

Sustainable Copper Detoxification Using *Murraya koenigii* Leaf Powder: A Low-Cost Biosorbent for Biomedical Applications

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Copper is an essential trace element involved in numerous biological processes; however, excessive accumulation can induce oxidative stress and severe cellular damage, as observed in Wilson disease. Synthetic drugs are the most commonly prescribed treatment for Wilson disease, promotes copper excretion but may be associated with adverse side effects, creating interest in alternative and complementary approaches for copper removal. This study investigates the potential of *Murraya koenigii* (karapincha) leaf powder as a sustainable, low-cost, and biocompatible biosorbent for Cu(II) removal from aqueous solutions under physiological conditions. Batch adsorption experiments were conducted by varying pH, contact time, initial Cu(II) concentration, and adsorbent dosage. Experimental conditions were optimized to simulate the gastrointestinal environment (pH 2–3, 37°C). The adsorption process is attributed to bioactive phytochemicals present in *Murraya koenigii*, including alkaloids, flavonoids, and polyphenols, which facilitate Cu(II) binding through chelation, complexation, ion exchange, and electrostatic interactions. Nitrogen-containing carbazole alkaloids are expected to play a significant role due to their strong affinity for Cu(II) ions. Fourier-transform infrared spectroscopy (FTIR) was employed to identify surface functional groups, while atomic absorption spectroscopy (AAS) quantified

residual copper concentrations. FTIR analysis revealed the presence of hydroxyl, phenolic, and amine groups, suggesting their involvement in the adsorption process. Adsorption capacities of 0.1234 mg g⁻¹ and 0.0852 mg g⁻¹ were obtained at initial Cu(II) concentrations of 12.32 ppm and 5.83 ppm, corresponding to removal efficiencies of 33.14% and 48.71%, respectively. The results demonstrate that *Murraya koenigii* leaf powder is a promising biosorbent for copper removal. This study provides insight into the adsorption mechanism and establishes a foundation for future investigations on adsorption isotherms, kinetics, and sustainable copper detoxification under simulated physiological conditions, thereby linking with potential biomedical applications.

Keywords:

Murraya koenigii, Biosorption, Cu(II) removal, Copper detoxification, phytochemicals

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