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MICROWAVE-ASSISTED PRODUCTION OF ACTIVATED CARBON FROM BREWERY WASTES FOR THE REMOVAL OF ANTIBIOTICS FROM WATER

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Abstract

The occurrence and fate of antibiotics in the aquatic environment has become a very serious problem as they can potentially and irreversibly damage ecosystems and human health due to the promotion of antibacterial resistance. For this reason, interest in developing strategies to remove these microcontaminants from water has increased. Adsorption by activated carbon (AC) has been proven to be an effective technology for the removal of antibiotics from water. The application of industrial wastes as AC precursors contributes to the sustainability of these adsorbents, avoiding the use of non-renewable raw materials. In addition, the utilization of microwave radiation instead of conventional pyrolysis in the production of AC allows for a faster and more energy efficient process, with much shorter production procedures (Sousa, et. al. 2021)[1]. In this study, main factors affecting AC production (nature of the activating agent (KOH and K_2CO_3), activating agent:precursor ratio, pyrolysis temperature and residence time) were studied in order to determine the optimal conditions when using spent brewery grain (a major solid by-product or the brewing industry) as precursor. For this purpose, a fractional factorial design using mixed levels was applied to evaluate the effect of the referred factors on several relevant responses, namely yield of production (%), specific surface area (S_{BET}), total organic carbon (TOC) and adsorption percentage of the antibiotics sulfamethoxazole (SMX), trimethoprim (TMP) and ciprofloxacin (CIP) from water. The statistical analysis revealed that the temperature was the main factor affecting all the considered responses. Under optimized conditions (K_2CO_3, microwave pyrolysis at 800 °C during 20 min and a K_2CO_3:precusor ratio of 1:2) an AC with S_{BET} of 1405 $m^2\ g^{-1}$, 65 % of TOC and adsorption percentages from 82 % to 94 % was obtained and selected for further characterization and evaluation of its kinetic and equilibrium adsorptive behaviour. The obtained results were well-described by the pseudo-first order kinetic model and the Langmuir equilibrium isotherm, with maximum adsorption capacities of 859 µmol g^{-1} (SMX), 790 µmol g^{-1} (TMP) and 621 µmol g^{-1} (CIP). Overall, obtained results demonstrate that spent brewery grain is a promising precursor to produce AC for the removal of antibiotics from water.

Keywords: spent brewery grains, adsorption, antibiotics, water treatment.

Reference

[1] Sousa et.al. *Science of the total environment,* 752, 141662, **2021.**

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