REMOVAL OF NAPROXEN FROM WATER USING ADSORBENTS OBTAINED FROM LOW-COST MATERIALS

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INTRODUCTION & MAIN OBJECTIVE

The continuous growth of world population together with the strong urbanization has triggered an increasing demand for freshwater which has resulted in a serious deterioration of water bodies [1]. Water pollution with pharmaceutical drugs is becoming a relevant problem. The concentration of non-steroidal anti-inflammatory drugs, estrogens, personal care products, among others, in waterways is reaching hazardous levels, posing a threat to the environment and human health. Moreover, conventional cleaning and degradation processes applied on wastewater treatment plants are inefficient to eliminate or remove these compounds. Adsorption is a treatment process considered as effective process used to remove micropollutants such as pharmaceutical drugs from wastewaters [2, 3].

This work will present the main experimental results obtained for the removal of naproxen, a representative anti-inflammatory drug, from water by adsorption using activated carbon obtained from olive stone. From the raw material, four different types of activated carbon adsorbent were prepared and characterized. The equilibrium adsorption isotherms were measured using the batch method. The most significant adsorption parameters were optimized, such as the solution pH, mass of the adsorbent, contact time and temperature. Four types of activated carbon materials were prepared from olive stones, the olive pits were powdered to an average diameter of 0.25 mm (type 1), then chemically activated with a strong acid (type 2) and then carbonized at 500ºC (type 3) or pyrolyzed at 800ºC (type 4). The batch method was applied to experimentally measure the equilibrium adsorption isotherms. The most significant adsorption parameters were optimized, such as the solution pH, mass of the adsorbent used, adsorption contact time and adsorption temperature.

PREPARATION OF ADSORBENTS (OSAC)

OLIVE STONES → GRIDING (0.25 mm) → ACTIVATION (H_2SO_4, 10%) → WASHING (Ultrapure water) → DRYING (AMBIENT & OVEN) → CARBONIZATION (550°C) → PYROLYSIS (800°C) → CHARACTERIZATION

CHARACTERIZATION OF THE ADSORBENTS

Table 1. Textural properties of the OSAC (type 4).

S_{BET} (m^2/g)	$S_{Langmuir}$ (m^2/g)	S_{ext} (m^2/g)	$S_{micropores}$ (m^2/g)	$V_{micropores}$ (mm^3/g)	V_{mic}/V_{Total} (%)	$W_{micropores}$ (nm)
409	608	16	393	213	92	2.2

Table 2. Physicochemical properties of OSAC (type 4).

Acidic sites (µmol H^+/g adsorbent)	Acidic sites (µmol H^+/g adsorbent)	pH_{ZC}
877.4	44.7	3.17

QUANTIFICATION BY HPLC CHROMATOGRAPHY

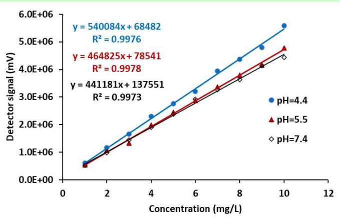


Fig. 1. Effect of pH in the calibration curve.

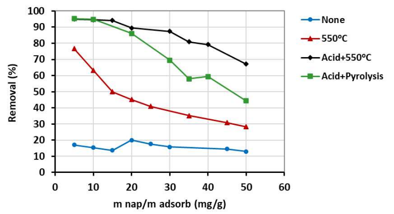
INITIAL CONDITIONS FOR ADSORPTION STUDIES

Temperature	25 °C
Agitation	150 rpm
Sertraline initial Concentration	20 mg/L
Volume	50 mL
Adsorbent mass	50 mg

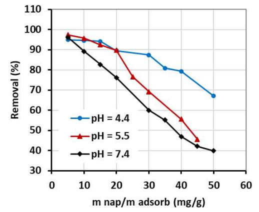
ADSORPTION EQUILIBRIUM AND KINETICS

Batch method: $q_t = \frac{(C_0 - C_t) \times V}{m_{ads}}$ $Removal\ (\%) = \frac{C_0 - C_e}{C_e} \times 100$

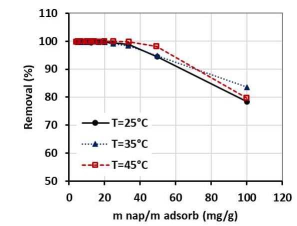
EFFECT OF TYPE OF ADSORBENT



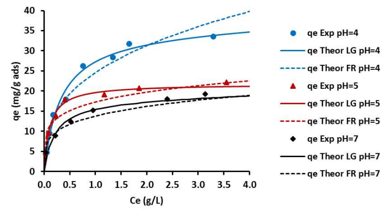
EFFECT OF pH SOLUTION



EFFECT OF TEMPERATURE



ADSORPTION EQUILIBRIUM



Langmuir model $$q_e = q_m \frac{K_L \times C_e}{1 + K_L \times C_e}$$

Freundlich model $$q_e = K_F \times (C_e)^{\frac{1}{n}}$$

KINETICS STUDY

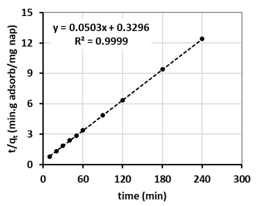
PSO model

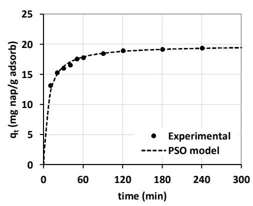
$$\frac{dq_t}{dt} = k_2 (q_e - q_t)^2$$

PSO model after linearization

$$\frac{t}{q_t} = \frac{t}{q_e} + \frac{1}{k_2 q_e^2}$$

$$q_e = 19.87\ mg_{naproxen}/g_{adsorbent}$$
$$k_2 = 0.00769\ M^{-1}s^{-1}$$





CONCLUSIONS

- From olive stones raw material, four types of adsorbents were prepared, characterized and studied for the removal of naproxen from waters.
- The produced adsorbent present a considerable volume of micropores (84% of the total volume) and significant superficial (BET) area of 411 m2/g. The type III adsorbent material presented the higher adsorption capacity of 37.0 mg of naproxen/g of adsorbent.
- The adsorption conditions were found to be better with a 24 h adsorption time, 150 rpm agitation, a temperature of 25°C and a pH value of 4.4.
- The Langmuir model was selected to better describe the adsorption behaviour of naproxen in the OSAC adsorbent. Finally, the pseudo-second order model was found to better describes the kinetic adsorption behaviour of naproxen into the OSAC adsorbent.
- The results presented in this work clearly indicate that the olive stone activated carbon presents is an excellent material for naproxen removal from waters, when compared with other bio-based materials or even when compared with commercial adsorbent materials.

REFERENCES

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