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ADSORPTION OF NON-STEROIDAL ANTI-INFLAMMATORY PHARMACEUTICAL RESIDUES USING ACTIVATED CARBON FROM WASTEWATER

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Introduction

The detection and quantification of pharmaceutical compounds and their degradation products in wastewater are being studied with interest due to the adverse effects they may have on human health and aquatic life. The concern related to persistent exposure to random combinations of pharmaceutically active compounds in wastewater are due to their toxic, carcinogenic and mutagenic potential.

Due to the large number of pharmaceuticals and different physico-chemical properties, pharmaceutical residues, are often inefficiently removed from conventional wastewater treatment. The present study indicates that pharmaceutical residues such as non-steroidal anti-inflammatory drugs (acetaminophen, diclofenac, ibuprofen and ketoprofen) found in wastewater can be removed with activated carbon. The physico-chemical properties (hydrophobicity, molecular size and structure, solubility and acid dissociation constant (pKa)) of pharmaceutical compounds tend to have a strong impact on adsorption. Thus, hydrophobic compounds tend to have a higher affinity for adsorption on various materials. Activated carbon may be a suitable material for removing non-polar or moderately polar compounds.

Materials and methods

Ibuprofen (purity ≥ 97.0%), Paracetamol (purity ≥ 95.0%), Diclofenac (purity ≥ 99.0%) and Ketoprofen (purity ≥ 99.0%) were obtained from Sigma-Aldrich. The solvents used for liquid chromatography analysis, Acetonitrile and Methanol were purchased from Honeywell, and Ammonium Acetate was obtained from Sigma-Aldrich. The activated carbon was purchased from Trace Elemental Instruments with a particle size between 10-50 µm.

The aim of this study was to investigate the effect of different experimental parameters on the performance of an adsorption system for the retention of four pharmaceutical compounds from wastewater on activated carbon.

Adsorption experiments were performed in 100 mL conical flasks. Stock solutions were prepared in methanol, and subsequent dilutions were performed using wastewater matrices as sample diluent. Volumes of 50 mL of different

concentrations (1mg/L, 5 mg/L and 10 mg/L) of each studied anti-inflammatory were contacted with 0.1 g, 0.5 g and 1 g of activated carbon and stirred on Shaker - orbital at 250 rotations. After each experiment the supernatant was filtered and subjected to HPLC analysis at different wavelengths corresponding to the analytes of interest (acetaminophen at 248 nm, diclofenac at 280 nm, ketoprofen at 255 nm and ibuprofen at 220 nm). The detector response was linear in the range 0.5-20 mg/L, with correlation coefficients values (R2) higher than 0.999 for each of the four anti-inflammatory drugs studied. After method development, the performance parameters were evaluated: linearity, accuracy, detection limit (LOD), quantification limit (LOQ).

Results and conclusions

In the study, a competitive absorption between the four pharmaceutical compound and the amount of activated carbon, was tested. Due to the complex wastewater matrices, energy field levels in active sites could suffer modification, causing competition between compounds that can be adsorbed on activated carbon.

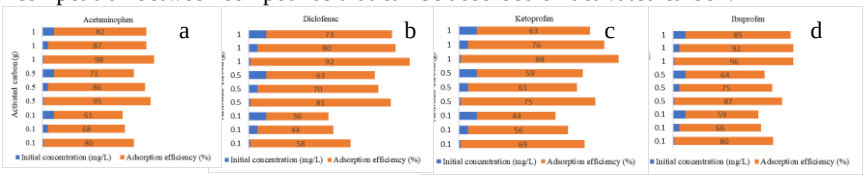

Fig.1. The removal efficiency of acetaminophen (a), diclofenac (b), ketoprofen (c) and ibuprofen (d) using different amounts of activated carbon

The removal efficiency increased considerably when the amount of adsorbent material was increased from 0.1 g to 1 g of activated carbon. The highest adsorption efficiencies of 98% for acetaminophen (Figure 1a) and 92% for diclofenac (Figure 1b) were achieved at 1 mg/L for each pharmaceutical compound and 1 g of adsorbent material.

The highest adsorption efficiencies, 88 % for ketoprofen (Figure 1c) and 96% for ibuprofen (Figure 1d) were obtained experiments conducted at 1 mg/L of ketoprofen/ibuprofen, and 1 g of activated carbon.

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