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Application of direct sonication under high-pressure two-phase system

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Abstract (less than 300 words)

The properties of supercritical fluids, in particular supercritical carbon dioxide (CO_2) are unique and have been well-established in the field of food, pharmaceutical, and cosmetic applications providing numerous opportunities in extraction, separation, fractionation, micronization, and encapsulation processes by acting as a solvent, co-solvent, or anti-solvent. Herein, we introduced a new technique of high-pressure CO_2-expanded liquid (CXL) system with a combination of direct sonication allowing rapid formation of liposomes or nanobubbles. Additionally, the application of direct sonication to the high-pressure CO_2 system has also been examined for the extraction of water soluble natural yellow pigments. Unlike $ScCO_2$, a gas phase may exist in the CXLs system in addition to the CO_2-expanded liquid phase; therefore, density change with pressure is negligible. As a result, excess solvent power sensitivity with the change of operation pressure can be avoided. The effects of different parameters including entrainers (water, or aqueous ethanol), temperature (5-25 °C), pressure (8-14 MPa), and sonication time (0-200 s) on the final product (liposome[1] or nanobubble or nanocellulose or extraction[2]) were examined. The efficacy of direct sonication was evaluated by analyzing particle size distribution (PSD), scanning electron microscope (SEM) and transmission electron microscopy (TEM).

Direct sonication to the water/CO_2 two-phase system caused rapid physical mixing between the water and CO_2 phases including micro-phase separation and cavitation which speed-up the mass transfer at lower frequencies, typically 20 kHz may be responsible for the production of high yielding liposomes or nanobubbles as well as facilitated the production of nanocellulose fiber for high or high yielding the natural pigment extraction.

References

[1] S. Tokunaga, H. Tashiro, K. Ono, T. Sharmin, T. Kato, K. Irie, K. Mishima, T. Satho, T.M. Aida, K. Mishima, Rapid production of liposomes using high pressure carbon dioxide and direct ultrasonication, J. of Supercrit. Fluids**,** 160 **(**2020).

[2] H. Sakai, K. Ono, S. Tokunaga T, Sharmin, T.M. Aida, K. Mishima, Extraction of Natural Pigments from *Gardenia Jasminoides* J.Ellis Fruit Pulp Using CO_2-Expanded Liquids and Direct Sonication, Separations, 8(2021).