



# Technical Briefing

## Replacing Milk Solids



starches



flours



fibres



proteins

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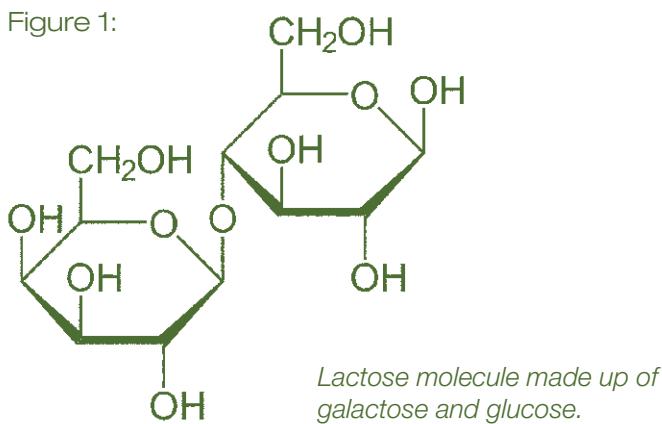
Milk solids are what is left after all the water has been removed from the milk. The main components of which are protein (whey and casein primarily), sugar (lactose), fat and vitamins and minerals. When the fat content is included in the breakdown it is referred to as the total solids content.

Generally milk powders are quite bland in taste and colour, typically being white or creamed coloured. The powders with a higher lactose content (whole milk powder, semi-skimmed milk powder and whey protein powder) have a slightly sweeter taste to them. Dairy products characteristically give a really creamy mouthfeel to an end formulation product. There is a lot of advanced technology these days which means making specific functionally advantageous milk based powders is very common for a wide range of end applications and for different functionalities.

The main reason that milk solids might be replaced is to remove a commonly talked about allergen, lactose. Dairy products, including milk and its derivatives, are naturally high in this milk sugar. Just like gluten, people are now avoiding lactose as a healthy choice or precaution just as often as people do due to an actual allergy.

Lactose is a disaccharide sugar made up of a galactose and a glucose molecule joined together by a glycosidic bond. Lactose is broken down by the enzyme lactase in the body.

Figure 1:



The component of milk which is even more functionally important than lactose is the proteins present. Milk contains all nine essential amino-acids required by humans. The proteins which milk contains are unique to milk and won't be found elsewhere. Milk protein interaction is a key area of interest worldwide; by understanding this food manufacture

can continue to be improved.

There are two main proteins which are used to add functionality to foods; whey (sometimes called serum proteins) and casein. Whey is soluble and is quickly digested; casein is insoluble and is a slow digesting protein.

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Casein is the more abundant of the two proteins and is what causes the white, opaque appearance of milk. There are two basic types of casein; acid and rennet. In naturally occurring milk, it forms micelles with calcium and phosphorus. Casein forms these micelles due to its insolubility.

Both casein and whey are used to stabilise physical aspects of food products such as the whipping and foaming capacity due to them being able to form a film around the air bubbles created. This film forming capacity also lends itself to water and oil emulsification. They are capable of binding substantial amounts of water, this helps to provide a product with viscosity and in some cases improve the texture of the product. Casein is often used in cheese manufacture due to the structure it is able to give to the product; it also helps with the final yield by binding large amounts of water. They both may be used to improve the nutritional profile of the product.

When milk is dried it is often separated out into its different concentrated components which each offer their own unique functionality. There are five key types of milk powders commercially available; whole milk powder, skimmed milk powder, whey protein powder, whey protein concentrate and milk protein concentrate.

**Whole milk powder** is the most basic dried form, containing all aspects of milk bar water. There must be at least 95% milk solids present and at least 26% fat content. Due to whole milk powder containing all of the major constituents of regular milk (protein, milk fat and sugars, lactose, calcium and phosphate) it has a wide range of applications which it can go into.

**Skimmed milk powder** is the most common form which dried milk powder is available. Just like with regular milk, the main difference between whole and skimmed is the fat levels;

skimmed milk powder should have no more than 1.5% fat and contain at least 95% milk solids.

