Protein Stabilised Submicron Emulsions

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Protein stabilised emulsions have many application in a wide range of sectors, yet the fundamentals of stabilisation mechanisms are to be fully understood. Little research involving submicron emulsions stabilised with proteins has been conducted. Stabilisation of nanoemulsions with protein has been achieved by indirect methods, which include the use of solvent evaporation[1]. Submicron emulsions presented in our study were stabilised by protein using direct methods.

Emulsions were formed with a number of dairy proteins; sodium caseinate (NaCas), whey protein isolate (WPI) and milk protein isolate (MPI). For comparative purposes, a low molecular weight surfactant, Tween 80, was also investigated. The effect of protein molecular weight was investigated by using sonolysis as a method of hydrolysing the proteins to reduce their molecular weight profile. A range of protein concentrations were investigated ranging from 0.1% to 10%. Emulsification involved the use of high pressure homogenisation at 1,250 bar for 2 passes.

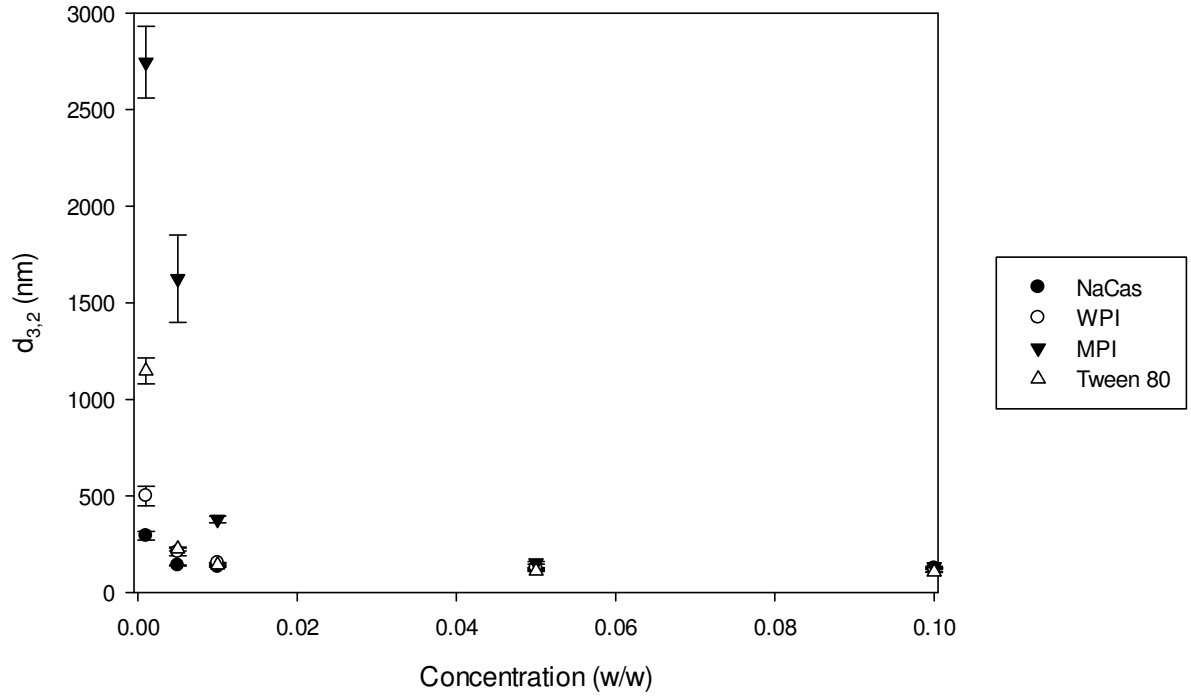

Figure 1. Comparison of the evolution of droplet size as a function of concentration of emulsions formed using Tween 80, NaCas, WPI and MPI

Emulsions produced at protein concentration above 5%, regardless of the protein type, yielded droplets ~120nm, which was similar to emulsions prepared with Tween 80 in the same range of concentrations. Lowering emulsifier concentration resulted in an increase of

the droplet size. Nonetheless, these changes were strongly dependent in the emulsifier type. For example, at the lowest concentration, a maximum droplet size of ~300nm was produced with NaCas against more than 1μm with Tween 80 or MPI. These differences are discussed as a function of emulsifier molecular size and interactions. Emulsions prepared with protein exhibit long-term stability (>1 month), except with MPI for which a minimum content of 1% is required to form stable emulsions. Droplet size did not change over 1 month, neither emulsion viscosity which shows that no depletion flocculation occurred throughout the duration of the study.

