RSM Process Optimization of Biodiesel Production from Waste Cooking Palm Oil in the Presence of SO_3H-PSC Catalyst

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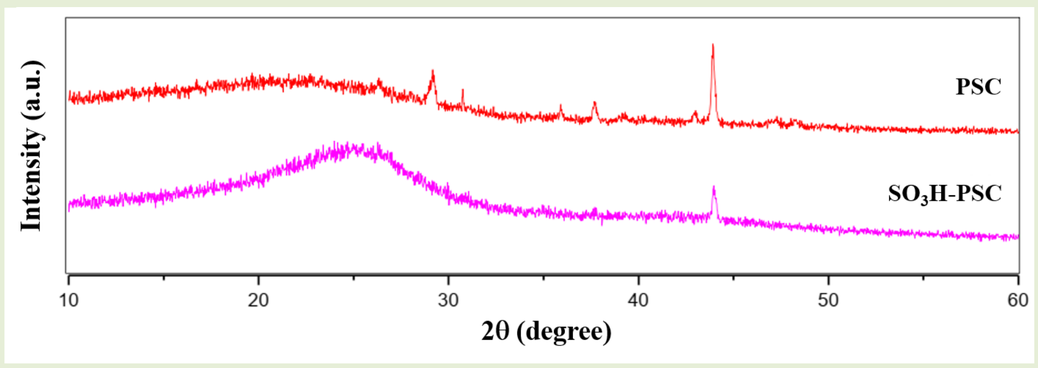

Figure 1. XRD patterns of PSC and SO_3H-PSC samples.

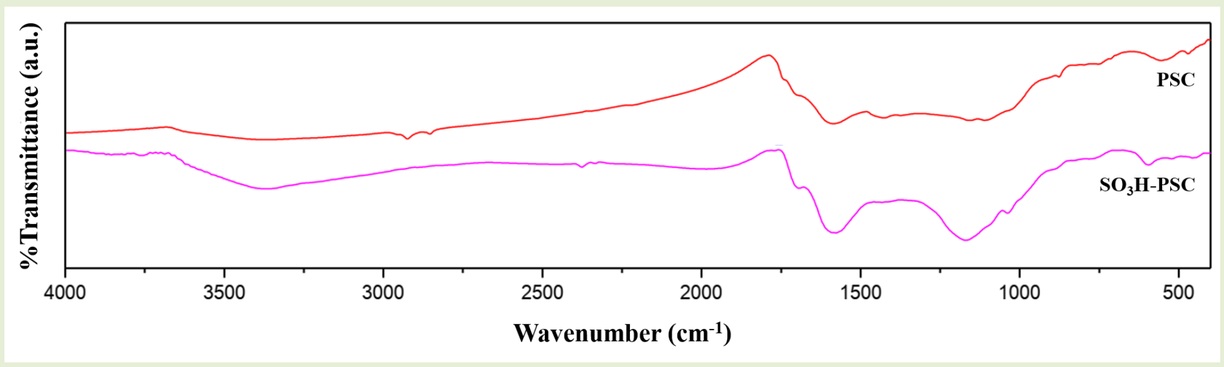

Figure 2. FTIR spectra of PSC and SO_3H-PSC samples.

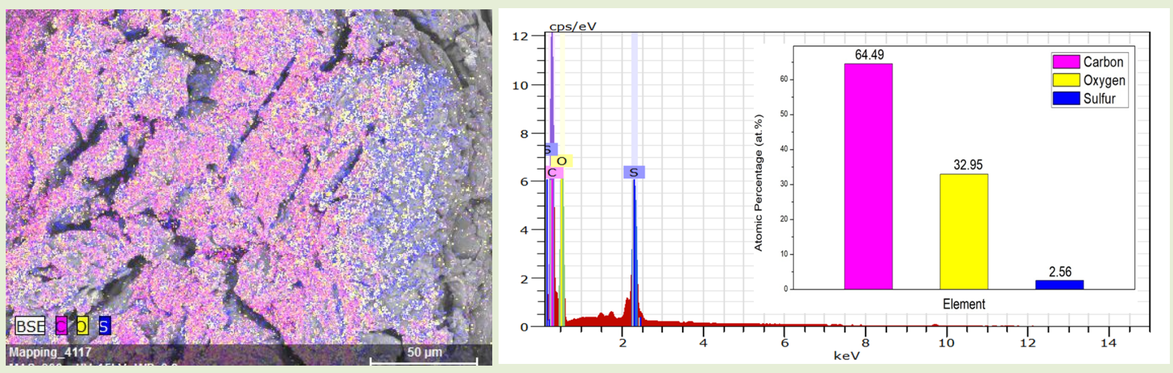

Figure 3. EDS analysis of SO_3H-PSC catalyst.

