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Production of Biodiesel-range Compounds via Fast Pyrolysis of Lipid-rich Biomass

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Abstract

Our recent studies have shown that the fast pyrolysis of mixed food waste (MFW) at a particular combination of operating conditions (500 oC temperature, 50 oC/min heating rate, and 10 LPM carrier gas flow rate) produced biodiesel range compounds, fatty acid alkyl esters (FAAEs) as a separate phase with 98% fraction. Detailed mechanistic studies revealed that lipids in MFW decompose into fatty acids, which subsequently reacted with alcohols generated from the decomposition of lignocellulosic components, including cellulose, hemicellulose, and lignin (Agrawal & Yadav, 2025). Building on these findings, a more commercially viable biomass, cotton stalk (CS), was investigated for further research. Although the results from CS pyrolysis were promising, the FAAE yield was lower than that obtained from MFW pyrolysis . It was therefore hypothesized that using another lipid-rich biomass as a co-feed with CS during co-pyrolysis could further enhance FAAE production. Accordingly, MFW was used as a co-feed with CS, and the co-pyrolysis process was optimized by varying the carrier gas flow rate and the mixing ratios of MFW and CS. Three carrier gas flow rates (5, 7.5, and 10 LPM) and five mixing ratios of CS:MFW (90:10, 75:25, 50:50, 25:75, and 10:90) were evaluated to achieve higher FAAE production from co-pyrolysis compared to the individual pyrolysis of each feedstock (Agrawal & Yadav, 2025). Though this study showed enhanced FAAE yield, more suitable biomass for co-pyrolysis is being investigated currently for scaling up this work. The scaling up to pilot level is being done in collaboration with our industry partner (Varhad Capital), who has also financed this research since beginning. The innovation of this route lies in the rapid and direct production of biodiesel through fast pyrolysis of lipid-rich biomass (solid feedstock). Notably, this process does not require an external alcohol supply or catalyst, making it significantly simpler and more efficient. Currently, biodiesel is predominantly produced via transesterification of waste cooking oil (WCO), a comparatively slow process with a need of large amount of external alcohol (oil: alcohol- 1:10), and catalysts. Additional challenges are feedstock heterogeneity, foam formation, and large amount of wastewater generation during purification. The proposed route of biodiesel production via pyrolytic conversion of lipid-rich biomass addresses these challenges with a great scope of providing cushion to already struggling biodiesel industry.

Keywords: Biodesiel, FAAE, fast pyrolysis, lipid-rich biomasss

References

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