

## Protein Products from Whey: Dr. J. S. Pai

Since whey is a natural product, there are variations in the composition in products from different suppliers. Differences in raw material as well as the process used can result in the product variation in functional and nutritional attributes. There are many different products available from whey.

Sweet Whey Powder is produced from drying fresh whey obtained from various manufacturing processes of cheeses like cheddar, mozzarella, swiss etc. This product is prepared by pasteurising whey and drying it. Since only water has been removed, the product has all the other component in the same proportion as in whey. It does not contain any preservative and can last for 6-12 months if kept in cool and dry place.

Acid Whey Powder is obtained by drying the whey from the manufacture of cheeses such as cottage, cream cheese and ricotta and has about the same shelf life as sweet whey powder. It has slightly less lactose as some lactose has undergone fermentative change to lactic acid.

	Acid Whey Powder	Whey	Sweet Whey Powder	Whey	Reduced Lactose Whey	Reduced mineral whey	Whey Protein Conc.	Whey Protein Isolate
Protein	11.0%–13.5%		11.0%–14.5%		18.0%–24.0%	11.0%–15.0%	34.0%–36.0%	90.0%–92.0%
Lactose	61.0%–70.0%		63.0%–75.0%		52.0%–58.0%	70.0%–80.0%	48.0%–52.0%	0.5%–1.0%
Fat	0.5%–1.5%		1.0%–1.5%		1.0%–4.0%	0.5%–1.8%	3.0%–4.5%	0.5%–1.0%
Ash	9.8%–12.3%		8.2%–8.8%		11.0%–22.0%	1.0%–7.0%	6.5%–8.0%	2.0%–3.0%
Moisture	3.5%–5.0%		3.5%–5.0%		3.0%–4.0%	3.0%–4.0%	3.0%–4.5%	4.5%

Reduced Lactose Whey is obtained by removing lactose from whey either by hydrolysis or by physical separation by crystallisation and filtration. Lactose content of the product is generally less than 60%. If the removal is accomplished by enzymatic hydrolysis, then glucose and galactose will be present in whey in proportion to lactose reduction. Both protein and ash content increases in this product substantially compared to whey powders.

Demineralised (or reduced mineral) whey is obtained by removal of part of the minerals from pasteurised whey. The extent of removal can be 25%, 50% or 90%. The dry product usually has ash content less than 7%. Minerals are removed by several techniques such as ion exchange, diafiltration and electro dialysis. This product if kept in cool and dry place, can have a shelf life of 9-12 months.

Whey Protein Concentrate is obtained by removing sufficient non-protein constituents from pasteurised whey so that the finished dry product contains high proportion of protein. It can be prepared by membrane separation processes. The pasteurised whey is subjected to ultrafiltration to remove water along with many small molecular weight compounds such as lactose, minerals etc. This concentrate may be spray dried or further concentration may be achieved by diafiltration before spray drying.

Acidity is adjusted before drying. The heat stability of whey protein concentrates in food systems is influenced by a variety of factors including pH especially between pH 3.5 & 6, duration and intensity of heat treatment especially temperatures above 75°C, concentrations of components including protein (above 5%), Ca & Mg, lactose, sugar and fat. UHT-treated beverages will show denaturation and flocculation of whey proteins if process is not controlled properly.

Whey Protein Concentrates of higher protein contents can be produced by further removal of non-protein constituents from the whey by membrane separation processes so the dried product obtained may contain protein contents of 50%, 60%, 75% or even 80%. As the protein content increases, there is a proportionate decrease in lactose content, the other constituents like fat and ash remaining more or less same.

