

Preparation of Highly Stable Microalgal Oil-Water Emulsions Using Homogenization-Extrusion Process with Polyvinylidene Difluoride Filter Membrane

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In response to sustainable development issues, the microalgae industry possesses significant development potential. Microalgae oil, rich in omega-3 fatty acids that are essential to the human body but cannot synthesize on its own, can be extracted from microalgae biomass, exhibiting substantial biomedical value. This study used microalgae oil as raw material, employing the surfactant Tween 80 combined with a hydrophobic polyvinylidene difluoride (PVDF) filter membrane to fabricate a stable microalgae oil emulsion with uniform droplet size distribution and high oil utilization through a homogenization-extrusion process. Experimental results showed that using a PVDF membrane with an appropriate concentration of the surfactant could prepare an emulsion with uniform droplet size distribution. This is probably attributed to the surfactant's ability to promptly cover the newly formed oil-water interfaces of the emulsion, preventing oil droplet aggregation and effectively improving the stability and uniformity of the emulsion. Compared with more hydrophilic filter membranes such as mixed fiber ester membranes and dopamine-modified membranes, under the same operating conditions, the PVDF membrane exhibited higher flux and oil utilization, and could prepare a uniform emulsion at lower pressures. This may be because the PVDF membrane was modified by the adsorption of surfactants during the extrusion process, thus reducing the retention of oil droplets on the membrane surfaces. In this study, using 0.8 mM Tween 80 and 2.63 g/L microalgae oil as raw materials, combined with a PVDF membrane and a pressure of 8 kg/cm², an emulsion with uniform droplet size, an oil utilization rate as high as 92.7%, and stability exceeding 274 days was fabricated, thus successfully improving the quality of the microalgae oil emulsion.