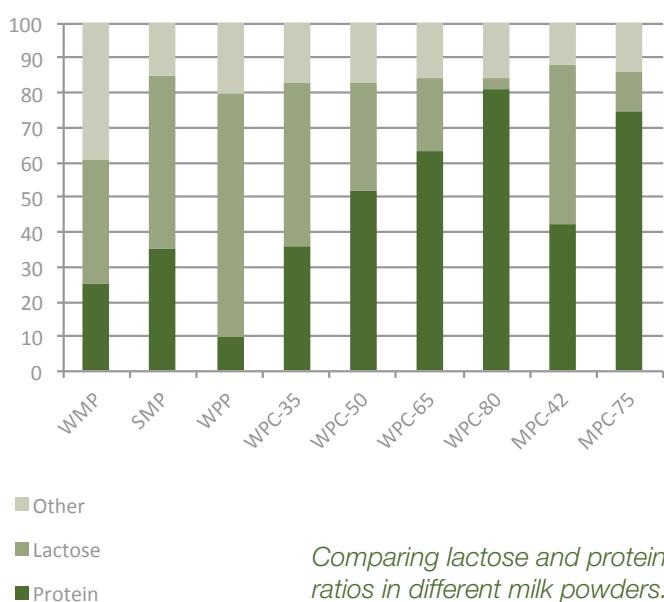
**Whey protein powder** has good water binding and emulsifying capacity. Originally it was a by-product of cheese manufacture but now it is highly sought after as a protein supplement for the health and fitness industry and for its functionalities in other sectors.

Skimmed milk powder and whey protein powder are very similar in functionality due to their protein contents. SMP has less lactose than whey powder but more protein due to the presence of casein as well as whey. Even though whey and casein are both proteins, they have unique functionalities.

**Whey protein concentrate** is concentrated whey protein, as the name suggests. This must be no less than 25% protein, though there are varying levels of protein available (from 35% crude protein right up to 80% crude protein). The more protein there is present the lower the amount of lactose present. The differing levels of these two components gives each concentration of whey protein concentrate different functionalities in the end products. Generally the higher the protein content of the whey protein concentrates, the more functional the product is.

**Milk protein concentrate** contains both whey and casein proteins in a similar ratio to that found in milk (much more casein than whey). They must contain at least 42% protein and some varieties have added casein levels. Just like the whey protein concentrate, there are varying levels of protein and lactose products available depending on the required functionality or nutritional requirements. They are extracted by ultrafiltration which gives a highly nutritious and functional product due to the proteins not being damaged by heat treatments. These, like the other milk powders are used to enhance a wide variety of different food products.

Figure 2:



So, when replacing these products, what are the functionalities to be replicated?

Most of the important functional properties of liquid milk and milk powders are very similar; below are the key functionalities which are achieved by using milk powders:

**Water binding** - texturiser and keeping quality in bakery products. Lactose can act as a humectant while proteins can also take on water, this can reduce costs by binding additional water.

**Colour formation** - sugars and proteins react (Maillard reaction). The lactose also caramelises. Both reaction also enhance/ create flavour in the product.

**Emulsification** - the proteins present in milk are capable of stabilising fat- water emulsions.

**Whipping / foaming / aeration** - the milk proteins form a stabilising film around air bubbles formed during processing. For this to occur though it is important that the powder is free from any anti-foaming agents. Foaming is important for texture development in certain products (ice-cream, mousse, whipped products and coffee). Proteins are responsible for the stability of foam formation.

**Thickening agent / viscosity** - able to give viscosity to a product by binding with the water and gelling. There is high water binding from both the lactose and the proteins which means both help to increase existing viscosity and gel strength of a product. Formation of a protein matrix with the water gives a higher viscosity.

**Dispersibility** - the milk powders are stable in low pH and high temp environments.

**Solubility** - (high, low and med solubilities give different properties to skimmed milk powder).

Heat treatment during manufacture may denature some of the proteins present and their interactions with other proteins and fat molecules. This can therefore affect the functionality of the final product, usually in terms of solubility.

Where rennetability or coagulation are occurring; such as in cheese and fermented dairy products (sour cream and yoghurts), skimmed milk powder is used over whey due to the casein proteins present.

