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BIOSORPTION OF AMERICIUM BY ALGINATE BEADS

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ABSTRACT

The use of biotechnology to remove heavy metals from wastes plays great potential in treatment of radioactive wastes and therefore the aim of this study was to evaluate the biosorption of americium by alginate beads. Biosorption has been defined as the property of certain biomolecules to bind and remove selected ions or other molecules from aqueous solutions. The calcium alginate beads as biosorbent were prepared and analyzed for americium uptaking. The experiments were performed in different solution activity concentrations, pH and exposure time. The results suggest that biosorption process is more efficient at pH 4 and for 75, 150, 300 Bq/mL and 120 minutes were necessary to remove almost 100% of the americium-241 from the solution.

. 1. INTRODUCTION

Radionuclides have been widely used in the industrial, agricultural, medicine and, mainly in the research area. The cost of the use of this technology for the society is the generation of radioactive wastes that require special treatment to prevent environmental and human contamination. The conventional techniques of removal metallic ions from solutions, such as precipitation, ionic exchange and electrochemical processes are incapable of removing trace levels of heavy metal ions from large volumes of liquid wastes. The awareness and concern about the environment have motivated researches for new efficient technologies that would be capable of removing, inexpensively, metals from wastes. The search for new technologies involving the uptake of heavy metals from wastewaters has addressed attention to biosorption [1]. This technique is defined as the capacity of biological materials to accumulate heavy metals from wastewater through metabolically mediated or physico-chemical pathways of uptake [2]. Biodegradable and hydrophilic biopolymers, such as alginates, in the form of beads are promising materials competing with the conventional clean up technologies.

Alginate is biopolymer extracted from brown seaweeds (*Phaeophyceae*). It is composed by β-1,4 linked D-mannuric and L-guluronic acids like monomers units. These carboxilic groups are capable of forming complexes with cationic metal [3-5]. Adsorption properties of alginate were investigated for Cu^{2+}, Co^{2+}, Zn^{2+}, Cd^{2+}, La^{3+} ions by Jang [6; 7] and [8; 9]. It was found that calcium alginate exhibited relatively higher uptake rate and distribution coefficient of Am^{3+} than the others metals ions [10].

In mixed solutions, calcium alginate in the form of beads, exhibited high capacity of removal copper and cadmium [8; 11; 12] beyond uptake americium-241 as described by Göksungur [13].

The objective of this study is to investigate calcium alginate beads as biosorbent for the treatment of radioactive liquid wastes.

2. METHODS

2.1 Calcium alginate beads preparation

Calcium alginate beads were prepared by dropping 2% (w/v) of sodium alginate aqueous solution using a peristaltic pump into 4% (w/v) $CaCl_2$ solution under magnetic stirring. Beads were collected and washed by distilled water [13].

2.2 Biosorption process

The solution of americium-241 at concentrations of 75 Bq/ml, 150 Bq/mL and 300 Bq/mL were prepared by diluting the standard solution in deionized water. The pH was adjusted to 2 and 4, with HCl and NaOH.

The uptake of americium-241 was performed by the batch method. 2% of calcium alginate beads were placed in contact with americium-241 solutions and kept under agitation in shaker for about 15, 30, 60, 120 and 240 minutes at room temperature. After the contact time, the solutions were examined by gamma spectrometry and the final concentrations were compared with the initial concentration. All experiments were performed in duplicate.

3. RESULTS

For this work the influence of Am^{+3} concentrations and the pH were study in order to verify the calcium alginate beads ability to remove americium-241 from aqueous solutions.

The biosorption of americium-241 by calcium alginate beads with three different concentrations are shown in figures 1, 2 and 3.

Figure 1 and 2 show that the biosorption of americium-241 reached the maximum value, close to 100% after 120 minutes at pH 4 for the initial activity of 75 Bq/mL and 150 Bq/mL.

At pH 2 the maximum americium-241 removal was 80 and 60 % respectively for 75 Bq/mL and 150 Bq/mL solutions after a contact time of 240 minutes.