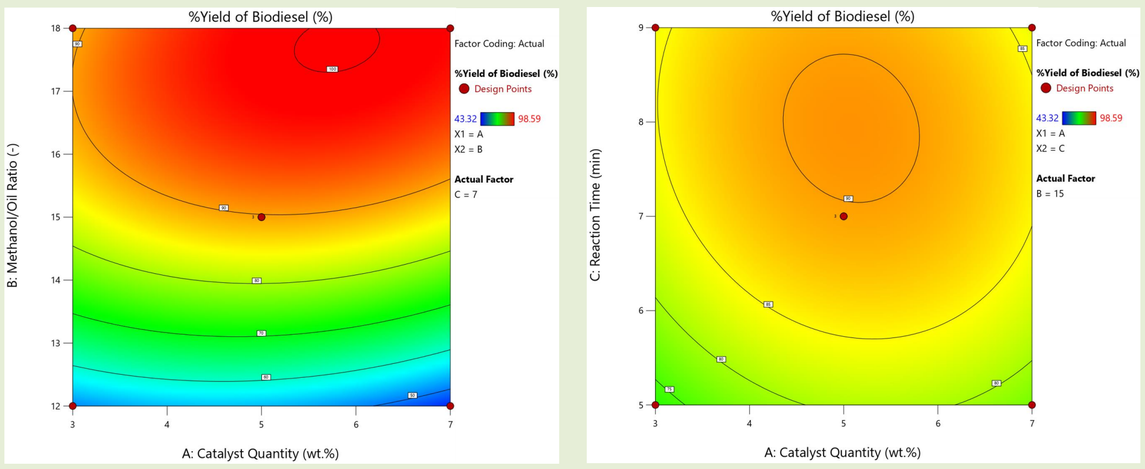

Figure 4. Optimal reaction conditions by contour plots of the catalyst quantity, methanol/oil mole ratio and reaction time, and cubical representation of effects of various parameters on %yield of biodiesel.

Table 1. Factors and levels of process for biodiesel production.

Factors	Levels		
	-1	0	+1
Catalyst quantity (A), wt.%	3	5	7
Methanol/WCPO mole ratio (B), mol/mol	12	15	18
Reaction time (C), min	5	7	9

Objective

The goal of this work is to make the transesterification/esterification of **waste cooking palm oil (WCPO)** more effective by adding a heterogeneous **sulfonated palm seed cake (SO_3H-PSC) derived catalyst** to the reaction system. The solid acid catalyst was synthesized by calcining of waste **palm seed cake (PSC)** and modified with **zine chloride ($ZnCl_2$)** and **sulfonic acid (SO_3H)**.

The choice of raw material for **novel catalyst** synthesis provides a promising way of preparing **"green catalyst"** as it comes from renewable biomass and could be biodegraded easily.

Catalyst Preparation

The **SO_3H-PSC catalyst** was made from **waste material** so that it could be used as the good and cheap source of **activated carbon (AC)**. The soaked PSC with $ZnCl_2$ was then transferred and calcined with tube furnace in N_2 atmosphere at 400 °C for 2 h. The sample will be dispersed in the 100 ml sulfonic acid (SO_3H) and subsequently sonicated for 2 h at 150 °C. Then, the novel catalyst was washed with excess hot distilled water to remove an excess of acid moieties.

Summary

Optimized reaction conditions by **response surface methodology (RSM)** in achieving **98.92% WCPO conversion** were identified as the **5.40 wt.% catalyst quantity**, **17.35:1 methanol/oil molar ratio**, and **8.57 min transesterification time**.

Biodiesel synthesis that employs biological residue and used waste vegetable oil will reduce waste disposal problem and cut the price of biodiesel, making biodiesel a viable fuel alternative compared to petroleum-derived biodiesel.