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Optimization of essential oil and fucoxanthin extraction from Sargassum binderi by supercritical carbon Dioxide (SC-CO_2) extraction with ethanol as co-solvent Using Response Surface Methodology (RSM) (Article)

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Abstract

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Supercritical carbon dioxide (SC-CO_2) extraction of fucoxanthin is more advantageous over conventional solvent extraction as it is less toxic, less hazardous to the environment and preserves the bioactivity of fucoxanthin. A face-centered central composite design (FCCCD) based on response surface methodology (RSM) was employed for SC-CO2 extraction of oils and fucoxanthin from the brown seaweed Sargassum binderi, with ethanol as a co-solvent. Three independent parameters namely, extraction temperature (A: 40, 50, 60°C), pressure (B: 2900, 3625, 4350 psig and particle size (C: 90, 500 and 1000 µm) were investigated to optimize extraction oil yields (EOY) and fucoxanthin yields (FY). A regression model was developed, tested for quality of fit (R^2) and expressed in the form of 3D response surface curve and 2D contour. The optimum extraction conditions were obtained at extraction temperature (A) 50°C, pressure (B) 3625 psig and particle size (C) 500 µm. Under these conditions, optimal EOY and FY were 10.04 mg/g and 3188.99 µg/g, respectively. The difference between the lowest and the highest response in EOY and FY were 5.44 - 10.04 mg/g and 2109.10 - 3188.90 µg/g, respectively. The lowest yields were identified at 60°C, 2900 psig and 1000 µm. The regression models generated showing interactions between the variables and EOY and FY response were significant as tested by ANOVA ($p < 0.0005$ and $p < 0.0007$, respectively) with high R^2 values (0.9848 and 0.9829, respectively). Interactions between the parameters had a strong synergistic effect on EOY and FY values, as indicated by the 3D response surface curve and 2D contour. The experimental results matched the predicted results closely. This indicated the suitability of the models developed and the success of FCCCD under RSM in optimizing the S. binderi extraction conditions.

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Author keywords

Fucoxanthin | Methodology | Response surface | Sargassum binderi | Supercritical carbon dioxide

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