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Removal of Rhodamine B and Malachite Green from Aqueous Solutions using Cinnamon Wood Biochar

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Abstract

The dye and pigment industry have become a well-established industry now because color has been very close to man since ancient times. Color is being widely used to showcase the quality life. Recent reports estimate that greater than 0.7 million tons of dyes are manufactured annually all around the world. After the dyeing process, dye effluents are released into the environment from industries without proper treatment, and the amount is estimated to 1 to 1.5×10^5 tons per year. Due to stability and complex structure, most of the dyes are resistant to degradation and they are highly toxic. It is required to remediate dye contaminated water effluents to protect natural water resources and ensure the well-being of the living organisms. In this study, an effort has been taken to develop biochar from low-cost precursor, cinnamon (*Cinnamomum zeylanicum*) wood and its ability to remove model dyes rhodamine B (RDB) and malachite green (MG) were investigated. Prepared biochar was characterized by Fourier Transform Infra-Red (FTIR) spectroscopy to identify the surface functional groups. The X-ray diffraction (XRD) analysis confirmed the amorphous structure of cinnamon wood biochar (CWBC). Batch adsorption experiments were carried out to investigate the optimum conditions such as adsorbent dosage, contact time, pH, and initial dye concentration. The best conditions for the maximum adsorption for the RDB dye was achieved in less than 15 minutes, using 0.20 g adsorbent dose in 100.00 ml dye solution at pH 3.09. The MG dye was adsorbed to CWBC effectively within 60 minutes, 0.01 g of adsorbent dosage in 100.00 ml dye solution at the pH 6.75. The maximum adsorption capacity for the RDB removal was obtained as 2.01 mgg^{-1} and that was 403.06 mgg^{-1} for the MG removal. Langmuir model explained the dye adsorption behavior and also it suggested that, adsorption mechanism was favorable in MG adsorption. Freundlich isotherm fitted best to explain the adsorption of RDB. Thus, the results confirm the feasibility of CWBC to be used as an efficient adsorbent in the removal of RDB and MG from aqueous solutions.

Keywords: Rhodamine B, Malachite green, Cinnamon wood biochar, Adsorption, Dye removal