Biosorption of Thorium by Bone Meal

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INTRODUCTION

The treatment of radioactive wastes with low radionuclides concentrations and large volumes of radioactive wastes with traditional techniques may not be favorable and, consequently, be expensive and unsatisfactory.

The capacity of removing heavy metal ions from solution by biomass can be applied to the treatment of radionuclides in solution. Bone meal, commonly used as a fertilizer, can adsorb metals in aqueous solutions and binds to an array of ions. The great amount of low soluble calcium phosphate on bone meal is responsible for its high affinity for metals.

Bone meal can be used as biosorbent for the remediation of metal-contaminated soils, on the removal of lead from aqueous effluent and nickel and copper from synthetic solutions. Bone meal can be used as an alternative adsorbent in the removal of dyes from aqueous solution and wastewater

OBJECTIVES

In this study, synthetic aqueous solution containing thorium was prepared in order to evaluate the biosorption of this metal by a commercial bone meal. The biosorption capacity was evaluated through batch experiments and analysis of contact time.

MATERIALS AND METHODS

This work was divided into three stages: i) Preparation and physical characterization of the bone meal; ii) Preparation of thorium solutions; iii) Batch biosorption experiments.

Stage I: Preparation/Physical Characterization of bone meal

Bone meal → Sieved → particle size 0.125 to 0.297 mm → Morphological Characteristics → Scanning Electron Microscopy (SEM)

MATERIALS AND METHODS (Cont.)

Stage II: Thorium solutions preparation

thorium nitrate pentahydrate + Distilled water + Nitric acid and sodium hydroxide → pH = 4 Thorium solution → favors the biosorption of a great number of species

Stage III: Biosorption Experiments

Bone meal (0.1g) + Thorium solutions (5 mL) concentrations fixed at 230 ppm → Stirred – 130 rpm room temperature – time varying between 15 and 240 minutes → Filtered → Thorium determination → ICP-OES → metal uptake

$$q = \left(\frac{C_i - C_f}{m}\right) V$$

RESULTS AND DISCUSSION

Physical Characterization of bone meal

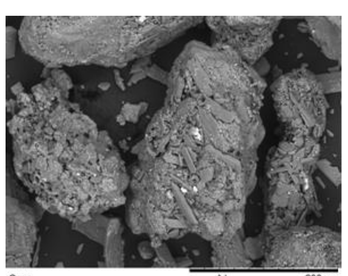

Fig. 1 shows the micrograph image of chopped and sieved bone meal with particle size between 0.125 mm and 0.297 mm before batch experiments. It is possible to see surface materials of raw form and open and close pores.

RESULTS AND DISCUSSION (Cont.)

Thorium Uptake

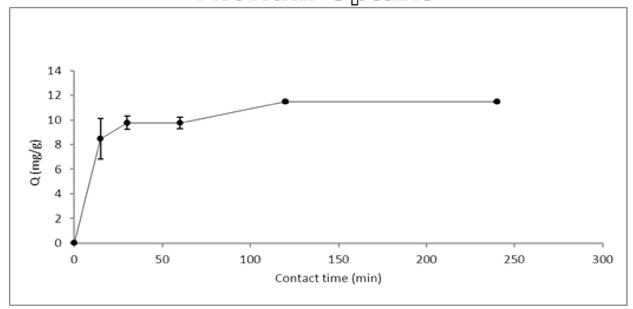

Figure 2 shows that with the passage of time, the uptake of thorium by the biosorbent is higher, i.e. thorium is accumulated on the adsorbent. The biosorption equilibrium was established in 120 minutes, when the biosorption capacity reached 11.48 ± 0.08 mg/g. In fifteen minutes of contact, the system achieves 73.7% of the total uptake, showing that the biosorption becomes slower as time goes by.

The equilibrium can also be analyzed by the ratio between initial and final thorium concentrations. Table 1 shows the amount of thorium removed as function of time.

Contact time (minutes)	Thorium removed (%)
15	72.5
30	83.7
60	83.7
120	98.6
240	98.5

The results showed that almost all thorium of aqueous solution was removed by bone meal. In 240 minutes, there is a decrease in this rate, that can be caused by a little desorption in the solution after the achievement of equilibrium.

CONCLUSION

The biosorption assays carried out by batch system showed two distinct behaviors, a high uptake velocity in the beginning and slower as equilibrium approaches. Bone meal can be used as a low cost alternative to remove thorium, being part of a viable waste treatment technique. Next studies may be useful to ascertain the biosorption analyzing other variables, such as initial concentration, pH and temperature.