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Utilizing crude rice bran lipase immobilized in alginate extracted from *Sargassum ilicifolium* for biodiesel production

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Enzymes are widely used in industries including food, textile, pharmaceutical and biofuel due to their specificity and efficiency under mild conditions. However, their applicability is limited by instability, short lifespan, and challenges in large- scale recovery. This study evaluated the effect of immobilizing lipase in alginate beads on biodiesel production using virgin coconut oil as the substrate. Lipase enzyme and alginate were extracted from rice milling by- products and *Sargassum ilicifolium,* respectively. FT-IR analysis of alginate extracted using formaldehyde (Method B) showed major peaks at 3452 cm^{-1} (O-H stretching), 1600 cm^{-1} (C=O stretching), and 1013.36 cm^{-1} (C-O stretching), closely matching pure sodium alginate. The Lowry assay detected the protein content of crude rice bran lipase as 6.07 $mgmL^{-1}$. Alginate beads were prepared in four different ratios of alginate-to-crude rice bran lipase (1:0.5, 1:1, 1:1.5, 1:4) and stored at 4 °C. Hydrolytic activity was assessed using coconut oil/PVA as a substrate, with the 1:4 ratio showed the highest activity (0.2341 U). Biodiesel is produced through transesterification, where triglycerides react with alcohol in the presence of a catalyst. This was evaluated against alkali-alcohol and free crude lipase methods. Yield of biodiesel, glycerol and density were 49.19%, 26.37%, and 0.743 kg/m^3, respectively, with a higher saponification value (111.41 mg KOH/g) and smoke point (230 °C) compared to the other methods. The use of alginate as a polymer substrate provides a sustainable approach for enzyme reuse in industrial applications. Future studies should focus on optimizing alginate and purification techniques for the reusability of these beads.

Keywords: Alginate, Immobilization, Hydrolysis activity, Rice bran lipase, Sargassum ilicifolium,

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