Abstract:

This comprehensive research focuses on the potential of *Catla catla* fish scales as a bio-adsorbent for the removal of heavy metals, particularly Cr(III) and Co(II) from wastewater. Different salt solutions including hydrated Cobalt nitrate [Co(NO3)2.6H2O] and Chromium sulfate [Cr2(SO4)3] with varying concentrations of metal ions are utilized to evaluate adsorption efficiency, and the effect of parameters like initial metal ion concentration, chemical treatment of adsorbent, and contact time are systematically examined using UV-Vis Spectrophotometry. It was found that the initial metal ion concentration influenced the adsorption efficiency, with higher concentrations leading to reduced adsorption capacity and with longer durations resulting in increased metal removal until reaching equilibrium. Acid-treated fish scales showed superior adsorption performance compared to the raw ones. The augmentation in efficiency magnitude exhibited a notable elevation of 50.2% with acid-treated fish scales. Characterization of the bioadsorbent is performed using advanced analytical techniques, including Fourier-Transform Infrared Spectroscopy (FTIR), Scanning Electron Microscopy (SEM), and Energy Dispersive X-ray Spectroscopy (EDS), revealing changes in structural and chemical properties post-metal adsorption. The adsorption equilibrium data are fitted to the Langmuir and Freundlich isotherm models, with Langmuir being more suitable for cobalt adsorption and Freundlich for chromium adsorption. The significance of Langmuir and Freundlich isotherms lies in their capacity to elucidate the exponential distribution of active sites and energy, interpreting the adsorption process on heterogeneous solids. It has been reported that in commercializing biosorption, extraction of heavy metals from industrial waters, employing reactors equipped with innovative biosorbents in the form of granules, is available at a cost approximately one-tenth that of ion exchange resins. This research highlights the cost-effective and sustainable potential of *Catla catla* making a significant contribution to the domains of water purification and heavy metal pollution mitigation.