Nanoemulsions Prepared by Emulsification and Solvent Evaporation

Sung Je Lee[1] and David J. McClements[2]

[1]Institute of Food, Nutrition and Human Health, Massey University, Auckland, New Zealand
[2]Department of Food Science, University of Massachusetts, Amherst, MA, USA

Abstract

Development of oil-in-water nanoemulsions is emerging in the food industry as they can be used as delivery systems in transparent foods and beverages and to increase the bioavailability of lipophilic active components. In this study, nanoemulsions with very small droplet size (<75 nm) were able to be prepared from food-grade ingredients (corn oil, whey protein, and water) using a combined method of high pressure homogenization and solvent evaporation technique. Nanoemulsions were formed by homogenizing 10 wt% organic phase (corn oil and ethyl acetate) with 90 wt% aqueous phase (water and whey protein isolate (WPI)). The resulting nanoemulsions were translucent in appearance. On the other hand, conventional emulsions prepared without the addition of solvent using the same method were much larger in their droplet size with opaque appearance. The mean particle diameter of nanoemulsion droplets decreased with increasing ethyl acetate concentration in the organic phase and also decreased with increasing emulsifier concentration. The effects of environmental factors (pH, ionic strength, and thermal treatment) on the stability and properties of nanoemulsions were compared to those of conventional emulsions ($d_{43} \approx 325$ nm). Overall, the nanoemulsions were more stable to droplet aggregation and creaming than conventional emulsions. Both nanoemulsions and conventional emulsions were unstable to droplet flocculation near the isoelectric point of WPI but remained stable at higher or lower pH values. The oxidative stability and lipid digestibility of nanoemulsions and conventional emulsions containing fish oil were also compared. Lipid oxidation was faster in nanoemulsions than conventional emulsions whereas the *in vitro* digestibility of the lipids was slower in nanoemulsions. The results obtained in this study have important implications for the design and utilization of food-grade nanoemulsions.