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Effect of Processing and Storage on the Reconstitution Properties of Whole Milk and Ultrafiltered Skim Milk Powders

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SUMMARY

Concentrated and dry milk products have a longer storage stability than fresh milk because of a lower water activity and they are therefore desirable in regions with unsuitable climates for fresh milk production and distribution.

During the manufacture of spray dried milk products, there are processing steps that cause interactions between the various components in milk that influence powder functionality. These processes include pasteurisation, homogenisation, concentration, heating, atomisation and the spray drying conditions.

Whole milk powders (WMP), particularly those sold directly to the consumer, are required to disperse rapidly in water and to be quickly and completely soluble *i.e* form a stable colloidal suspension of fat and protein leaving little or no visible residue suspended in the water or coated to the inside surface of the container. Spray dried ultrafiltered skim milk containing 85% protein (UFSMP85) is used for a wide range of applications including protein fortification of liquid milks, nutritional foods and cheese milks. The UFSMP85 should have good solubility in water and milk for it to be used successfully in these applications.

The main objective of this work was to further our knowledge about the influence of processing factors on component interactions during the manufacture of WMP and UFSMP85, using microscopy as a major investigative tool. Evaluation of the influence of milk component interactions on the functional characteristics of the powders was an integral part of the work and provided important insights towards improving the reconstitution properties of these powders.

The development of confocal laser scanning microscopy methodology for WMP proved valuable for the localisation of fat globules, lactose crystals and a phospholipid-based surface wetting agent.

Major structural changes in the fat globules, casein micelles and whey proteins occurred during the manufacture of WMP. Preheating resulted in the formation of hair-like structures on and between casein micelles onto the fat globule surface. Upon further heating the adsorbed protein on the fat aggregated with other micelles to form a chain-like network. Reduction in the whey protein concentration of the concentrated milk appeared to reduce the number of hair-like structures, aggregation and the extent to which this network formed upon heating.

A study of instant-WMP products, obtained from the marketplace, indicated that WMP with poor functional properties (solubility in coffee and hot and cold water, and dispersibility) generally had been manufactured using high preheating conditions, had a high fat globule protein load (excessive shear during processing) and exhibited a high degree of protein-protein interactions. The instant-WMP sample with the most favourable functional properties (good solubility in hot and cold water and coffee, excellent dispersibility and good agglomerate structure) was manufactured using low preheating conditions and exhibited fewer protein-protein interactions as observed by transmission electron microscopy (TEM).

In the manufacture of UFSMP85 there were changes that occurred during membrane

concentration and evaporation that predisposed the concentrated milk to protein-protein and protein-mineral interactions upon drying. The extent of these protein interactions increased with an increase in protein content of the UFSMP. It was considered that these interactions gave UFSMP85 a solubility of only 40% when it was reconstituted in water at 20°C. The solubility was approximately 98% when UFSMP85 was reconstituted in water at 60°C. Determination of the location of β-lactoglobulin and κ-casein by immuno-gold labelling and TEM showed that these components may be associated with the formation of an aggregated matrix that 'sets' upon drying thus influencing particle solubility.

Storage of UFSMP85 at temperatures ≥ 20°C caused a "skin" to develop at the particle surface that reduced water penetration . This skin eventually (after 6 months of storage) decreased the powder solubility even in water at 60°C. The application of shear at approximately 14.50 MPa was required to break down these poorly soluble reconstituted UFSMP85 particles.

Changes in the pH of milk prior to ultrafiltration and a reduction of temperature during drying and storage of the powder may result in some incremental improvements in the solubility of the UFSMP85.

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