SYNTHESIS AND CHARACTERIZATION OF MAGNETIC 4d- TRANSITION METAL ION-IMPRINTED KAOLIN CHITOSAN HYBRID FOR SELECTIVE MITIGATION OF METAL TOXICITY IN PLANT

BY

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ABSTRACT

The contamination of soil by toxic metals is a critical environmental challenge which poses a significant risk to the ecosystem and human health. Several soil remediation methods have been explored but have been limited by poor selectivity, high production cost and reusability. This work explored the adsorption capability of chitosan and kaolin in developing a sustainable, selective, and reusable solution for cadmium detoxification in soil using a bio-based hybrid material. It successfully synthesized and characterized palladium (pd), Silver (Ag) and cadmium (Cd) ion-imprinted polymers (IIPs) and non-imprinted (NIP) from Magnetic kaolin-chitosan nanocomposite (MKCNC) and studied their adsorption potentials. IIPs and NIP were characterized using Ultra-violet/Visible spectroscopy (UV-vis), Fourier Transform Infra-red spectroscopy (FTIR), Scanning Electron Microscopy coupled with Energy Dispersive X-ray Analysis (SEM-EDX), Thermogravimetric Analysis (TGA) and Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES). The adsorption potential of the synthesized IIPs and NIP were investigated on maize plantings. Maize seeds were planted in soil spiked and treated with water only (pot 1), 25 mg CdIP (pot 2), 25 mg CdIP + 20 mg $CdCl_2$ (pot 3), 50 mg CdIP + 20 mg $CdCl_2$ (pot 4) and 25mg NIP + 20 mg $CdCl_2$ (pot 5). The UV-vis absorption bands of the leached and unleached IIPs showed sharp band at around 224-240 nm indicating $\pi \rightarrow \pi^*$ transition. The FTIR result of the nanocomposite showed the υ(C=N)str (imine/azomethine) functional group at 1615 cm^{-1}, however upon polymerization, the three IIPs showed a higher vibrational frequency (blue shift) at the region of υ(C=N)str at 1628 cm^{-1} (PdIP), 1638 cm^{-1} (AgIP) and 1636 cm^{-1} (CdIP). The SEM-EDX showed crystalline morphology of large irregular particles. The surfaces of the IIPs appeared to be covered with powdered materials. TGA of the NIP and IIPs showed 4 stages of weight loss. There was no obvious difference between the absorbance bands of leached

and unleached IIPs. This is an indication that the polymer matrix remains unaltered even after leaching. The powdery surfaces of the SEM-EDX images could be attributed to the imprinting of ions on the surface of the IIPs. The thermal studies showed that CdIP demonstrated the greatest thermal stability amongst the three IIPs. Optimal reaction condition of 89% adsorption was observed at pH 6.5 at a reaction time of 90 minutes. The NIP and CdIP showed excellent adsorption capacity by successfully mitigating Cd ions from being translocated into the maize plant body. The non-imprinted and ion-imprinted polymers have the potential of contributing to the advancement of sustainable soil remediation technologies and support agricultural productivity and environmental health.