Binary adsorption of chromium and cadmium metal ions by hemp (*Cannabis sativa*) based adsorbents

Shooto, ND*, Thabede PM

Applied Chemistry and Nano Science Laboratory, Department of Biotechnology and Chemistry, Vaal University of Technology P.O. Box X021, Vanderbijlpark 1900, South Africa

*Corresponding author. Tel: +27169506690. Email: davidshooto12@gmail.com

Abstract

Hexavalent chromium Cr(VI) and divalent cadmium Cd(II) are among the most dangerous metal ions in aqueous solutions. The removal of Cr(VI) and Cd(II) from aqueous media requires serious attention. This study reports on the potential of adsorbents produced from hemp seeds to simultaneously remove Cr(VI) and Cd(II) from a synthetic aquatic medium. Pristine hemp seeds (PHS) were carbonized to obtain carbonized hemp seeds (CHS). The surface of the CHS was impregnated with Fe_3O_4 nanoparticles to yield a composite CHN. The biomaterials were characterized by SEM-EDX, FTIR, XRD and BET. The characterization revealed that CHS and CHN differed from the PHS adsorbent by exhibiting distinct properties such as higher cation exchange capacity, larger surface area, and porous surface morphology. The SEM images of CHS and CHN were porous. FTIR results of the adsorbents exhibited functional groups such as –OH, –COOH, –C=O and $–NH_2$ that could easily bind to the metals ions. XRD spectra revealed that cellulose materials disintegrated in CHS and CHN. The adsorption data were fitted into kinetics and isotherm models for assessing the uptake mechanism(s). The adsorption rate was rapid in the initial stages until equilibrium was reached after 40 min. The rate data correlated with the pseudo-second-order (PSO) model. The average removal efficiency of Cr(VI) was 19.29, 33.43, and 48.28 mg/g and for Cd(II) 20.19, 40.16, and 42.12 mg/g by PHS, CHS, and CHN respectively. CHS and CHN were better adsorbents than PHS.

Keywords: hemp seeds, carbon, nanoparticles, chromium, and cadmium