Biodiesel production from residual cooking oils and its purification through adsorption processes using activated carbon prepared from cork waste

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INTRODUCTION

Biodiesel is a renewable fuel that can be produced from waste cooking oil mainly through transesterification [1]. However, from its production results a contaminant called glycerol, which must be removed. Wet washing is the most common method for biodiesel purification, but it has several drawbacks, including high costs and the generation of large amounts of aqueous effluent [2]. This study proposes using activated carbon obtained from industrial cork waste in adsorption as an alternative method for glycerol removal. This approach could potentially reduce the environmental impact and cost of producing biodiesel, while also providing an alternative for the valorization of industrial cork waste.

EXPERIMENTAL

Figure 1 summarizes the experimental process. First, the ester yield in biodiesel production was optimized by its temperature and oil:alcohol ratio. In the activated carbon production, residual cork powder was pyrolyzed at 550°C for 1h and 2h, followed by a chemical activation with KOH for 2h at 750°C. Besides raw cork, all produced materials were studied for glycerol removal from biodiesel through adsorption. Kinetics and equilibrium mechanisms were studied in order to evaluate the adsorption process.

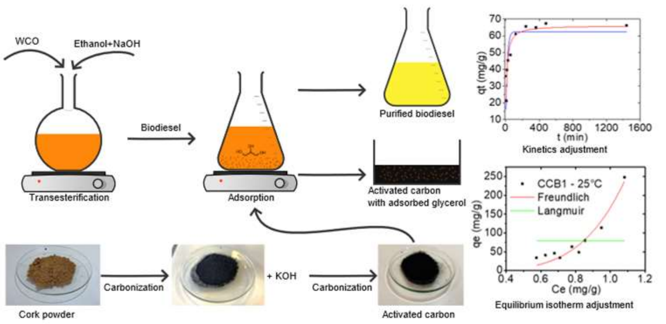


Figure 1 – Scheme of the experimental process.

RESULTS

The studies showed that the best Fatty Acid Ethyl Esther's yield of 88.26%, was achieved with a reaction temperature of 30°C, 1%wt catalyst load and 1:9 oil:alcohol molar ratio.

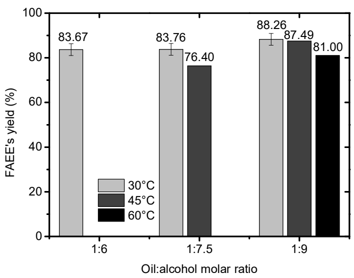
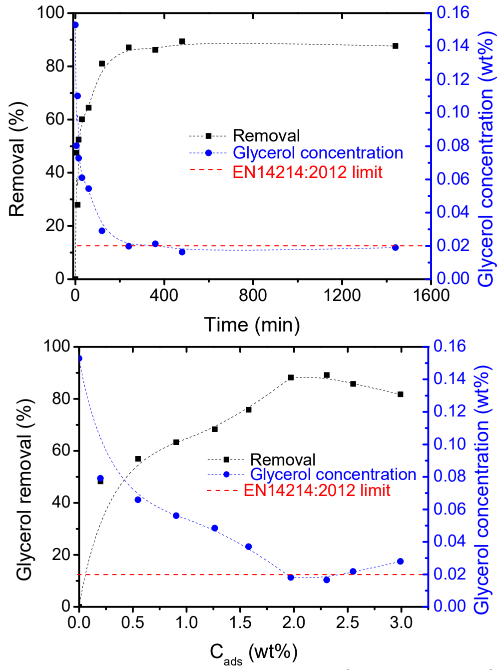


Table 1 - Cork and activated carbons characterization.

Material	S_{BET} (m^2/g)	C/H[a]	pH_{PZC}
Cork	5.16	0.65	4.64±0.15
CC1	203.65	3.07	10.47±0.05
CC2	64.41	3.18	10.40±0.02
CCB1	2057.25	11.21	9.76±0.00
CCB2	1687.22	11.40	8.71±0.02

Table 2 - Parameters obtained in the adsorption with CCB1 at 25°C.

Pseudo-second order adjustment parameters	k_2 ($g.mg^{-1}min^{-1}$)	q_e ($mg.g^{-1}$)	R^2
	0.001	66.25	0.7958
Freundlich isotherm adjustment parameters	K_F	n	R^2
	167.44	0.223	0.9391



Figures 2 and 3 – Glycerol removal and content for biodiesel purified with CCB1. Effect of time and adsorbent load; red line shows the limit specified by EN14214:2012.

CONCLUSIONS

- ✓ Biodiesel produced at 30°C with 1:9 oil:alcohol ratio has a higher ester yield;
- ✓ Carbonization and activation processes resulted in increased surface area and higher C/H molar ratios compared to cork powder;
- ✓ Cork powder and CCB1 demonstrated superior glycerol removal capacity for the purification of crude biodiesel;
- ✓ The most effective glycerol removal occurred at 25°C using 2%wt CCB1. This approach achieved a glycerol removal rate of approximately 88%, resulting in a final glycerol content of 0.017%wt, in accordance with the EN14214:2012 standard.

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