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Interpretation of Cr(III) adsorption by water hyacinth (*Eichhornia crassipes)* biosorbent through kinetics and isotherm analysis

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Water contamination by chromium species is a serious environmental and health issue, making its removal from water sources a top priority. Adsorption is a well-established method for heavy metal removal, with biosorbents emerging as an eco-friendly and cost-effective alternative to synthetic adsorbents. In this study, water hyacinth (WH) powder extracted from live plants was explored as a natural biosorbent for removing Cr(III) from synthetic contaminated water. The dried WH powder (300–500 μm) under optimum conditions of solution pH, dosage, shaking time and settling time achieves an impressive extent of removal of 95%. Fourier transform infrared spectroscopic analysis identifies -OH, C-O-C and C=O functional groups present in the biosorbent which would aid in complexation with Cr(III), which is supported by shifts in band positions upon interaction with Cr(III) solution. X-ray fluorescence spectroscopy confirms the uptake of chromium with an additional peak appearing for Cr, while scanning electron microscopic images reveal structural changes on the surface after adsorption of Cr(III) from solution. The point of zero charge determined at pH = 8 indicates that the biosorbent functions well under slightly alkaline conditions. At equilibrium, the adsorption behavior aligns the best with the Sips adsorption isotherm, combining characteristics of both the Langmuir and the Freundlich isotherm models, indicating a combination of monolayer and multilayer adsorption. These findings demonstrate that WH powder is a highly efficient and sustainable biosorbent for Cr(III) removal, offering a low-cost and environmentally friendly solution for water purification.

Keywords:
Adsorption; biosorbent; *Eichhornia crassipes*; isotherm; point of zero charge