REMOVAL OF ESTROGENS FROM WATER USING ACTIVATED CARBON ADSORBENT MATERIALS PREPARED FROM OLIVE STONES

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INTRODUCTION & MAIN OBJECTIVE

Estrogens belong to the class of water micropollutants named as endocrine disrupting chemicals and are considered persistent substances in the environment. Estrogens are a type of hormones that are continuously released to environment presenting several undesirable effects on aquatic species and human health even when present at very low concentrations (trace levels) [1, 2]. Additionally, it is known that traditional sewage and drinking water treatment plants are not able to remove or degrade these compounds and additional treatments are required [3, 4].
Activated carbons (ACs) are low-cost carbonaceous materials with a high surface area. ACs undergo an activation process in order to increase its adsorption performance. Activation can be performed by physical treatment, in which the organic material is thermal treated with an atmosphere of air, CO_2, and water vapor, or also by applying some chemical treatments using generally, strong acids, chloride salts or strong bases [5].
With this work, we present an extensive set of experimental results that shows the valorization of olive stones residues to prepare activated carbons to be used as adsorbent for the removal of estrone (E1), 17β-estradiol (E2) and 17α-ethinylestradiol (EE2) by adsorption from water.

PREPARATION OF ADSORBENTS

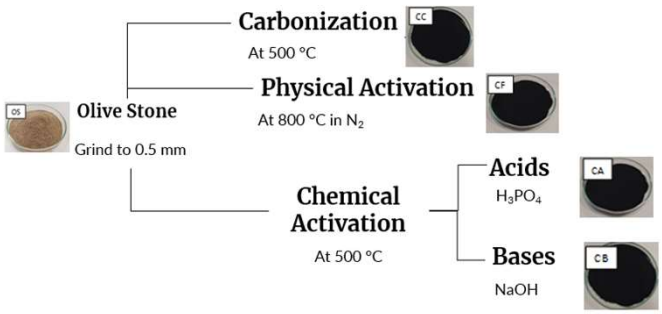


Figure 1. Production of five olive stone adsorbents.

CHARACTERIZATION OF ADSORBENTS

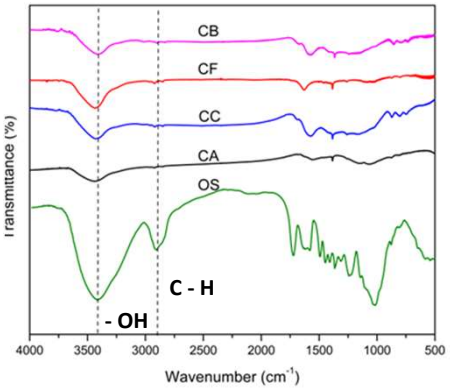
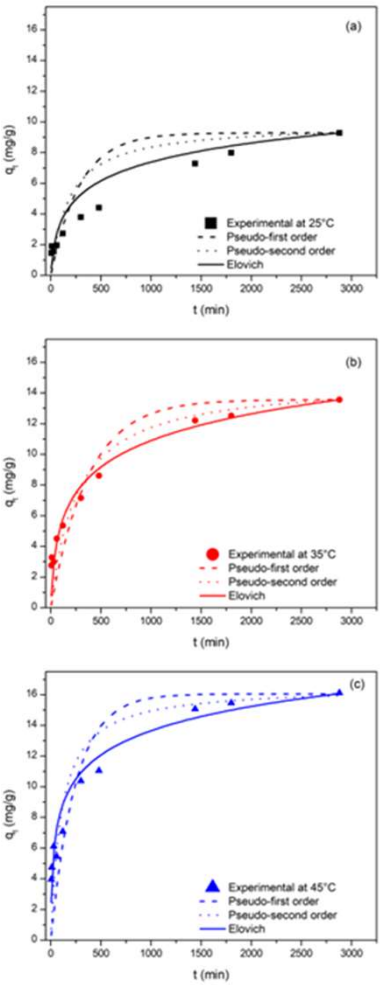


Figure 2. FTIR analysis of the five prepared adsorbents.

Table 1. Some surface properties and estrogen removal using five olive stone adsorbents.

Adsorbents	Yield (%)	pH_{PZC}	S_{BET} (m^2/g)	Total estrogens removal (%)
OS	-	5.43	4	24.2
CF	23.0	8.64	14	24.9
CC	26.9	8.46	67	51.2
CA	**57.5**	**3.84**	**590**	**96.4**
CB	33.9	8.92	27	36.6

ADSORPTION KINETICS



Pseudo-first ordem

$$q_t = q_{e,1}(1 - e^{-k_1 t})$$

Pseudo-second ordem

$$q_t = q_e - \frac{q_e}{K_2 q_{e,2} t + 1}$$

Elovich

$$q_t = \frac{1}{\beta}\ln(1 + \alpha\beta t)$$

Time	5 to 2880 min
Stirring	150 rpm
Initial concentration	2 mg L^{-1}
pH	7.0

Figure 3. Adsorption kinetics of total estrogens for 15 mg of CA activated carbons in temperatures of 25°C (a), 35°C (b) and 45°C (c).

CONCLUSIONS

- Acid activation increased the surface area (590 m^2/g) and carbonization yield (57.45%).
- Acid activation decreased the pH_{PZC} (3.84).
- Activated carbons are promising for the removal of estrogens by adsorption: 96.4% for activated carbon CA.
- The increase in temperature favored the removal of estrogens E2, EE2 and E1.
- The models that best fit to the experimental data were first the Elovich model, then the pseudo-second order. This indicates that the adsorption of estrogens in this adsorbent occurs through a chemisorption process.

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