Due to the lower level of lactose present in skimmed milk powder versus whey protein powder, skimmed milk powder is often used in ice-cream and frozen desserts to help prevent lactose crystallisation happening, preventing it from being detected by the tongue. The skimmed milk powder also helps to stabilise the ice-cream and gives a much creamier mouthfeel and taste to the product. Crystal formation can be controlled by adjusting the protein to fat ratios in ice-cream

and chocolate; this helps to prevent blooming in chocolate and icy ice-cream. Also allows for fat reduction in dairy based products.

Milk powders are also a great way of adding dairy without the additional water content; something which is undesirable in bakery and confectionary products where water content is crucial.

Milk protein concentrate is absent of lactose and is high in protein, this gives it a high foaming capacity and good heat stability. It is also good for use in nonfat yoghurts as the casein present adds needed structure and stabilisation to the product. Milk protein concentrate may also be added to enhance protein content or final product yields in milk and/ or cheese formulations. It is also increasingly used in nutritional drinks as it provides both casein and whey protein without additional sugar (lactose).

A tenderizing effect in cake and sponge products can be seen from using whey solids. The coatings used on fried products usually contain whey due to its shortening effect.

Due to its high protein content, whey protein concentrate with the highest level of protein present is great for egg white replacement in whipped products (meringues, ice-cream and sweet toppings).

## Key areas of milk powder use in the food industry:

- Reconstitution
- Recombination
- Confectionery
- Sports and nutrition
- Beverages and sports drinks
- Baby formula/ infant food
- Bakery

- Dry blends
- Fermented milk products
- Ice-cream and frozen desserts
- Processed cheese
- Cultured milk products (e.g. yoghurts)
- Spreads and shortenings
- Meat products
- Sauces, soups and gravies
- Cereals
- Egg replacer
- Whipped toppings and puddings
- Battered and breaded products
- Coffee creamers
- The possibilities are endless.....

With such a diverse set of products, functionalities and applications for milk powders it can be a challenge knowing how replace these products in your formulations when going allergen/ dairy free, or just reformulating your products.

Here at Ulrick & Short we have a wide range of functional starches, proteins and fibres which have been specially developed for adding functionality to products. We have dairy free (and often completely allergen free) solutions for replacing milk powders in a number of applications:

- Casein replacement in cheese analogue
- Fat replacement in dairy sauces
- Enhanced mouthfeel and flavour throughput
- Aeration in bakery products
- Keeping quality in bakery products
- Both hot and cold thickening agents
- Emulsifiers for meats and other applications
- Dairy-free egg replacements
- Stabilisers
- pH and heat stable products





## Starches and Flours

Produced from a range of crops including Tapioca, Wheat, Rice, Sweet Potato, Pea and Waxy Maize.

- Available in 'cook up', 'pre-gelatinised' and 'cold water swelling' formats.
- Heat, pH, freeze/thaw stable versions available with a range of viscosity profiles and a whole palette of textures.
- Thickening, stabilising, fat replacement, sugar reduction, phosphate removal and glazing are only a few of the functions possible.
- Simple, clean and consumer friendly declarations in the following key application areas:
  - Bakery
  - Processed meats
  - Sauces
  - Ready meals
  - Desserts
  - Snacks



## Fibres

Produced from a range of crops including Wheat, Oat, Bamboo, Flax and Pea.

- Insoluble fibres with high water binding capacity in a range of fibre lengths, giving full control over the desired texture.
- 'Source of' and 'high in' claims for fibre and omega 3 achievable.
- Shear, acid, heat and freeze/thaw stable.
- Key application areas:

- Bakery	- Sports nutrition
- Processed meats	- Snacks
- Sauces	- Breakfast cereals
- Performance foods	



## Proteins

Produced from a range of crops including Wheat, Pea and Rice.

- A range and variety of protein content.
- Can be used as effective binders and emulsifiers.
- Nutritionally enhance foods and boost amino acids.
- Easy to apply and use in the following key application areas:
  - Processed meats
  - Bakery
  - Sports nutrition
  - Infant formulas
  - Functional foods



## Clean & Clear Label

Starches | Flours | Fibres | Proteins

- ✓ Non-GM
- ✓ Additive free
- ✓ Wide range of crops and functionalities
- ✓ Allergen free options
- ✓ Simple consumer friendly declarations
- ✓ Enhanced nutritional profiles
- ✓ Quality assured from field to fork
- ✓ Fully accredited including BRC, Kosher and Halal approved

All backed up by onsite technical support.



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