Facile nitric acid activation of carob seeds for efficient recovery of heavy metals from water

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\textbf{ABSTRACT}

In order to prepare an efficient activated carbon, facile chemical activation of carob seeds using nitric acid was investigated. Box–Behnken design coupled with response surface methodology was used to optimize the preparation conditions process for efficient sorption of cadmium and cobalt ions. The effect of various factors including impregnation ratio, activation time and activation temperature was studied extensively. The obtained activated carbons were evaluated through iodine number, methylene blue index and by their sorption capacities of cadmium and cobalt ions. Experimental results showed that the activation temperature and impregnation ratio were the most significant influencing factors. For the iodine number, the greater value of 1,034.83 mg/g was obtained for a carbon-impregnated with 0.05 g/g and activated at 500°C for 1 h 30 min. While the maximum value of the methylene blue index was 279.59 mg/g, it was acquired for activated carbon with an impregnation ratio of 0.075 g/g, activated at 500°C for 2 h. In the case of the elimination of the heavy metal ions, the carbon activated at 500°C during 2 h with an impregnation ratio of 0.025 g/g has a higher sorption capacity for cadmium ions. While, in the same conditions but for 1 h, the maximum sorption of cobalt was obtained. The highest sorption capacities via the Langmuir isotherm model were 91.92 mg/g for cadmium and 79.18 mg/g for cobalt, respectively. Structural properties and surface chemistry of the optimized activated carbons were studied by X-ray diffraction, Fourier-transform infrared spectroscopy, scanning electron microscopy, Boehm titration and pH\textsubscript{pzc}. The obtained activated carbon-based carob seeds would be one of the potential adsorbents for heavy metal ions removal.

\textit{Keywords:} Carob seeds; Nitric acid activation; Heavy metals; Box–Behnken design