Topic: Hydrocolloid structure-function relationships

Linking adsorption dynamics and interfacial viscoelasticity to droplet formation using microfluidics: Insights from faba and whey protein mixtures

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The composition and viscoelastic properties of interfaces are key factors in imparting stability to emulsions. In mixed protein systems, the adsorption dynamics may affect the composition and interactions between proteins, with important consequences to the bulk properties. Microfluidics is proposed as a means for rapid screening of such interactions. In this work, we aimed to evaluate the viscoelastic properties of oil water interfaces obtained with a mixture of whey protein isolate (WPI) and faba protein isolate (FPI), measured via drop tensiometry, and relate such properties to the properties of emulsion droplets obtained using microfluidics.

Drop tensiometry revealed that all WPI/FPI mixtures effectively reduced the interfacial tension at the oil-water interface but displayed distinct interfacial adsorption dynamics: WPI-stabilized droplets exhibited slow adsorption and rearrangement rates, while FPI-stabilized droplets showed fast adsorption rates and rearrangement rates. Although both WPI and FPI formed viscoelastic interfaces alone, the interfacial viscoelasticity was significantly reduced when combinations of WPI and FPI were used, likely due to the difference in adsorption dynamics and, thereby, competitive displacement between the proteins for the interface.

The lack of interfacial stability in FPI/WPI mixtures was reflected in the behavior of the droplets formed with microfluidics. WPI (0.1 mg/mL) formed stable, elongated droplets, while FPI-stabilized droplets were prone to coalescence, forming large, non-spherical oil clusters, indicating that a higher concentration of FPI is required to obtain stable droplets. WPI/FPI mixtures showed increased instability compared to WPI alone. However, at low ratios of WPI (25/75 WPI/FPI) droplet stability was increased, indicating that small amounts of WPI may aid in droplet stability. Alternatively, small amounts of FPI caused significant instability reflected in the larger droplet sizes and more elongated droplet shape due to increased competition at the interface at low ratios FPI (75/25 WPI/FPI). The microfluidics results will be compared to bulk emulsion properties to demonstrate how microfluidic techniques can serve as a rapid screening tool for optimizing interfacial interactions and enhancing product formulation.

Overall, the findings highlight the critical interplay between protein-protein interactions, interfacial viscoelasticity, and droplet stability, providing the first evidence linking drop tensiometry with coalescence and shape eccentricity during microfluidic droplet formation.