Name(s)
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Project Number
J1106

Project Title
Constructing a Sustainable, Low-Cost Herbal Biosorbents Filter to Remove Heavy Metals from Contaminated Groundwater

Abstract

Objectives/Goals
22% of California's community water systems rely on contaminated groundwater.Activated carbon filters are expensive and nonrenewable.The goal of my project is to construct a sustainable, low-cost filter by investigating the biosorptive effect of torrefied Oryza sativa hull pellets, Moringa oleifera seed kernels, Vetiveria zizanioides roots, Azidirachta indica leaves,and the adsorptive effect of Kaolinite, and Kaolinite-Carica papaya on the removal of iron and copper by 75% and reduce turbidity by 50%.

Methods/Materials
Torrefied O.sativa hulls, M.oleifera seed, V.zizanioides roots, A.indica leaves, kaolinite and kaolinite-c.papaya clay bowls were tested by soaking each of them in groundwater and varying:
Temperature (100,110,120C)
Adsorbent dose (5g,10g,15g)
Contact times (60,120,180 minutes)
with four trials each against the control of untreated groundwater. A Sper Scientific Turbidity meter was used to test turbidity. The removal efficiency was calculated and analyzed through ANOVA and supported by literature.

Results
My experiments supported the hypotheses proving that the biosorbents could remove iron and copper from groundwater by more than 75%. All tested biosorbents removed iron by 100%. V.zizanioides and the Kaolinite hybrid clay removed copper by 100%, while the others were at 80%. M.oleifera, V.zizanioides, and Kaolinite reduced turbidity by 50% and Kaolinite hybrid clays by 70%. However, O.sativa and A.indica did not support the hypothesis as they increased turbidity by 105% and 80% respectively.

Conclusions/Discussion
All the biosorbents adsorbed metals for different reasons. Torrefying O.sativa created a porous cell structure that increased the surface sites available for metal ion adsorption. The herbs adsorbed through complexation although they contain different compounds: both M.oleifera, V.zizanioides contain saponin, while A.indica contain salannin and azidiractin.Kaolinite clay possesses a high ion exchange capacity, while kaolinite-C.papaya has a high cation exchange capacity. M.oleifera, kaolinite and kaolinite-C.papaya possess strong flocculation and/or coagulative properties which reduced turbidity. My product which consists of a kaolinite- C. papaya hybrid bowl with V.zizanioides roots and a water-soluble capsule containing M.oleifera only costs $1.35 to produce.This provides a low-cost and sustainable alternative to carbon filters for rural communities dependent on groundwater.

Summary Statement
My project investigated the effect of six biosorbents on the removal of iron and copper and turbidity reduction in groundwater, to construct a sustainable, low-cost herbal filter as an alternative to activated carbon filters.

Help Received
I designed, experimented, and analyzed my results on my own. I thank my teacher, Dr. Wilmot, for his support; Mr. Dan Coltrin (Forensic Laboratories) for answering my questions; Clay Planet for firing my kaolinite bowls.