Functionalized Bio-Composite Sorbent: Novel Core-Shell Beads With Encapsulated Functionalized Biochar Engineered for Selective Chemical Removal of Waterborne Contaminants, Affording Magnetic Retrieval for Optional Circular Water Management

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Widespread contamination of surface and groundwater systems from heavy metals, excess nutrients, and other hazardous pollutants has intensified the need for sustainable water remediation technologies. Previous experimentation suggested success in removal of generalized pollutants using engineered bio-sorbent beads. This project sought to develop a functionalized, multi-layered, and magnetically retrievable bio-sorbent for high specificity capture of pollutants in aquatic environments, facilitating a circular water management system. Core-Shell beads were engineered for selective absorption based on various chemical mechanisms, primarily electrostatic attraction and ion exchange, to enable capture. Four bio-sorbent recipes were formulated for targeted removal of different pollutant types: heavy metal micronutrients (Recipe A), toxic heavy metals (Recipe B), inorganic plant macronutrients (Recipe C) and a non-functionalized base. Contaminate removal was assessed pre and post 84 hour exposure to prepared chemical solutions, using an Electrical Conductivity Meter, Nitrate probe, and a Spectrophotometer to measure changes in concentration, and ensure selective removal. Replicate results showed that Recipe A reduced pollution levels in Copper Sulfate by 55%, Recipe B reduced Zinc concentrations by 40% and Recipe C reduced Phosphate levels by 57%. In the Well Water Test, Recipe A removed 100% of copper ions and Recipe C removed 67% of nitrate ions and 62% of overall ions. An ANOVA test was conducted, results indicating significance of the data collected. The findings suggest the success and further potential of an engineered magnetically retrievable, functionalized, Core-Shell structure selective for targeted contaminants as a more efficient circular water treatment approach.

Awards Won:

Second Award of $2,400

National Taiwan Science Education Center: Taiwan International Science Fair Special Award is a trip to participate in the Taiwan International Science Fair