whey," "modified whey" and "reduced protein whey" on the ingredient label.

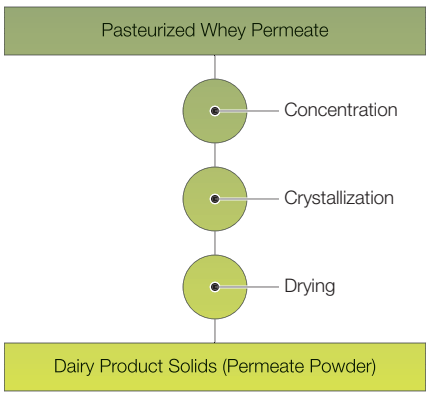
Permeate

For the purpose of this manual, whey permeate is defined as a source of dairy solids obtained by the removal of protein and some minerals and lactose from whey. The separation is accomplished by ultrafiltration and diafiltration. The product is appropriately labeled to reflect protein, ash, and lactose content. The acidity of permeates may be adjusted by the addition of safe and suitable ingredients. Permeates represent an economical source of dairy solids for food and feed applications.

The major products are:

- Feed grade permeate
- Food grade permeate

Figure 4.14
Processing of Permeate



Feed Grade Permeate
Typical Composition*

Protein	3.5–4%
Lactose	82.0%
Fat	0.2%
Ash	8.5%
Moisture	4–5%
Calcium	800 mg/100 g
Phosphorus	600 mg/100 g
Sodium	1000 mg/100 g
Magnesium	180 mg/100 g

Food Grade Permeate
Typical Composition*

Protein	3.0 –8.0%
Lactose	65.0–85.0%
Fat	1.5% (maximum)
Ash	8.0–20.0%
Moisture	3.0–5.0%
Calcium	870 mg/100 g
Phosphorus	720 mg/100 g
Sodium	570 mg/100 g
Magnesium	130 mg/100 g

Physical and Chemical Aspects*

Typical microbiological analysis	
Standard Plate Count	<30,000/g
Coliform count	<10/g
Listeria	Negative
Salmonella	Negative
Coagulase-positive Staphylococci	Negative
Other characteristics	
Scorched particle content	7.5–15.0 mg
pH	5.7–6.5
Color	White to cream
Flavor	Salty, slightly sweet
Appearance	Free-flowing powder

*Please consult your U.S. supplier for detailed product specifications.

Feed Applications

Whey products, including high-carbohydrate permeate, are consumed by a wide variety of animal species. The greatest utilization in the feed industry is by swine. Dairy and veal calves, dogs and cats, poultry and other animals nutritionally benefit from the uses of whey products in rations.

Food Applications

- Functions as a direct replacement of other dairy solids in many applications.
- Dissolves easily and blends uniformly.
- Functions as a source of lactose and proteins in bakery blends and products:
  - to give the brown crust in bakery blends and products.
  - to improve the appearance, color, flavor and texture of the finished product.
  - to reduce levels of sweeteners such as sucrose or corn syrups in bread applications.
  - to extend shortenings, giving more richness with minimum fat in piecrusts.

Other Uses and Benefits

Permeates as Media for Yeast

Permeates can be used as a medium to grow some types of yeast. In this process, a 65% protein permeate-yeast product can be produced to be fed to swine and other animals.

Permeates as Media for Other Fermentations

Permeates can be used as a medium to produce:

- Lactic acid, acetic acid, calcium magnesium acetate, citric acid and propionate
- Ethanol
- Methane
- Single cell proteins
- Glycerol
- Lipids and oils

Typical Applications

For feed, bakery, confectionery, fermentation, and other food and non-food products as:

- A cost-efficient source of lactose and other dairy solids in calf milk replacers, and swine feeding programs.
- A source of lactose and other dairy solids in bakery, confectionery products.
- An ingredient in yeast-leavened products.
- A raw material for fermentation medium in producing bacteriosin.
- A source of hydrolyzed permeates.

