

From Bone Waste to Environmental Remediation: Hydroxyapatite-Based Materials for Metal Immobilization

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Abstract

Hydroxyapatite-based materials are promising sorbents for the immobilization of inorganic contaminants due to their affinity for metal ions and potential application in environmental remediation. In this study, bone-derived materials were tested for the removal of Pb, Cd and Zn from aqueous solutions and compared with a commercial nano-hydroxyapatite. The investigated materials included chicken and bovine bone chars, calcined chicken and bovine bones, and the commercial reference.

The materials were characterized by XRD, FTIR, SEM and BET analyses to evaluate their mineralogical, chemical and morphological properties, as well as their specific surface area. Batch adsorption tests were performed at different initial metal concentrations, and adsorption capacities were estimated using the Langmuir model. Preliminary results showed the highest affinity for Pb, followed by Cd and Zn. Pyrolyzed materials displayed the best adsorption performance, with chicken bone char consistently showing the highest capacities for all tested metals. For Cd and Zn, bone-derived materials generally outperformed commercial nano-hydroxyapatite, whereas for Pb the commercial reference performed better than calcined samples but worse than pyrolyzed materials. Ongoing work will include Langmuir and Freundlich models and test selected materials on naturally aged, multi-element contaminated substrates from Friuli-Venezia Giulia through column leaching tests and BCR sequential extractions.