



CALIFORNIA SCIENCE & ENGINEERING FAIR 2019 PROJECT SUMMARY

Name(s) Eshani Jha	Project Number S1111
Project Title A Novel and Affordable Water Filtration System for Complete Removal of Heavy Metals	
<p style="text-align: center;">Abstract</p> <p>Objectives Water potability is a key challenge of modern civilization. Worldwide, two billion people lack access to clean drinking water and heavy metals are the primary toxic contaminants. This research created a highly efficient, sustainable, and affordable water filtration system for the rapid removal of heavy metals from water using enhanced biochar.</p> <p>Methods Biochar was enhanced using manganese dioxide, cysteine, and potassium permanganate solutions. Enhanced biochar was tested for proper chemical composition using X-Ray Absorption Near-Edge Structures and Transmission Electron Microscopy. It was then placed in a prototype constructed using PVC riser plus coupler pairs. Sand and calcite (common filter materials) were also placed in the prototype for particulate matter removal.</p> <p>For lab testing, water with variable heavy metal concentrations was passed through the filter at various flow rates to characterize filter effectiveness. Then, enhanced biochar, sand, and calcite were left in contaminated water for an extended period of time to test reversibility of contaminant removal. For controls, experiments were repeated without any enhanced biochar. Final heavy metal concentrations were determined through Inductively Coupled Plasma Mass Spectrometry (calibrated to 1 ppb).</p> <p>For field testing, residential water samples from Flint, MI and surface water samples from Flint River were collected. As per standard EPA methods, original and post-filtration contaminant levels were determined by Brejle & Race Laboratories, Santa Rosa, CA.</p> <p>Results All contaminants were removed for slow and medium flow rates. For fast flow rates, no mercury or cadmium was detected. Trace amounts of arsenic and lead detected were well below EPA guidelines. No heavy metals were detected after extended time periods, demonstrating effective long-term heavy metal removal. In practical application, the water filter completely removed heavy metals at various flow rates.</p> <p>Conclusions Through creative design, rigorous testing, and cutting-edge technology, a novel water purification system has been developed by integrating environmental chemistry with engineering. This filter completely and rapidly removes heavy metals. Mass manufacturing is expected to lower the floating cost to twenty-five</p>	
Summary Statement I have created a novel and affordable water purification system for the rapid and efficient removal of arsenic, lead, mercury, and cadmium from contaminated water using enhanced biochar.	
Help Received Prof. Bhoopesh Mishra at the Illinois Institute of Technology gave me laboratory access and equipment. Dr. Krista Hennig at the Pasca Lab of Stanford University deepened my understanding of heavy metal toxicity. Mr. Nelson Brock at the Greenfield Labs of Ford Motor Co. established an industrial partnership	