4.15 MINERAL-CONCENTRATED WHEY (REDUCED LACTOSE WHEY)

Product Definition

Mineral-concentrated whey is produced by the partial removal of lactose from whey. The mineral concentrated whey is spray-dried to provide a highly functional ingredient. Products defined as mineral-concentrated whey are:

- Reduced lactose whey
- Fractionated whey

Reduced lactose whey is defined in the U.S. Code of Federal Regulations (21 CFR 184.1979 (a)(2) 1991) as the substance obtained by the removal of lactose from whey. The lactose content of the finished dry product shall not exceed 60%. Removal of the lactose is accomplished by physical separation techniques such as crystallization, filtration, or dialysis. As with whey, reduced lactose whey can be used as a fluid, concentrate, or a dry product form. The acidity of reduced lactose whey may be adjusted by the addition of safe and suitable pH-adjusting ingredients.

Mineral-concentrated whey also functions to improve texture, flavor, solubility, and nutritional profile in food formulations. Foods containing mineral-concentrated whey will have a higher nutrient density than other comparable products.

The functions and benefits are:

- Good solubility, heat stability and economy.
- Lower lactose content helps minimize texture problems caused by lactose crystallization.
- High protein and mineral content helps provide the flavor and smooth texture desired in food products. Proteins contribute to the structure, texture, and integrity of the finished products by delivering the dispersibility and suspension characteristics of a colloidal system with the added benefit of an evenly distributed calcium content during processing.
- Conveys a milky flavor, helps emulsify added fats, provides good solubility and heat stability in sauces and gravies.
- A rich source of calcium, magnesium and phosphorus, which enhances nutritional value and flavor profile in comminuted meat products and sauces.

Typical Applications

For dairy, meat, confectionery, bakery, snacks, seasonings, soups, sauces and gravies, dry mixes, follow-up formula, frozen desserts, and nutritional soft drinks as:

- A cost-efficient source of dairy solids with a high mineral content.
- An alternative to other calcium sources or milk powders, when lower lactose concentrations are desired and higher mineral concentration is required.
- A nutritional ingredient in powdered beverages, nutritional drinks, dairy products, powdered soups and desserts and baked goods.

Reduced Lactose Whey

Typical Composition*

Protein	18.0–24.0%
Lactose	50.0–60.0%
Fat	2.5% (maximum)
Ash	14.0–22.0%
Moisture	3.0–5.0%
Calcium	940 mg/100 g
Magnesium	220 mg/100 g
Phosphorus	1,150 mg/100 g
Potassium	4,400 mg/100 g
Sodium	1,840 mg/100 g

Physical and Chemical Aspects*

Typical microbiological analysis	
Standard Plate Count	10,000/g
Coliform count	10/g
E. coli	Negative
Listeria	Negative
Salmonella	Negative
Coagulase-positive Staphylococci	Negative
Other characteristics	
Scorched particle content	15.0 mg/25 g (maximum)
Appearance	Free-flowing powder
Color	Light cream
Flavor	Clean, slightly salty, whey flavor

*Please consult your U.S. supplier for detailed product specifications.

4.16 DAIRY MINERALS, CALCIUM

Whey Products as Source of Calcium

Calcium can be obtained in diet by various sources, but the most highly recommended source is dairy products. Dairy products are a significant source of calcium with high bioavailability. The ingredient milk calcium is derived from milk by a unique separation technique. Whey-based products are an excellent and cost-efficient source of dairy calcium.

Photo courtesy: Glanbia Nutritionals USA

Functions and Benefits of Dairy Calcium

- Dairy calcium is 100% natural (all natural "clean" label appeal) and contains a range of other minerals, such as phosphorus and magnesium.
- Dairy calcium contains very low levels of materials such as lead and aluminum, compared to some other sources of calcium.
- Calcium absorption from dairy sources is determined by the physiological need of the body for calcium, and when that need is high, essentially all of the dairy calcium is available for absorption. Sources of dairy calcium are more readily absorbed by the gastrointestinal tract than other sources, such as calcium carbonate, resulting in a relatively higher bioavailability.
- Calcium absorption from dairy sources is higher by Beta-galactosidase-deficient subjects than by subjects with a regular Beta-galactosidase.
- Lactose increases the dairy calcium absorption and bioavailability in infants compared to sucrose and starch hydrolyzates.
- Research studies link a higher calcium intake (1,575 mg/day) from dairy calcium during the first 20 weeks of pregnancy with a lower risk of gestational hypertension.
- Recommendations to consume dairy calcium as a way to meet calcium requirements also provides an opportunity to increase intake of potassium and magnesium, which have been linked with reduced risk of hypertension.
- The risk of consuming excessive amounts of calcium is also lower with dairy foods than with calcium supplements.

