Effects of urea addition on the structural and material properties of caseinate solutions and emulsions

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Abstract

The effects of urea addition on the self-assembly of caseinate sub-micelles and subsequent impact on the structural and material properties of caseinate solutions and caseinate stabilised oil-in-water emulsions (30 vol% oil) were studied.

Sub-micellar particle size and distribution were measured using dynamic light scattering. Sodium caseinate in solution showed a bimodal particle size distribution centred at 20 and 120 nm (radius). The increasing addition of urea (1.1 to 6.6 M) was seen to cause a reduction in the size of caseinate sub-micelle, which was attributed to a dissociation of the sub-micellar fraction arising from a reduction in hydrophobic interactions.

For sodium caseinate solutions above estimated sub-micellar close-packing phase volumes (＞10 wt% protein concentration), increasing addition of urea was seen to significantly lower solution viscosity with more pronounced changes observed with increasing protein concentration. All the urea-treated solutions were Newtonian.

For sodium caseinate stabilised emulsions, where protein concentrations were above the critical threshold for onset of depletion flocculation, the addition of urea was seen to result in a reduction in depletion free energy of the emulsions. The effects of reduced depletion interaction on emulsion stability, structural and rheological properties were found to be dependent not only on the concentration of added urea, but also on the protein concentration in the emulsions. For 2 and 4 wt% caseinate concentrations, depleted droplets reduced with increasing urea concentration and the emulsion stability increased as well. For 6 wt% protein concentration, the stability decreased with the addition of 1.1 and 3.3 M urea, and it was re-established when the urea concentration was up to 6.6 M. This was attributed to the synergic effects on the depletion potential and continuous phase viscosity which were induced by urea, and it was supported by the results of creaming profiles, rheological properties and microstructure. Likewise, urea had similar effects on the emulsions stabilised by potassium caseinate.

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Table of Contents

1 Contents

List of Figures

List of Table