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Banana Peel Impregnated with Biochar in the Application of Waste Cooking Oil to Biodiesel

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Structured Abstract

Background: Rising energy consumption and environmental concerns are driving a transition from fossil fuels to renewable biofuels which is biodiesel. However, improper waste disposal without any valuable application has led to an increase in emissions, causing global warming and increasing production costs. In addition, the repeated use of waste cooking oil poses serious health and environmental hazards. Therefore, a method of utilizing a solid agricultural waste like banana peels for catalyst generation through the transesterification process could make the system more economical and eco-friendly.

Methods: Heating the banana peel turned the banana peel (BP) into a reusable banana peel biochar (BPB) catalyst. The banana peel (BP) and banana peel biochar (BPB) were characterized to investigate the morphology of the catalyst using X-ray Diffraction (XRD), Thermogravimetric Analysis (TGA), Fourier Transform Infrared (FTIR), Scanning Electron Microscopy (SEM) and Brunauer-Emmett-Teller (BET). Meanwhile, the waste cooking oil (WCO) undergoes a pretreatment analysis to determine its suitability for the transesterification process and Gas Chromatography-Mass Spectrometry (GC-MS) analysis was conducted to determine the fatty acid methyl ester (FAME).

Results: The banana peel biochar shows an amorphous structure and improved thermal stability compared to banana peel. Fourier Transform Infrared (FTIR) analysis indicated the presence of residual oxygen-containing functional groups. Biochar also has a high porosity, high surface area while Scanning Electron Microscopy (SEM) images revealed a rough porous surface morphology of biochar, which was useful to enhance the catalytic performance. The waste cooking oil (WCO) showed free fatty acid value was below 2% which was suitable for the transesterification process. The Gas Chromatography-Mass Spectrometry (GC-MS) results show the percentage of the fatty acid methyl ester (FAME) present in the biodiesel is 0.80%, 66.46%, 27.98% and 8% for Methyl Laureate (C12:0), Methyl Palmitate (C16), Methyl Oleate (C18:1) and Methyl Linoleate (C18:2) respectively.

Conclusion: The study shows that biochar produced from banana peel waste can successfully function as a catalyst in biodiesel production. Its amorphous structure, high surface area, and porosity improve catalytic performance. Combined with suitable waste cooking oil, this approach offers an eco-friendly, cost-effective solution that supports sustainable waste utilization and renewable energy advancement.

Keywords: Banana Peel, Biochar, Waste Cooking Oil, Transesterification, Renewable Energy

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