Range of Commercial Products Available

Whey products represent an ideal economical source for dairy calcium. The products are:

- Whey Powders
  - Sweet-type
    700-800 mg calcium/100 g
  - Acid-type
    2,054 mg calcium/100 g
- Reduced lactose whey
  800-900 mg calcium/100 g
- Whey protein concentrates
  500-700 mg calcium/100 g
- Whey protein isolates
  100-300 mg calcium/100 g
- Deproteinized whey
  600-700 mg calcium/100 g
- Whey permeate
  800-900 mg calcium/100 g
- Milk calcium minerals
  Approx. 23-28 g calcium/100 g

Milk Calcium Minerals and Concentrates

Product Description

Milk calcium minerals are a natural milk calcium that is predominantly in the form of calcium phosphate. There are various types of natural milk calcium products although most are fractionated from whey by one of several different isolation techniques, dried, and then ground into fine powders.

Production Processes

There are several different processes that can be used to manufacture milk minerals. The following is an example, please contact your supplier for specific and detailed information.

Typical Composition*

Calcium	23–28.0%
Phosphorus	13.0–14.00%
Ca: P ratio	1.7:1–2:1
Total Minerals	76.0–77.5%
Moisture	4.0%–7.0%
Protein	1.0–8.0%
Lactose	1.0–6.0%

Physical and Chemical Aspects*

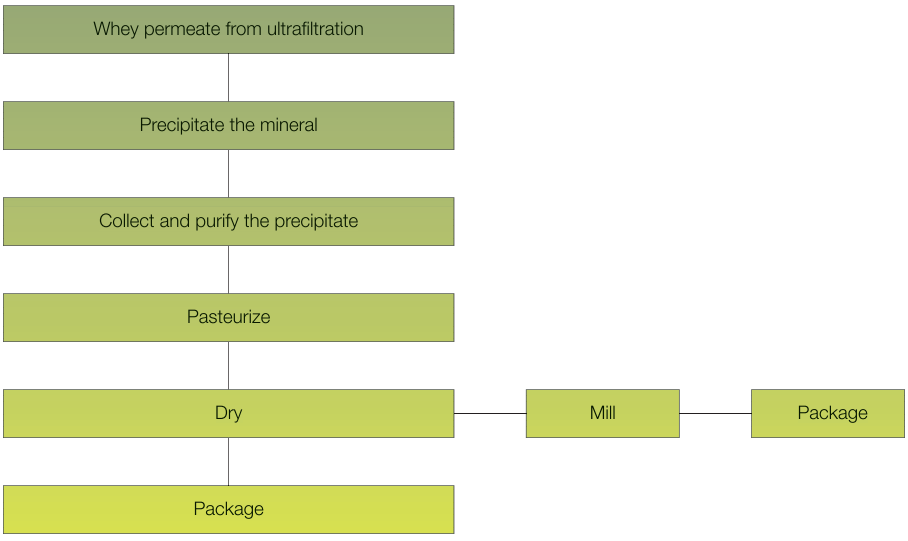
Typical microbiological analysis	
Standard Plate Count	<10,000/g
Coliform	<10/g
Coagulase-positive Staphylococci	Negative
Listeria	Negative/50 g
Salmonella	Negative/50 g
Other characteristics	
Appearance	Free-flowing powder
Color	White to cream color
pH (10%)	6.5–7.5 (may vary)
Particle size	Coarse: 95% <10 µm Fine: 95% <100 µm

*Please consult your U.S. supplier for detailed product specifications.

Typical Applications

- Nutritional supplements, such as tablets, capsules, nutritional bars, chews
- Calcium-fortified foods, such as baked goods, processed meats, dairy and confectionery products
- Calcium-fortified beverages, such as juices and dairy drinks

Figure 4.16
Processing of Milk Minerals



Information courtesy of Glanbia USA.