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Effect of Salt Addition on the Formulation Process of Double Emulsions by Using Microchannels

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Summary

Double emulsions consist of oil droplets dispersed within an external water phase, with the droplets themselves containing smaller internal water droplets. Their double-compartment structure can be used to reduce the fat content of emulsion-based foods or to encapsulate substances within the internal water droplets. Generally, emulsion-based foods contain salt in concentration of several percent. However, effects of salt on the preparation process and quality of double emulsions have not been clarified yet. In this study, the formulation of double emulsions by using a microfluidic emulsification method called "microchannel (MC) emulsification" was conducted under various salt concentrations to study the effect of salt addition on the preparation process of double emulsions.

Preparation of double emulsions by MC emulsification consists of two steps: (1) ultrasonic treatment to obtain the primary water-in-oil emulsions that contain a water-soluble fluorescent dye, calcein, in their dispersed water droplets and oil-soluble emulsifiers in the oil phase; (2) MC emulsification to prepare water-in-oil-in-water double emulsions.

Double emulsions were successfully prepared by MC emulsification using sodium caseinate as a water-soluble emulsifier dissolved in the external water phase with the addition of NaCl (0-0.5 M). The presence of NaCl affected the breakthrough pressure of MC emulsification, average droplet diameter and droplet size distributions of double emulsions. Interestingly, the uniformity of droplet diameter of double emulsions was improved by the increase of NaCl concentration. Difference in droplet generation behavior between the emulsification systems with and without NaCl addition were revealed by high-speed observation of the MC emulsification process. Under the all NaCl concentrations tested, high entrapment efficiency (80-90% determined by fluorescence measurement) of calcein into the internal water droplets of double emulsion was obtained.