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Response Surface Methodology to Supercritical Carbon Dioxide Extraction of Microalgal Lipids

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Abstract : As the world experiences an energy crisis, investing in sustainable energy resources is a pressing mission for many countries. Microalgae-derived biodiesel has attracted intensive attention as an important biofuel, and microalgae Chlorella protothecoides lipid is recognized as a renewable source for microalgae-derived biodiesel production. Supercritical carbon dioxide (SC-CO_2) is a promising green solvent that may potentially substitute the use of organic solvents for lipid extraction; however, the efficiency of SC-CO_2 extraction may be affected by many variables, including temperature, pressure and extraction time individually or in combination. In this study, response surface methodology (RSM) was used to optimize the process parameters, including temperature, pressure and extraction time, on C. protothecoides lipid yield by SC-CO_2 extraction. A second order polynomial model provided a good fit (R-square value of 0.94) for the C. protothecoides lipid yield. The linear and quadratic terms of temperature, pressure and extraction time—as well as the interaction between temperature and pressure—showed significant effects on lipid yield during extraction. The optimal lipid yield from the model was predicted as the temperature of 59 °C, the pressure of 350.7 bar and the extraction time 2.8 hours. Under these conditions, the experimental lipid yield (25%) was close to the predicted value. The principal fatty acid methyl esters (FAME) of C. protothecoides lipid-derived biodiesel were oleic acid methyl ester (60.1%), linoleic acid methyl ester (18.6%) and palmitic acid methyl ester (11.4%), which made up more than 90% of the total FAMEs. In summary, this study indicated that RSM was useful to characterize the optimization the SC-CO_2 extraction process of C. protothecoides lipid yield, and the second-order polynomial model could be used for predicting and describing the lipid yield very well. In addition, C. protothecoides lipid, extracted by SC-CO_2, was suggested as a potential candidate for microalgae-derived biodiesel production.

Keywords : Chlorella protothecoides, microalgal lipids, response surface methodology, supercritical carbon dioxide extraction
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