CALIFORNIA STATE SCIENCE FAIR
2014 PROJECT SUMMARY

Name(s)

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Project Number

34857

Project Title

A Greener Cleaner: Investigating a Potential Biosorbent for the Removal of Heavy Metals from Aqueous Solutions

Abstract

Objectives/Goals

Heavy metal contamination of water poses a serious threat to the global ecosystem, since heavy metals are toxic even at low concentrations. Lead, copper, and chromium have been classified as priority pollutants by the U.S. EPA, and their accumulation in the body may cause disorders like brain damage and cancer. Conventional methods of removal are expensive and may generate toxic sludge; therefore, a need exists for a low-cost and eco-friendly biosorbent for heavy metal removal from wastewaters. Since scientific literature about using spent coffee grounds (SCG) as a biosorbent is limited, this experiment investigated the use of SCG for the removal of heavy metals from aqueous solutions. The effects of pH, contact time, adsorbent dose, and initial metal ion concentration on the biosorption of lead, copper, and chromium were studied.

Methods/Materials

Adsorption experiments were conducted in triplicates by treating the metal solutions with SCG at 37.5°C and 100 rpm and varying: pH values (3, 4, 5, 6, and 7); contact times (30, 60, 90, 120, and 150 minutes); adsorbent dose (0.5, 1.0, and 1.5 g); and initial metal ion concentrations (10, 25, and 50 ppm). The samples were analyzed using Atomic Absorption Spectroscopy. The removal efficiency (RE%) of the SCG for each sample was calculated.

Results

The highest removal efficiency was ~99% for lead, ~97% for copper, and ~89% for chromium. The maximum RE% was at pH 5 for lead and copper and pH 3 for chromium. RE% increased with the increase in contact time and equilibrium was reached at 90 minutes. Increasing the adsorbent dose resulted in greater RE%. By increasing the initial metal ion concentration, RE% decreased. The removal efficiency for lead was the highest, followed by copper and chromium, respectively.

Conclusions/Discussion

SCG can be used as a biosorbent for the removal of lead, copper, and chromium from aqueous solutions. Functional groups on the surface of coffee grounds and cell wall components are responsible for metal ion adsorption. Experimental data showed that removal efficiencies up to 99% can be achieved when using SCG as a biosorbent, depending on the adsorption conditions. Over 6 billion kilograms of SCG are generated worldwide every year and are of no commercial value. The utilization of SCG as a biosorbent of metal ions can promote this large amount of waste into a new, environmentally-friendly resource due to its low cost and easy availability.

Summary Statement

My novel project investigates the use of spent coffee grounds as an environmentally-friendly and low-cost biosorbent for the removal of heavy metals from aqueous solutions.

Help Received

My family and teacher for their support; Mr. Caesar Munera from San Jose State University for help with the AAS equipment.