Abstract

Water pollution is one of the most significant environmental concerns of the 21st century. Heavy metal contamination is one of the most pressing concern of water pollution as they are persistent, non-biodegradable, toxic, and bio-accumulative such as Ni(II) ion. Conventional treatment methods such as coagulation-flocculation, ion-exchange, and precipitation are effective in wastewater treatment. They have pitfalls such as high energy demand, operational charges, and secondary residue production. As a green alternative, plant-based mucilages have gained a lot of attention in recent times due to their abundance, environmental friendliness, and biodegradability. This study evaluated the Ni(II) ion adsorption ability of flaxseed mucilage (FSM) from aqueous solution under parameters of initial nickel metal ion concentration, adsorbent dose, temperature, contact time, and pH. Maximum adsorption efficiency of FSM (92.73%) was reported at 1500 mg/L nickel concentration, 40 mg FSM dose, 50-60 ℃, 40 min, and pH 7. The results validated the rapid uptake of Ni(II) ions by FSM and temperature and pH-responsive nature of adsorption. A moderate regeneration capacity of FSM was also evaluated using desorption experiments which showed the regenerability potential of FSM. However, the regenerability potential of FSM needed further optimization. The adsorption mechanism was confirmed by characterization. FTIR spectra show a clear shift in the hydroxyl and carboxyl peaks to lower wavenumber after Ni(II) adsorption onto FSM, validating direct involvement of Ni(II) with the functional groups. XRD patterns showed a clear transition in mucilage nature from amorphous to semi-crystalline, which suggests the metal-mucilage complexes are formed. SEM images of FSM showed porous and smooth surfaces with an average pore size of 27.30 μm; however, after Ni binding, the surface became irregular and compact with a decrease in pore size (14.7 μm). EDX analysis shows the distinct peak of Ni(II) ions at 6.5-7.8 keV with the weight% of 17.25% in the adsorbed sample. FSM has a promising future as a biosorbent in wastewater treatment as it has the capacity to bridge the gap between the conventional methods and environmentally friendly alternatives.