

Utilization of Biowaste-derived Catalyst for Biodiesel Production: Process Optimization Using Response Surface Methodology and Particle Swarm Optimization Method

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Table of Contents

XPS core level spectra of Ca, Si, Mg, S, P and Cl of mango pill ash (BFPA) catalyst	Fig. S1
EDS result of reusable catalyst after 5 th cycle	Fig. S2
XPS core level spectra of catalyst after 5 th cycle Survey, C 1s, O 1s and K2p	Fig. S3
SEM and TEM image of reusable catalyst after 5 th cycle	Fig. S4

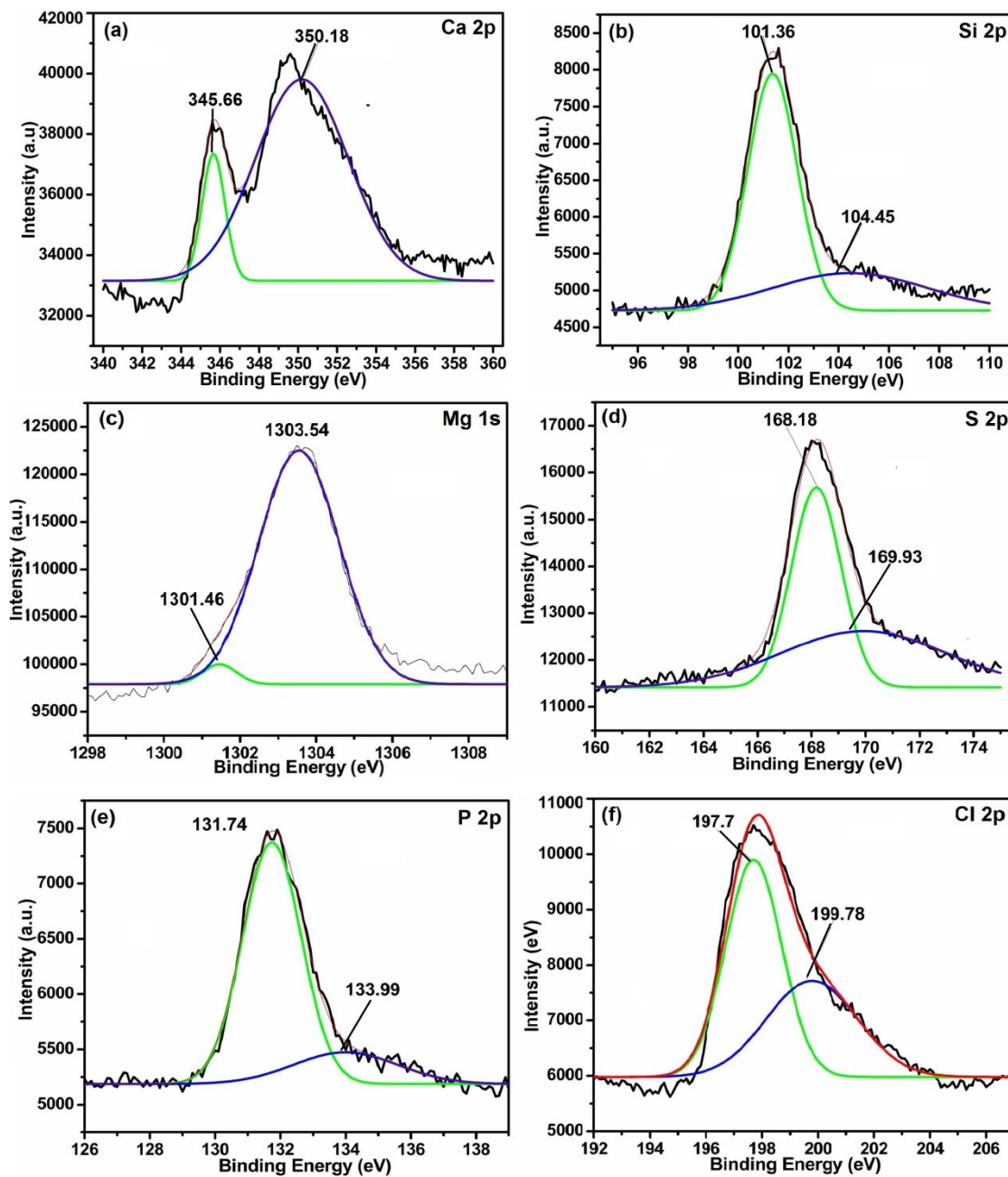


Fig.S1: XPS core level spectra of (a) Ca (b) Si (c) Mg (d) S (e) P and (f) Cl

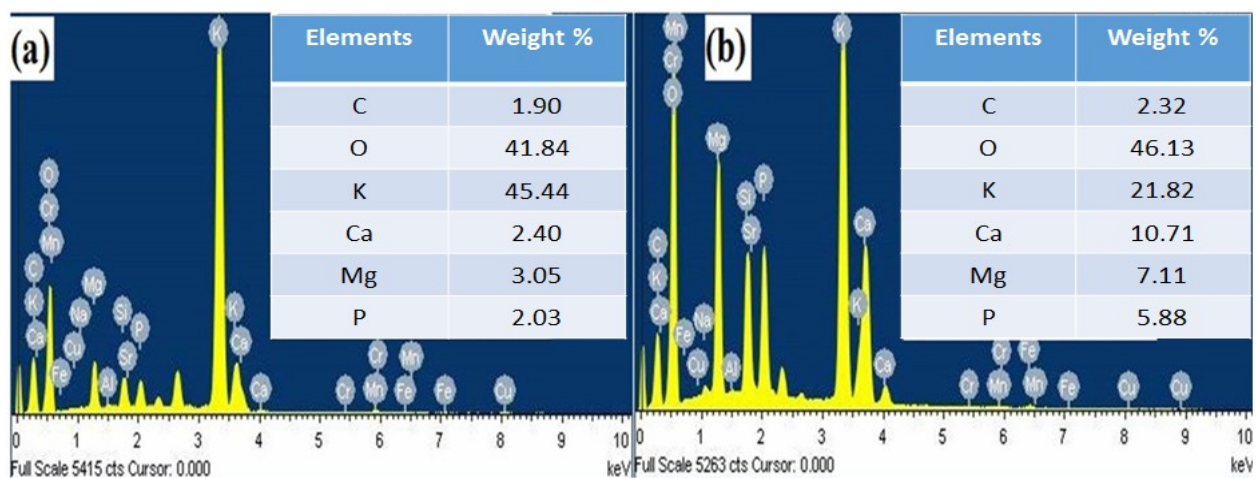


Fig. S2: EDS spectra of (a) fresh BFPFA catalyst (b) reused catalyst after 5th cycle

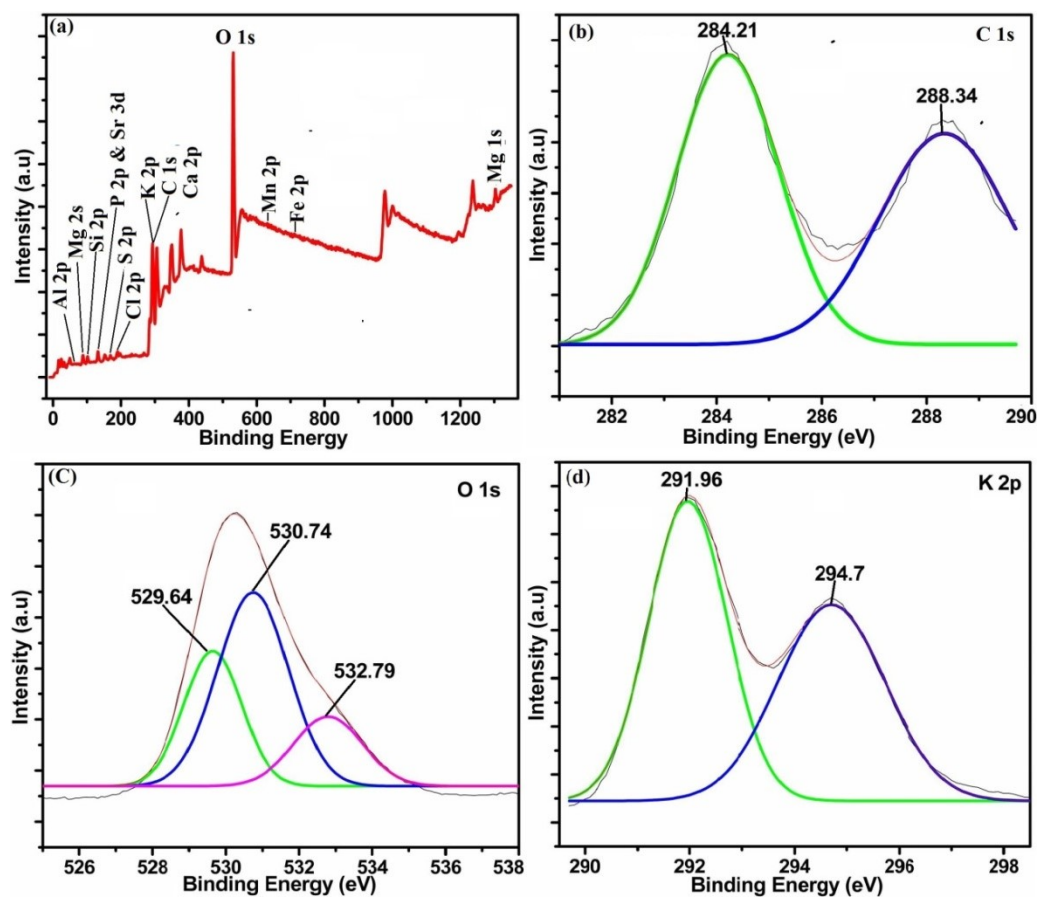


Fig. S3: XPS spectra of catalyst after 5th cycle (a) Survey (b) C 1s (c) O 1s and (d) K2p core level spectra

