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Master Thesis Defense

Entitled

USING SWITCHABLE SOLVENTS FOR ENHANCED BIODIESEL PRODUCTION.

Faculty Advisor

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Abstract

This thesis presents a sustainable approach to biodiesel production using in-situ technology for direct conversion of microalgae-to-biodiesel. The proposed method operates on wet, untreated microalgae, thereby eliminating the cost/energy intensive drying and cell disruption steps. Owing to their favorable properties, the use of enzymes, specifically lipase, as a catalyst for the process was suggested over acid/base catalysts. However, the high cost of the enzyme necessitates its reuse at sustained activity for the process to be economically feasible. The use of non-toxic green solvents, such as switchable solvents, as an alternative to conventional organic solvents was a significant challenge for the process. The use of thermoresponsive switchable solvents (TSS), which allow solvent hydrophobicity manipulation by changing the temperature, has been used to reduce the complexity of simultaneous cell disruption and oil extraction-reaction from wet microalgal biomass. To enhance the stability and activity of the enzyme, the use of zeolitic imidazole framework (ZIF-8) was suggested. The successful attachment of the enzyme to ZIF-8 was confirmed via Fourier-transform infrared spectroscopy, and the encapsulated lipase@ZIF-8 system demonstrated higher stability than the adsorbed system due to reduced leaching. After five cycles, the encapsulated lipase@ZIF-8 retained 32% of its initial activity compared to 21% for the adsorbed system. An increase in methanol beyond 0.2 mL had a negative impact on enzyme activity, and the FAMEs yield increased significantly up to 3 hours of extraction-duration before reaching equilibrium yield after 5 hours. Increasing the percentages of ionic liquid and polypropylene glycol components in the TSS and reducing the water percentage achieved a higher yield of FAMEs. Further work should be done by using encapsulated Lipase@ZIF-8 and optimization of TSS as this work focused more on the adsorbed Lipase@ZIF-8.

Keywords: Biodiesel; Biofuel; Immobilization; Lipase; Microalgae; Switchable solvents.