

Egg shell-activated carbon from water hyacinth for heavy metal Removal from wastewater: Isotherm and kinetic studies

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Introduction

The discharge of heavy metals (HMs) from industrial activities in developing countries has been a cause for environmental and public health concerns. [1]

In this study, the potential of egg shell-activated carbon derived from water hyacinth as a sustainable adsorbent for HM removal from industrial wastewater was investigated.

Methods

Wastewater (5 L) was sampled from three industries: (S1 to S3). They were analyzed for HMs (Pb, Cd, Cu, Zn and Cr; **Figure 1**).

Water hyacinth plants were collected from the shores of Lake Victoria in Jinja, and used to prepare egg-shell activated carbon, which was then characterised [2,3].

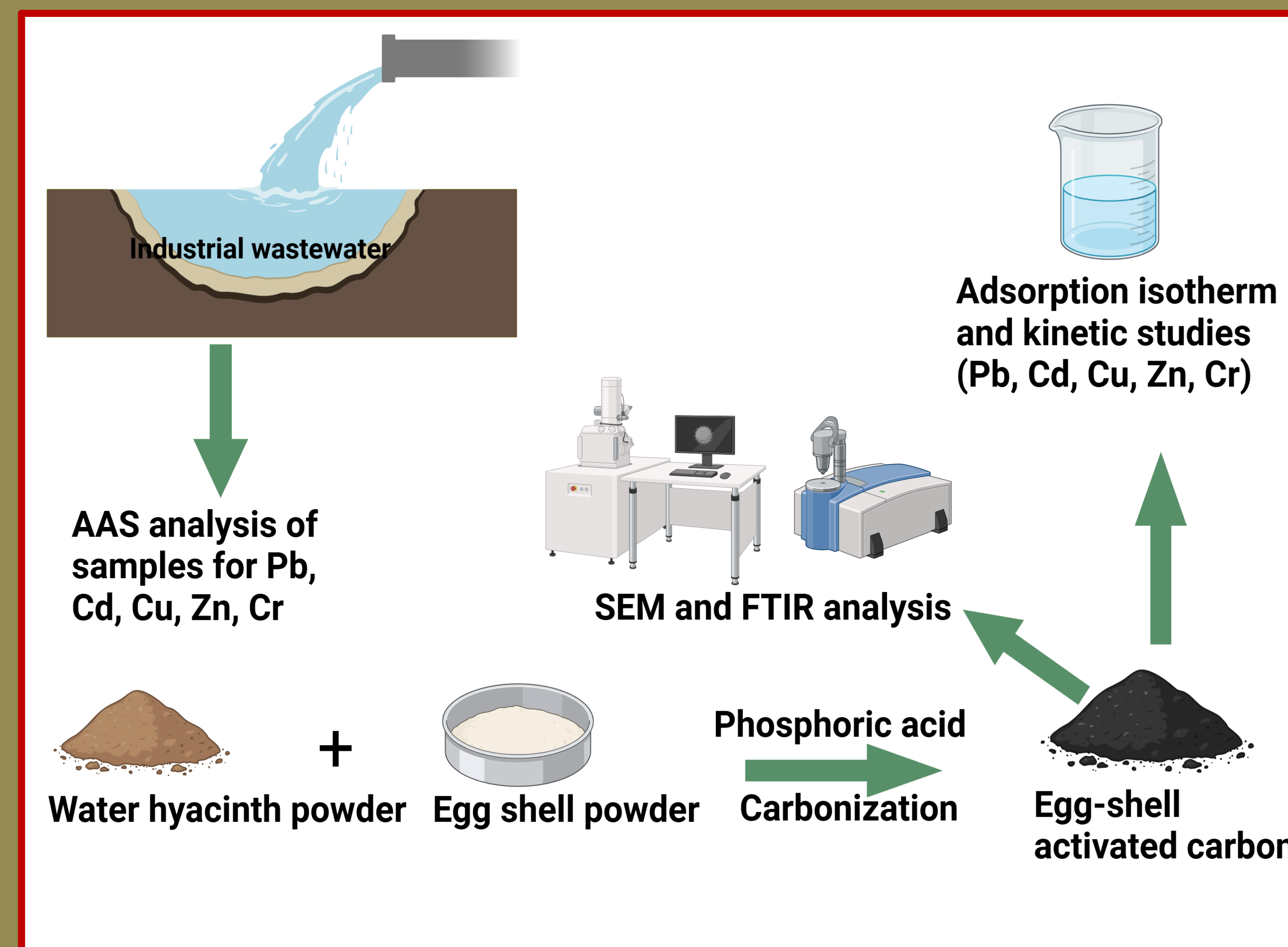


Figure 1. Summary of methods used in the study

Results

The concentration of HMs in WW (0.54 mg/L for Cr to 93.54 mg/L for Pb) varied significantly between sites ($P < 0.05$) and exceeded the permissible limits of 0.01, 0.1, 0.5, 0.5 and 2.0 mg/L for Cd, Pb, Cr, Cu and Zn as per National Environment (Standards for Discharge of Effluent into Water or Land)

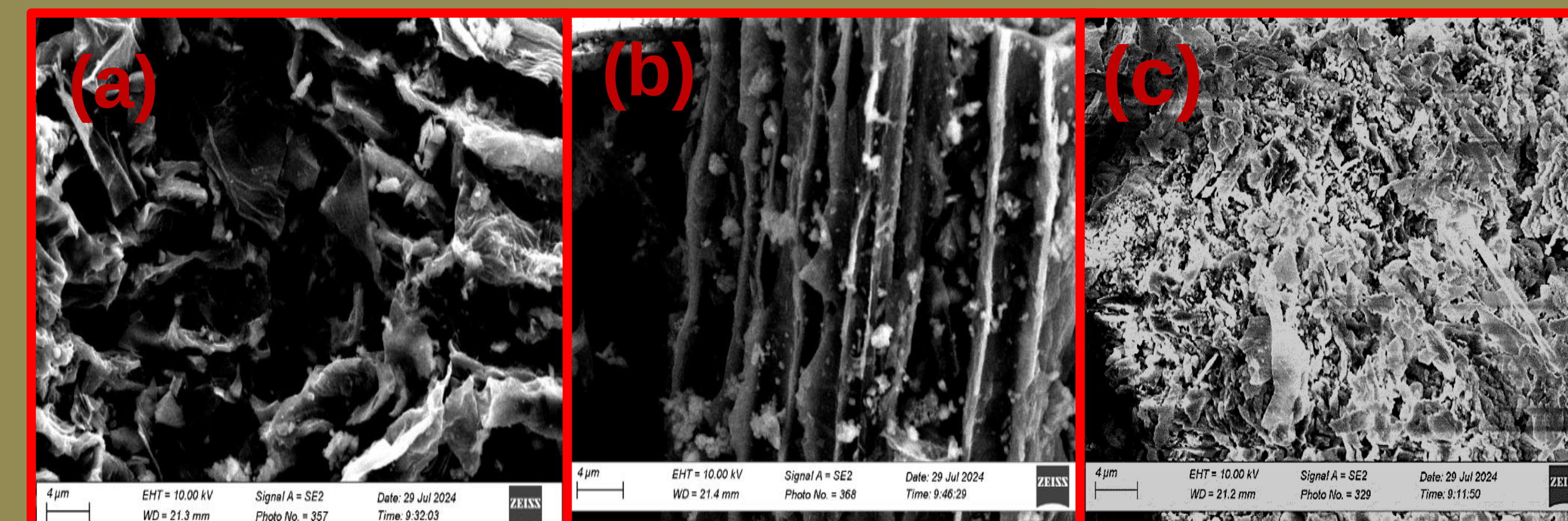


Figure 2. Scanning electron micrographs of water hyacinth biochars (a) unactivated, (b) eggshell-activated, and (c) double-activated.

