

High-performance removal of 2,4-dichlorophenoxyacetic acid herbicide in water using activated carbon derived from Queen palm fruit endocarp (*Syagrus romanzoffiana*)

Yamil L. de O. Salomón; Jordana Georjin; Dison S. P. Franco; Matias S. Netto; Daniel G. A. Piccill; Edson Luiz Foletto; Luis F. S. Oliveira; Guilherme L. Dotto

Abstract

In this work, an activated carbon sample with a high adsorptive performance for the herbicide 2,4-dichlorophenoxyacetic acid (2,4-D) was prepared from queen palm endocarp (*Syagrus romanzoffiana*) by pyrolysis process. The activated carbon presented an XRD pattern related to carbon graphite and functional groups such as C–H, C=O, O–H. The material particles presented a highly-porous structure, being beneficial to the adsorption process. The activated carbon showed a remarkable specific surface area of $782 \text{ m}^2 \text{ g}^{-1}$ and pore volume of $0.441 \text{ cm}^3 \text{ g}^{-1}$. The solution pH presented a strong influence on the adsorption process, with ideal pH = 2, being the best adsorbent dosage, 0.5 g L^{-1} . The correspondent removal percentage was 95.4%. The pseudo-second-order model represented kinetic data, presenting $R^2 > 0.992$ and $\text{MSR} < 19.62 \text{ (mg g}^{-1}\text{)}^2$. The Langmuir model was the most suitable for describing the equilibrium data with the highest $R^2 (> 0.997)$ and lowest values of MSR ($< 92.04 \text{ (mg g}^{-1}\text{)}^2$), indicating a maximum capacity of 367.77 mg g^{-1} . The thermodynamic study indicated a spontaneous operation, with ΔG° ranging from -23.2 to $-32.6 \text{ kJ mol}^{-1}$ and endothermic process ($\Delta H^\circ = 67.30 \text{ kJ mol}^{-1}$), involving physical interactions in the adsorbent/adsorbate system. The adsorbent could be regenerated by NaOH and used 7 times with the same adsorption capacity. Hence, overall, the activated carbon prepared from the Jerivá endocarp corresponds to a promising adsorbent in removing 2,4-D herbicide in wastewater.

Keywords

Activated carbón; *Syagrus romanzoffiana*; Queen palm; 2,4-D, adsorption