Isotherm Study of Metribuzin and Tebuconazole Adsorption on Various Carbonaceous Materials

Margita Ščasná, Alexandra Kucmanová, Maroš Sirotiak, Michal Hebnár, and Maroš Soldán

Slovak University of Technology in Bratislava, Institute of Integrated Safety, Faculty of Materials Science and Technology, Botanická 49, 917 24 Trnava, Slovakia

This study examines the sorption capacity of various carbonaceous materials for removing metribuzin and tebuconazole from water under equilibrium conditions. The tested sorbents comprise hydrochars prepared from municipal wastewater sludge at 200 °C, 220 °C, and 240 °C, as well as one hydrochar from microalgal biomass at 220 °C, and commercial activated carbon used as a reference. All hydrochars were produced via hydrothermal carbonization, a process that lasted three hours.

Sorption experiments were conducted in batch mode using 10 mg of sorbent and 5 mL of pesticide solution with initial concentrations ranging from 10 to 50 mg/L. After 24 hours of contact, equilibrium concentrations were measured by high-performance liquid chromatography (HPLC-UV, Agilent 1260) equipped with a C18 reversed-phase column. Experimental data were fitted to both the Freundlich and Langmuir isotherm models.

Isotherm parameters enabled a comparison of sorption efficiency across sorbents, considering feedstock type and processing temperature. Hydrochars showed distinct sorption behaviours influenced by both parameters. The results suggest that waste-derived carbon materials have potential as cost-effective options for removing pesticides from water.

Keywords: Adsorption, biochar, hydrochar, activated carbon, metribuzin, tebuconazole, isotherm modelling.

This work was funded by the EU NextGenerationEU through the Recovery and Resilience Plan for Slovakia under the project No. 09I03-03-V05-00005.