Nanomodified activated carbon produced from yeast residues: application in the removal of hormones in water

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Introduction

Due to the advances in medical researches, the use of hormones in several drugs, such as contraceptives, has become increasingly common. Consequently, this fact has led to an increase in these contaminants in water bodies and has been characterized as a global problem, causing several health problems to living organisms. In addition, it has contributed to environmental imbalance, and water or sewage treatment plants cannot remove these substances. Biosorption arises in the face of this pollution concern, considered a sustainable, efficient, and low-cost option. The process consists of retaining contaminants from an aqueous medium from naturally occurring solids or their derivatives. Activated carbon is a biosorbent with great adsorbent power due to its high surface area and the presence of several functional groups on its surface, being a highly porous material and presenting a broad range of pore sizes. Nanotechnology allows obtaining biomass particles at the nanoscale. The impregnation of magnetic nanoparticles is reported as an alternative to improve the sorption capacity of the material, enhancing this process.

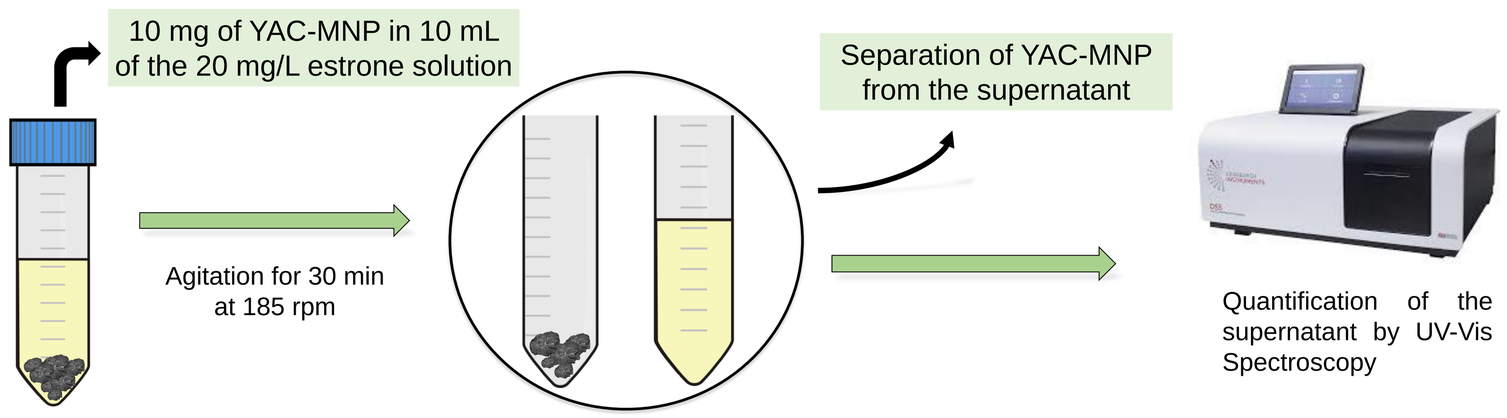
Goals

This work proposes to evaluate the potential of a biosorbent (activated carbon) produced from yeast residues of the sugar and alcohol industries and its nanomodification with magnetite (Fe_3O_4) to be used in the removal of estrone (E1) from contaminated aquatic environments.

Material and Methods

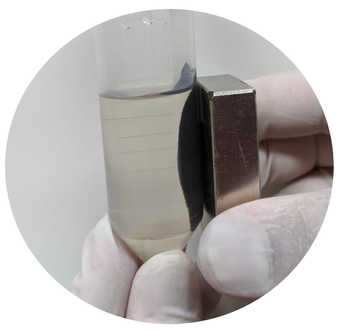
Preparation of yeast activated carbon magnetic nanocomposite (YAC- MNP):

Batch process used to evaluate the sorption capacity of the estrone by YAC-MNP



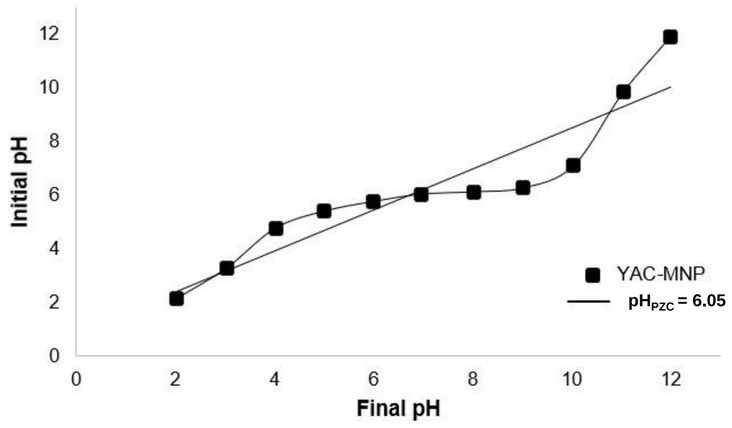
Results and Discussion

Magnetization effect of yeast activated carbon magnetic nanocomposite (YAC-MNP) in estrone solution