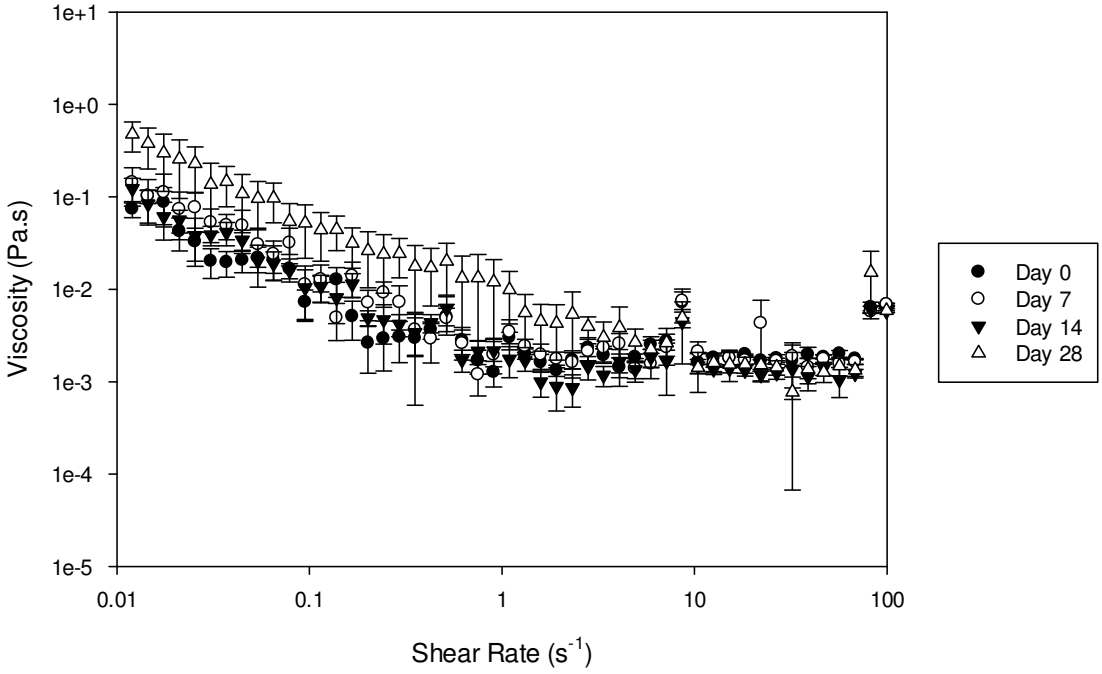

Figure 2. Rheology curves of.1% NaCas stabilised emulsions over a 28 day periods from a shear rate of 0.01 s^{-1} to 100 s^{-1}

Sonicated proteins yielded similar droplet sizes to the native proteins, in spite of the fact that hydrolysates were significantly smaller (NaCas was reduced from an initial size of ~250nm to ~70nm) and exhibited differences in bulk and interfacial properties. To further investigate the effect of molecular weight of proteins on the formation of emulsions, pressure within the homogeniser was reduced. This showed that no or only small differences in the droplet size.

In conclusion, long-term stable submicron emulsions can be formed with proteins, either within their native or hydrolysed state, using direct emulsification methods. The negligible differences between emulsions made with native proteins and their hydrolysates showed that submicron emulsion stabilisation with proteins results in conformation of the proteins at the interface rather than in their size and interfacial properties.

1. Lee, S.J. and McClements, D.J. (2010). Fabrication of protein-stabilized nanoemulsions using a combined homogenization and amphiphilic solvent dissolution/evaporation approach. *Food Hydrocolloids*, *24*, 560 – 569.