The optimization of oil extraction from macroalgae, Rhizoclonium sp. by chemical methods for efficient conversion into biodiesel

ABSTRACT

Optimization of biodiesel production from freshwater macroalgae, Rhizoclonium sp. was investigated in this study. Biodiesel production process parameters such as chemical solvent extraction, hexane:ether and different extraction techniques were optimized by using the response surface methodology based on the central composite design. Optimization of the transesterification process was conducted by varying two factors each at three different levels and this required a total of thirteen runs. A quadratic model was created to predict the biodiesel yield where the R2 value was found to be 0.97, which indicates the satisfactory accuracy of the model. Based on the results, the optimum process parameters for transesterification of the macroalgae Rhizoclonium sp. oil mixture at an agitation speed of 300 rpm over a period of 180 min was found to be a hexane:ether molar ratio 1:1(40 mL), NaOH catalyst concentration of 1 wt% and reaction temperature of 45 °C. Finally, a process optimization found highest macroalgae oil by simple treatment was 0.376 ± 0.14 g and ultrasonic treatment was 6.044 ± 0.81 g is the highest of biodiesel weight. For transesterification reaction from macroalgae oil, a triglyceride was mixed with 0.25 g methanol converted to biodiesel into methyl esters. The biodiesel weight 0.174 ± 0.034 g and 82.2% of the total fatty acid methyl esters (FAME) were confirmed from gas chromatography (GC) analysis. The biodiesel properties were characterized and the results obtained. Design-Expert Version 11 was used to draw both 3D surface plots and 2D contour plots to predict the optimum biodiesel yield.

KEYWORDS: Rhizoclonium sp.; Transesterification; FAME; Response surface methodology (RSM)

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REFERENCES

[1] Ma Y, Liu S, Wang Y, Adhikari S, Dempster TA, Wang Y. Direct biodiesel production from wet microalgae assisted by radio frequency heating. Fuel 2019; 256:115994.

[2] Martinez N, Callejas N, Morais EG, Vieira Costa JA, Jachmanian I, Vieitez I. Obtaining biodiesel from microalgae oil using ultrasound-assisted in-situ alkaline transesterification. Fuel 2017; 202:512–9.

[3] McCurdy AT, Higham AJ, Morgan MR, Quinn JC, Seefeldt LC. Two-step process for production of biodiesel blends from oleaginous yeast and microalgae. Fuel 2014; 137:269–76.

[4] Kumar R, Strezov V, Weldekidan H, He J, Singh S, Kan T, et al. Lignocellulose biomass pyrolysis for bio-oil production: a review of biomass pre-treatment methods for production of drop-in fuels. Renew Sustain Energy Rev 2020; 123.

[5] Nwokoagbara E, Olaleye AK, Wang M. Biodiesel from microalgae: the use of multicriteria decision analysis for strain selection. Fuel 2015;159:241–9.

[6] S. Soumiya GB. Macroalgae : source for sustainable production of biodiesel.