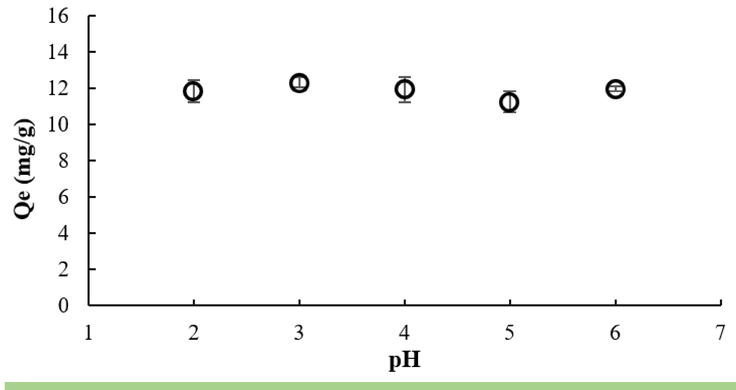


Point of zero charge pH_{PZC}

The pH at the point of zero charge (pH_{PZC}) of YAC-MNP, with a dosage of 1 g/L of the nanocomposite and 0.1 mol/L NaCl solution in the range of pH 2-12.

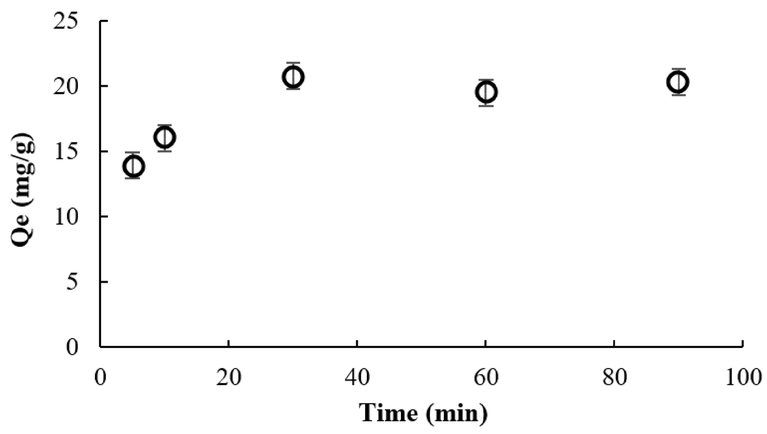


pH assessment

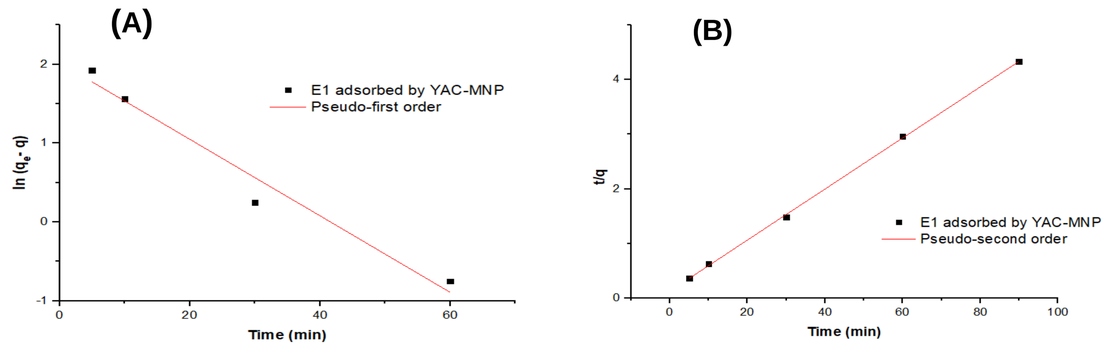


Effect of pH increase on the removal capacity of E1 by YAC-NP, using 10 mg of the biosorbent with 10 mL solution of 20 mg/L of E1. n= 2

Sorption kinetics



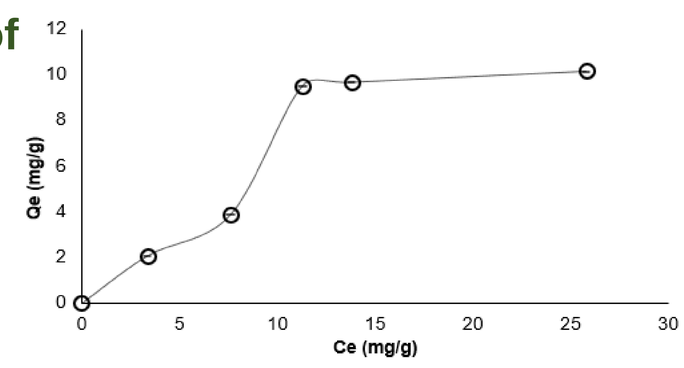
Effect of kinetic increase on the removal capacity of E1 by YAC-MNP, using 10 mg of the biosorbent with 10 mL solution of 20 mg/L of E1.



Kinetic adjusts using the (A) Pseudo-first order and (B) pseudo-second order model by YAC-MNP, using 10 mg of biosorbent suspended in 10 mL of 20 mg/L E1 solution.

Adsorption profile of estrone by YAC - MNP

Adsorption profile of E1 by YAC-MNP, using 10 mg of the biosorbent with 10 mL of solutions in increasing concentrations between 5 and 40 mg/L. n = 2



Conclusions

The synthesized material is presented as a promising biosorbent to remove estrone in aqueous medium at all pH valuesinvestigated, reaching up equilibrium in 30 min. The presence of magnetic nanoparticles MNP facilitates the removal of the E1-containing biosorbent. Therefore, YAC-MNP showed the potential as an efficient, abundant, and low-cost material produced from the sugar and alcohol industry residues to remove hormones from water.

Acknowledgments

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