	WPC 50%	WPC 60%	WPC 70%	WPC 80%
Protein	50.0%–52.0%	60.0%–62.0%	75.0%–78.0%	80.0%–82.0%
Lactose	33.0%–37.0%	25.0%–30.0%	10.0%–15.0%	4.0%–8.0%
Fat	5.0%–6.0%	1.0%–7.0%	4.0%–9.0%	4.0%–8.0%
Ash	4.5%–5.5%	4.0%–6.0%	4.0%–6.0%	3.0%–4.0%
Moisture	3.5%–4.5%	3.0%–5.0%	3.0%–5.0%	3.5%–4.5%

Whey Protein Isolate contains 90% protein on dry basis and is prepared using membrane separation along with ion exchange chromatographic separation. In a typical process, proteins are first absorbed on ion exchange column and removing the deproteinated whey. After draining all the whey, the whey proteins are then desorbed from the column and they are subjected to ultrafiltration to remove the minerals. This gives mostly the whey proteins in the filtrate which are concentrated and spray dried to give whey protein isolate powder of following composition.

Lactoferrin is a glycoprotein present in whey. It has molecular size of 78 kilo Dalton and consists of single polypeptide chain linked to two glycans by N-glycosidic linkages. Its concentration is quite low in cow's milk (10mg/l) but is present in higher levels in whey (about 30-100mg/l sweet whey). Selection of ion exchange column and eluate of proper pH can selective remove lactoferrin from other whey proteins and other components. After desorption and spray drying, lactoferrin powder is obtained. Dried powder has protein content of more than 90% with more than 90% lactoferrin purity. Moisture is less than 5% and ash less than 1.5%. Iron saturation of low (<10mg/100g protein), medium (35mg/100g) and high (>100mg/100g) level is adjusted.

Lactoferrin has antibacterial properties and these bactericidal and bacteriostatic activities are due to iron-scavenging properties of lactoferrin. It binds iron very strongly and makes this essential component unavailable to bacteria. Studies have shown that the mechanism is more complex than simple nutritional deprivation. Bacterial inhibitory action has also been ascribed to binding of lactoferrin to enterocyte lactoferrin receptors.

Lactoferrin from cow's milk was found to be more potent against various Gram-negative and Gram-positive bacteria at concentrations 0.3 to 3 $\mu$ M than human lactoferrin. Lactoferrin appeared to protect against septic shock, an often fatal complication of bloodstream infection. Especially elderly, surgical patients and people with AIDS are particularly susceptible to this. Antiviral effects of lactoferrin against several types of human viruses have been reported.

Lactoferrin also inhibits free radicals. This biological function gives protection against oxidative damage by scavenging excess iron that catalyses the undesired formation of free radicals. Skin damage seen by the appearance of wrinkles and other aging symptoms are caused by excess formation of free radicals like superoxides and hydroxyl radicals.

One of the primary functions of lactoferrin in nutrition is iron-binding. It is effective iron transport in the diet. Iron saturated lactoferrin is used in infant formulas which gives readily bioavailable iron. It is used in dietary supplements, sports drinks & bars and foods specially formulated for anaemic women. Another advantage is that it does not induce constipation.

Among benefits has also been shown effects on cell growth at the intestinal level leading to rapid restoration of normal digestive functions. It can stimulate a variety of cells of the immune defence system. It has been reported to stimulate the growth of Bifidobacteria.

Among other minor components of milk are lactoperoxidase and Glycomacropeptide. Lactoperoxidase, a glycoprotein with a molecular weight of 77.5 kilo Daltons is an enzyme with natural antimicrobial activity and is present in sweet whey at 1-30mg/l concentration. It is relatively heat-resistant and can inactivate or kill a broad spectrum of microorganisms including E. coli and Salmonella. It has been added to yogurts to prevent additional acid production during storage. It is also used in the prevention of some neonatal infections as well as in personal care products for prevention of cavities, gingival and skin infections. Glycomacropeptides are isolated from fresh cheese whey using ion exchange chromatography and membrane technology. Glycosylated portion of caseino-macropeptide is formed by rennin cleaving  $\kappa$ -casein from the casein micelle. Glycomacropeptide can suppress appetite via stimulation of pancreatic hormone cholecystokinin release, act as a prebiotic and has immunomodulatory actions.

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