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Oil-in-water emulsion system stabilized by emulsion droplets coated with whey protein microgels

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Structurally designed emulsions are a developing group that is likely to find increasing utilization within the food industry because of their potential advantages over conventional emulsions. A novel droplet-stabilized (DS) emulsion system emulsified with casein micelles has been previously reported[1]. However, the mechanism of DS emulsion formation, physicochemical properties, and their stability are not yet been fully explored. In the present study, heat-induced whey protein microgel (WPM) particles were used as an alternative emulsifying agent. The structure of WPM particles on the formation and physicochemical properties of the primary (PE) and the DS emulsions was investigated. WPM particles were prepared by heating 4 wt% whey protein isolate solution in the presence (PB) or absence (NPB) of 10 mM phosphate buffer at pH 5.9, 85℃ for 45 min, followed by washing, centrifugation, and micro-fluidization. The PE coated with WPM were homogenized using 3 passes at the pressure of 250/50 bar. DS emulsions were prepared by mixing (at 30000 rev/min for 2 min) 10 wt% oil with 10, 30 or 60 wt% PE. The structure of WPM particles and emulsions were analyzed by dynamic light scattering, confocal light scattering microscopy (CLSM), transmission electronic microscopy (TEM), and the combination of small and ultra-small angle neutron scattering (SANS and USANS). The results showed that the WPM particles produced in the absence of phosphate buffer (WPM-NPB) were smooth spherical particles, giving a surface fractal dimension of 2.0 and a hydrodynamic diameter of 270 nm. However, WPM particles made in the presence of phosphate buffer (WPM-PB) were rough spherical particles with a surface fractal dimension of 2.3 and a hydrodynamic diameter of 290 nm. Particle fragments present in the WPM-PB dispersion, resulted in their competitive adsorption onto the surface of the DS emulsions; reducing the adsorption of PE droplets. For the PE coated with WPM-NPB particles (PE-NPB), a flocculation due to protein bridging and protein intramolecular interaction, lead to a network with a fractal dimension of 2.7. For the DS emulsions stabilized by PE-NPB, the interfacial layer thickness of DS emulsion droplets increased with the increase in the concentration of PE as observed by CLSM, whereas the size of DS emulsion droplets decreased. A fractal network consisting of adsorbed PE-NPB on the interfacial layer of DS emulsion was observed by TEM and measured by USANS. These results suggest that both the structure of the interfacial layer and the size of the DS emulsion is dependent on the concentration of the PE used.

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