Facile fabrication and characterization of kenaf core as natural biochar for the highly efficient removal of selected endocrine-disrupting compounds

ABSTRACT

This study aims to formulate and fabricate the optimum condition of modified kenaf core (MKC) for the removal of targeted endocrine-disrupting compounds in a batch adsorption system. Kenaf core was chemically modified using phosphoric acid as an activating agent, which involved the pyrolysis step. Results indicated a significant difference ($p < 0.05$) for unmodified and novel modified biochar, observed in characteristic performance analysis via ultimate analysis, Field Emission Scanning Electron Microscopy (FESEM), Fourier Transform Infrared Spectroscopy (FTIR) spectrum, and Brunauer-Emmett-teller (BET) surface area. The removal percentage of 17β-estradiol (E2) and 17α-ethinylestradiol (EE2) in individual and binary mixture systems was examined in order to ascertain the highest removal percentage for MKC application in an aqueous solution. The main and interaction effects of three prepared variables such as incorporate of impregnation concentration of an acid catalyst (0.1-1.0 M), particle size (45-1,000 μm), and dosage (1.0-20.0 g/L) were examined and statistically analyzed via design of experiment (DoE) through developed quadratic models. The removal efficiency of E2 and EE2 in an individual system leads to T2KC > T1KC > T3KC, whereas that in the binary mixture system leads to T2KC > T1KC > T3KC and T1KC > T2KC > T3KC for E2 and EE2 adsorption, respectively, through hydrogen bonding and the π-π interaction mechanism. Thus, the findings revealed T2KC at a moderate level of acid concentration (0.5 M H3PO4) to be a potential biochar, with an environmentally safe and sound profile for opposing emerging pollutant issues as well as for the attainment of sustainable development goals.

Keyword: 17α-ethinylestradiol (EE2); 17β-estradiol (E2); Kenaf core; Modified biochar; Phosphoric acid; Water sustainability