Table S1: Surface elements of reusable catalyst after
5th cycle determined using XPS

Element	Wt%	At%
O1s	36.83	44.04
K2p	13.79	6.75
C 1s	18.69	29.8
Mg1s	3.71	2.92
Ca2p	10.95	5.23
P2p	5.79	3.58
Si2p	4.31	2.94
S 2p	1.5	0.9
Cl2p	0.14	0.08
Al2p	0.55	0.39
Cu(2p1 & 2p3)	0.26	0.08
Fe2p3	0.2	0.07
Mn (2p1&2p3)	0.83	0.29
Sr3d	2.381861	0.52

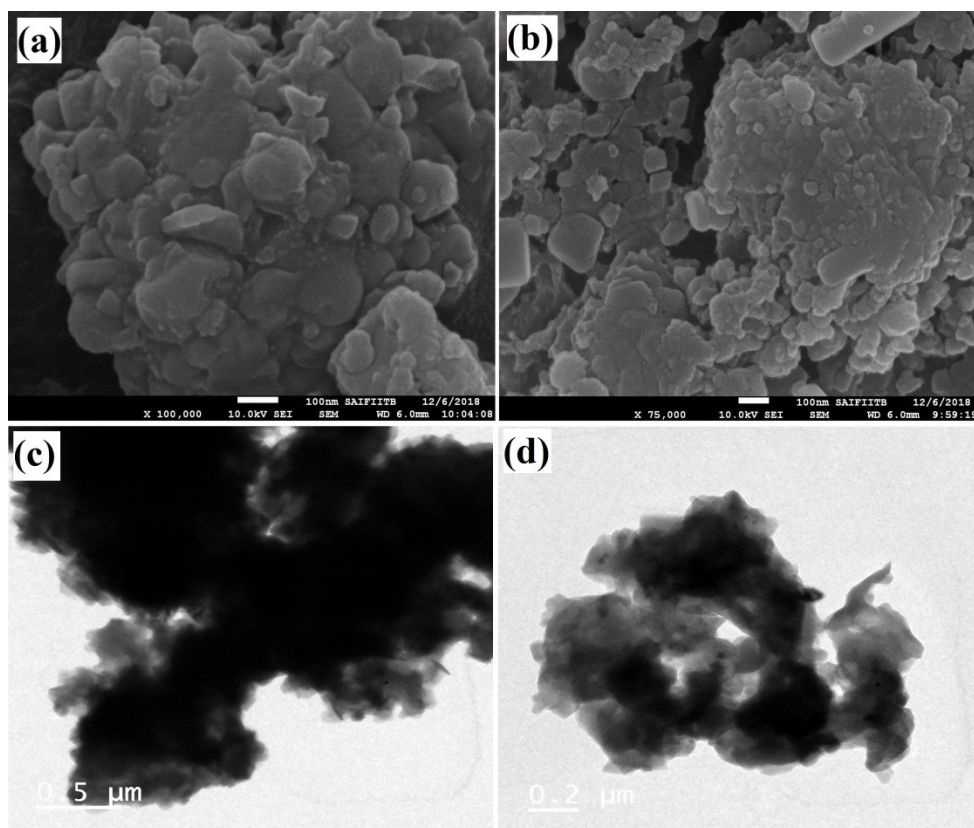


Fig. S4: (a-b) SEM images (c-d) TEM images of BFPA catalyst after 5th cycle

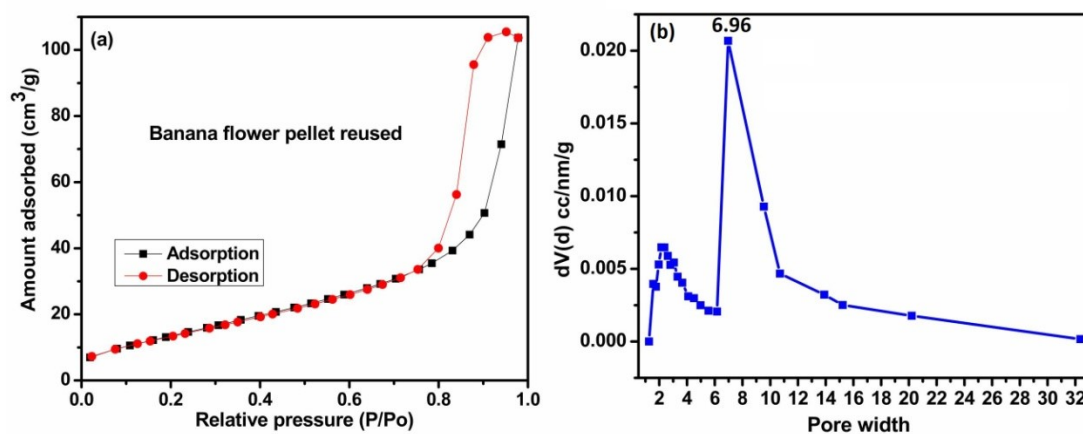


Fig. S5: BET results of reusable catalyst after 5th cycle (a)N₂ adsorption- desorption isotherm (b) pore size distribution