A Novel Modified Adsorptive Composite for the Targeted Immobilization and Long-Term Stabilization of Lead and Copper in Contaminated Soil Systems to Restore Crop Viability

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Up to 17% of cropland worldwide is contaminated with at least one toxic heavy metal, with lead and copper among the most prevalent contaminants. While some remediation methods exist today, they are either too expensive or require heavy machinery, excavation, or complete disruption of the soil. As a potential solution, this study developed ROOTCAUSE, a reactive-oxide tablet for soil remediation. To create the novel composite, biochar was modified by increasing surface area, creating additional chemical binding sites utilizing functional groups, loading iron nanoparticles, and stabilizing the soil pH. For efficient delivery, the composite was created into a dissolvable tablet by utilizing bentonite clay and Tween-80. The efficiency of the compound was tested by utilizing calcium chloride extraction followed by colorimetric analysis. ROOTCAUSE was tested in 500 g soil samples spiked with 100 mg/kg of both lead and copper. Relative to the untreated heavy metal control, ROOTCAUSE reduced bioavailable lead and copper by more than 90%. Soil pH stabilized at 7.35, and radish fresh mass recovered to more than 60% of the uncontaminated control over 28 days. Across all measured metrics, ROOTCAUSE outperformed plain biochar by 2.7 to 3.2 times. ROOTCAUSE demonstrated a decrease in bioavailable lead and copper, soil stabilization, and recovery of plant mass. With the cost for production being just $0.27/kg, this composite offers an environmentally friendly, yet cost-effective approach to combat the rising issues of global pollution affecting agricultural soils and crops.

Awards Won:

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