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Sequestration of crystal violet from aqueous solution using ash of black turmeric rhizome

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ABSTRACT

Activated carbon obtained from rhizomes of black turmeric is used for the removal of industrial pollutant crystal violet dye from aqueous solution. The ash was characterized by Fourier transform infrared, X-ray diffraction (XRD), and scanning electron microscopy. Powder XRD pattern of the adsorbent reveals the peaks at 2θ angles 26.7°, 28.6°, 30.5°, 32.8°, 34.1°, 40.64°, 43.4°, and 45.1° and pattern was found to remain unchanged after every cycle (after desorption) till eighth cycles. The calculated column adsorption capacity lower than the batch adsorption capacity. IR peaks of black turmeric ash before adsorption were observed at 1,397.33 and 1,007.13 cm^{-1} and after adsorption it shifted to 1,012.62 cm^{-1}. Studies on effect of various parameters viz. dye concentration, dose of adsorbent, contact time, pH, and temperature were carried out. The dye adsorption increases with increasing pH and temperature. In higher pH ranges the adsorbent surface carries negative charge which benefits the adsorption of cationic crystal violet dye through electrostatic interaction. 100% dye removal was achieved at 40°C and above. Mechanism and kinetics of the adsorption process have also been investigated. Temkin adsorption isotherm was found best fit for adsorption process indicating the presence the energetically non-equivalent adsorption sites present on the surface of adsorbent and the adsorption of CV takes place on the more energetic adsorption site at first. Pseudo-second-order kinetics with rate constant 1.85×10^{-4} g/mg min is best fit for the adsorption process. Adsorption was found to be endothermic and processed via chemisorption.

Keywords: Crystal violet; Adsorption isotherms; Adsorption kinetics; Dye removal; Black turmeric

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