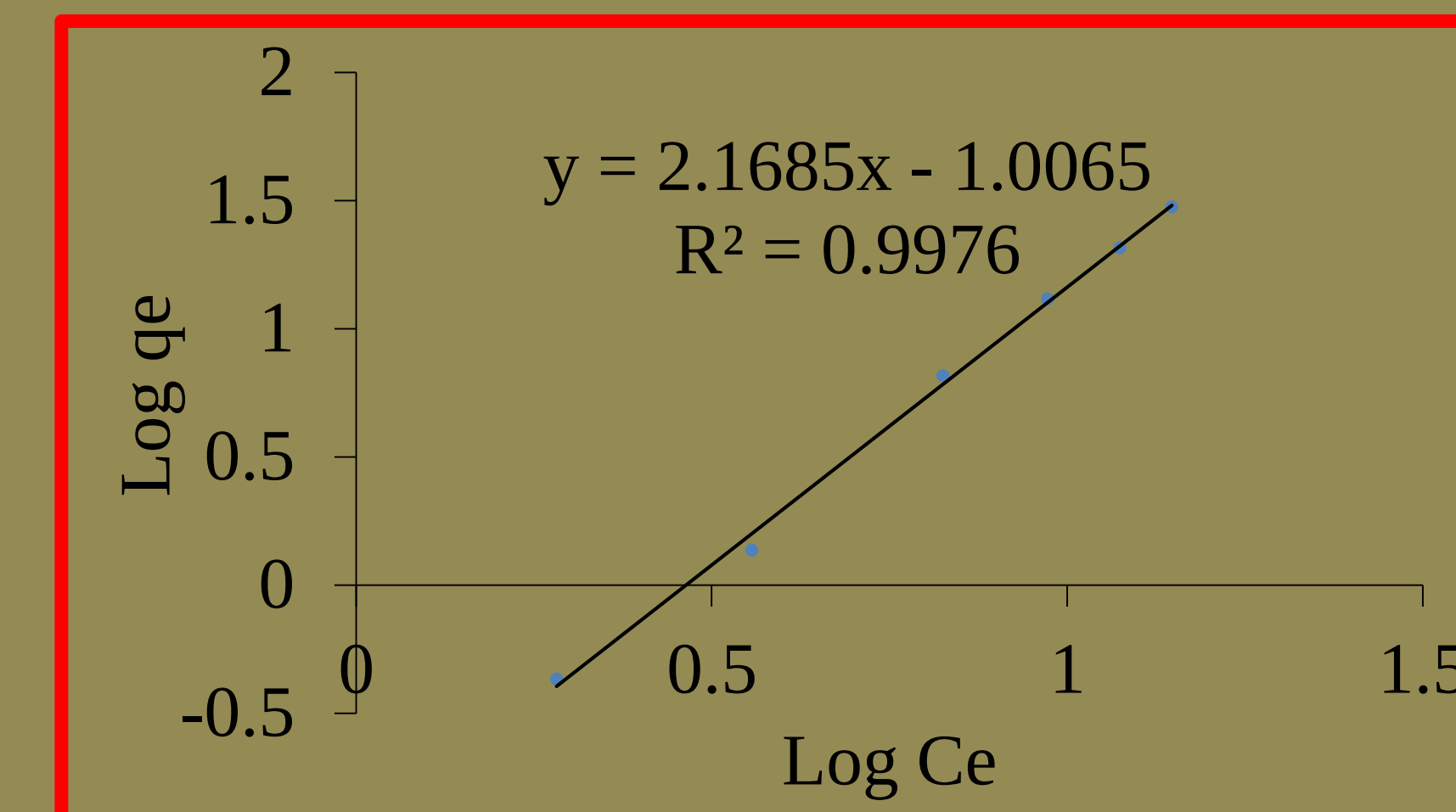


Figure 3. Representative linear Freundlich plot for the adsorption of Cd^{2+} ions onto activated water hyacinth biochar.

SEM and FTIR indicated successful activation of the biochar (Figure 2). Optimal removal of HMs was achieved at pH 4-5, contact time of 90 min, and 1.0 g of adsorbent. Maximum adsorption capacities of the HMs were in the range of 1.04-8.36 mg/g. Adsorption occurred through multilayer coverage, as indicated by the experimental data which fitted well to the Freundlich isotherm (Figure 3).

Cd^{2+} , Zn^{2+} and Cr^{3+} ions were better represented by the pseudo-second-order model, while Pb^{2+} and Cu^{2+} adsorption showed better agreement with the pseudo-first-order kinetic model.

Conclusions

Activated water hyacinth-based adsorbent had a higher adsorption efficiency, with up to 100% removal of HMs at lower concentrations.

