ELECTRONIC SUPPORTING INFORMATION

Valorisation of corncob residues to functionalised porous carbonaceous materials for simultaneous esterification/transesterification of waste oils

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Materials and methods



Figure 1. Materials and Products Obtained. A) ground cobs; b) waste oil; c) carbonized and sulfonated corn cobs; d) FAME diluted with heptane.



Figure 2. Set-ups and Instruments used. a) Sulfonation Set-up; b) Furnace used for carbonization; c) Transesterification/Esterification Set-up; d) Gas Chromatograph for analysis.



FTIR SPECTRA

Figure 3. IR Spectra of samples carbonized at 400°C.







Figure 5. IR Spectra of samples carbonized at 600°C.



Figure 6. SEM Image of S-400-10-0 at 1300x.



Figure 7. SEM Image of S-500-5-0 at (a) 500x, (b) 900x, and (c) 2000x.



Figure 8. SEM Image of S-500-10-0 at (a) 400x, (b) 2500x, and (c) 700x.



Figure 9. SEM Image of S-600-5-0 at (a) 370x, (b) 4000x, and (c) 800x.



Figure 10. SEM Image of S-600-10-0 at (a) 400x, (b) 1100x, and (c) 800x.

S-400-5-0



Relative Pressure (P/Po)

Figure 11. Representative isotherm profile of S-400-5-0 and S-400-10-0.



S-500-5-0

Figure 12. Representative isotherm profile of S-500-5-0 and S-500-10-0.



S-600-5-0

Figure 13. Representative isotherm profile of S-600-5-0 and S-600-10-0 materials.

ELEMENTAL ANALYSIS, SURFACE AREA, AND POROSITY DATA

 Table 1. Percentages of Carbon, Oxygen, Silicon, and Sulfur Present in the Catalyst samples (Elemental Analysis).

Sample	% C	% O	% Si	% S
S-400-5-0	70.43	28.75	0.26	0.62
S-400-10-0	74.70	24.11	0.36	0.89
S-500-5-0	75.61	22.82	0.45	0.85
S-500-10-0	82.09	16.20	0.88	0.87
S-600-5-0	82.24	16.21	0.39	1.13
S-600-10-0	80.76	17.70	0.44	1.10

Table D2.	Surface Ar	ea and Pore	Volume of	the samples	with their	corresponding
interpreta	tions					

Sample	Surface Area (m ² /g)	Pore volume (mL/g)	Conclusion		
S 400 5 0	4	0	Non nonous		
5-400-5-0	4	0	Non-porous		
S-400-10-0	118	0.38	Porous	w/ interparticular macroporosity	
S-500-5-0	30	0.29	Porous	w/ interparticular macroporosity	
S-500-10-0	93	0.31	Porous	w/ interparticular macroporosity	
S-600-5-0	97	0.22	Porous	w/ interparticular macroporosity	
S-600-10-0	74	0.29	Porous	w/ interparticular macroporosity	

1. Viscosity and Density

Table E1. Raw Data for the Viscosity of the Used Cooking Oil

Trial	t	Density	Viscosity	t	Density	Viscosity	Average	%RSD
	$(C_6H_6),$	$(C_6H_6),$	$(C_6H_6),$	(oil),	(oil),	(oil),	Viscosity,	
	S	g/mL	cP	S	g/mL	cP	cP	
1	25.67	0.879	0.567	4644	0.9228	107.7		
2	25.96	0.879	0.567	4680	0.9228	107.3		
3	25.89	0.879	0.567	4701	0.9228	108.1	107.7	0.004

Sample Calculation:

Viscosity (oil) =
$$\frac{\text{Viscosity}(C_6H_6) * t \text{ (oil) } * \rho_{\text{oil}}}{t_{C6H6} * \rho_{C6H6}}$$

$$= \frac{(0.567 \text{ cP})(4644 \text{ s})(0.9228 \text{ g/mL})}{(25.67 \text{ s})(0.8794 \text{ g/mL})} = 107.7 \text{ cP}$$

Table E2. Raw Data for Density of Used Cooking Oil

Trial	Mass (empty	Mass	Mass	Volume	Density,	Average	%RSD
	pycnometer),	(pycno +	(oil), g	(pycno),	g/mL	Density,	
	g	oil), g		mL		g/mL	
1	29.0116	52.0665	23.0549	25	0.922196		
2	28.9784	52.0672	23.0888	25	0.923552		
3	29.0001	52.0636	23.0635	25	0.922540	0.922763	0.001

Sample Calculation:

$$\rho$$
 (g/mL) = $\frac{\text{mass oil (g)}}{\text{volume pycno (mL)}} = \frac{23.0549 \text{ g}}{25 \text{ mL}} = 0.922196 \text{ g/mL}$