THE FUNCTIONAL PROPERTIES OF MILK PROTEIN CONCENTRATES

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Abstract

The aim of this thesis was to explore aspects of the functional properties of MPC85 (milk protein concentrate, 85% protein). A rheological study of milk protein concentrate (52°C) prior to spray drying showed a slight age-thinning behaviour which lasted about one hour, after which the apparent viscosity of the concentrate remained constant. This result is the opposite of skim milk concentrate which age-thickens at evaporator temperatures. The flow behaviour of the concentrate was adequately described by a Power Law rheological model.

The rheological properties of reconstituted commercial MPC85 were studied at various temperatures and concentrations. At low concentrations (<10% w/w total solids) MPC85 solutions were Bingham Plastics. The yield stress was found to increase with temperature and concentration. At high concentrations (>15% w/w total solids) the logarithm of apparent viscosity was found to increase linearly with protein concentration. These solutions were also found to be Bingham Plastics. At lower temperatures (< 35°C), however, these MPC85 solutions (>15% w/w total solids) were pseudoplastic and did not possess a yield stress.

The solubility of commercial MPC85 was found to be dependent on the temperature at which the solution was prepared, increasing from ≈59% at 20°C to 100% at 50°C. Homogenisation was shown to improve the solubility of MPC85 at 20°C. The rheological properties of MPC85 were profoundly influenced by the presence of any insoluble solids.

The effect of preheat treatments during the pilot-scale manufacture of MPC85 on functionality was investigated. Heat treatment had no effect on heat stability of reconstituted MPC85 solutions for whey protein denaturation (WDN) values up to 86%. Heat treatments resulting in ≥90% WDN produced a dramatic loss in heat stability. The variations in rheology and rennet coagulation properties among the pilot plant powders were found to be correlated with the apparent diameter of the casein micelles. In

reconstituted solutions the apparent diameter of the casein micelles increased gradually with heat treatments up to 86% WDN and dramatically at higher WDN levels.

The main effect of preheat treatments during manufacture on the rheology of MPC85 solutions was the linear increase in apparent viscosity with apparent diameter of casein micelles. The variation in apparent viscosity with apparent diameter of casein micelles was found to be greater at low shear rates. A schematic model was proposed to account for these observations.

A factorial design experiment was used to identify the components and interactions of components which play a significant part in determining the functionality of MPC85. This work demonstrated techniques for modelling heat stability - pH profiles and thereby allowing the quantitative comparison of the entire profiles of different solutions rather than comparisons at just single pH values or qualitative comparisons regarding the shape of the profile. The addition of divalent cations in the absence of added phosphate resulted in solutions that were completely unstable at 120°C.

Overall this work has provided a detailed characterisation of commercial MPC85, both of the rheology of the concentrate prior to spray drying and of the functional properties of the powder. The research presented here has implications for both processing and product formulation.

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