ABSTRACT

This novel study investigated the adsorption intensity of raw and chemically modified sawdust and corn husk to eliminate copper (II), chromium (III), and nickel (II) ions from the hydrous solutions. Sawdust (SD) and corn husk (CH) were used as biosorbents and were treated chemically with an acid, sulfuric acid (H_2SO_4); a base, sodium hydroxide (NaOH), and detergent powder. The adsorption potential was estimated based on percentage removal efficiency (% RE) of copper (II), chromium (III), and nickel (II) ions and the adsorption intensity (q_{max}). The effects of pH, contact time, biosorbent dose, and temperature were also studied on raw sawdust and corn husk. The obtained results represented that the biosorption of Cu (II), Cr (III), and Ni (II) ions were dependent on pH and maximum biosorption of Cu (II), Cr (III), and Ni (II) ions was achieved at pH 7.0 and 6.0 for sawdust and corn husk, respectively. The optimum contact time was 120 min and the optimum dose was 1.0 g of biosorbents at which maximum % RE was obtained. The effect of temperature showed that biosorption intensity increased by increasing temperature and the optimum temperature was 25◦C for both sawdust and corn husk. The SEM analysis of surface morphology highlighted enhanced surface porosity in chemical treated biosorbents compared with raw biosorbent. Similarly, the FTIR spectrum indicated the presence of active surface functional groups after chemical treatment. The enhanced surface porosity and active functional groups were the main factors for increased biosorption capacity. The results of % RE revealed that the detergent-treated sawdust (DTSD) and detergent-treated corn husk (DTCH) showed 9.27 ± 0.15 (%) and 99.16 ± 0.08 (%) elimination as compared to base-treated sawdust (BTSD) and base-treated corn husk (BTCH) which exhibited 95.53 ± 0.18 (%) and 92.43 ± 0.22 (%) percentage removal efficiency for chromium (III) from aqueous solutions, respectively. Similarly, BTSD and BTCH exhibited high removal for copper (II) and nickel (II) ions which were 83.72 ± 2.35 (%) and 78.38 ± 2.60 (%) for copper (II) ions and 69.11 ± 2.94 (%) and 78.68 ± 2.67 (%) for nickel (II), respectively. The raw and acid-treated sawdust and corn husk showed less removal potential for copper (II), chromium (III), and nickel (II) ions. The Langmuir isotherm model and the Freundlich isotherm model were employed to predict the adsorption process, and these are best-fitted models. The adsorption isotherms revealed that DTSD and DTCH had 4.69 mg/kg and 4.70 mg/kg of adsorption capacity (q_{max}) compared with 4.67 mg/kg and 4.64 mg/kg of (q_{max}) for BTSD and BTCH for chromium (III) ions elimination. The adsorption capacity for copper (II) was 3.67 mg/kg and 3.61 mg/kg for BTSD and BTCH, x

respectively. Similarly, the value of q_{max} of 3.38 mg/kg and 3.49 mg/kg for nickel ions was obtained by BTSD and BTCH, respectively. Therefore, the obtained results highlight that base and detergent treatment enhanced the % RE of the biosorbents, and BTSD, BTCH, DTSD, and DTCH are highly efficient biosorbents for eliminating copper (II), chromium (III), and nickel (II) ions from hydrous solutions.