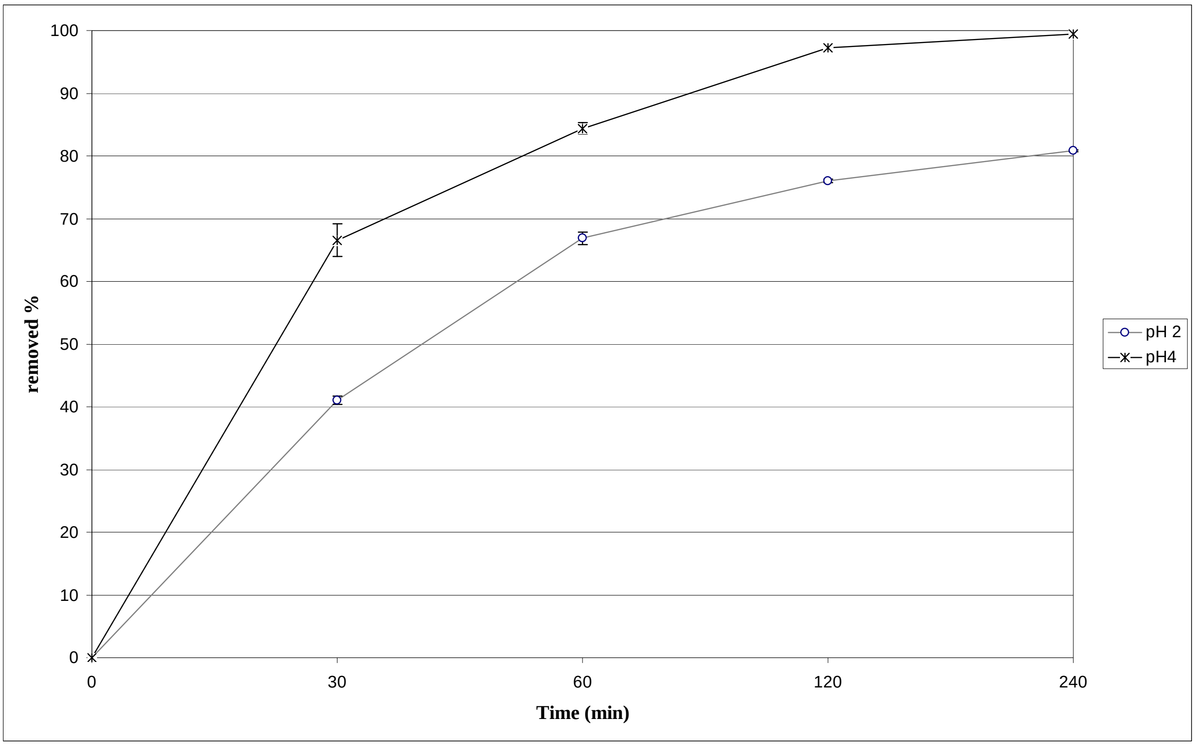

Figure 1: Biosorption of americium-241 with initial activity of 75 Bq/ml at pH 2 and 4 by calcium alginate beads.

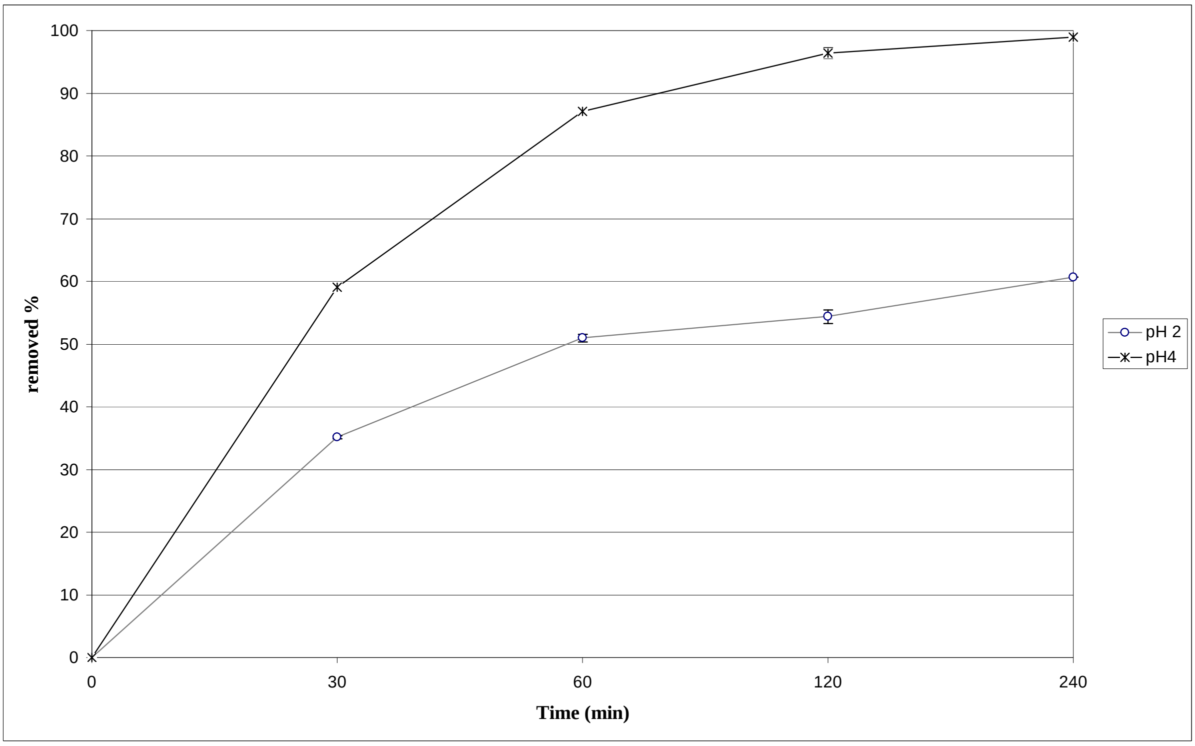

Figure 2: Biosorption of americium-241 with initial activity of 150 Bq/ml at pH 2 and 4 by calcium alginate beads.

The best result was obtained when the calcium alginate beads were placed in contact with Am solutions with initial activity of 300 Bq/mL. It was observed that the biosorption was almost 100% after 60 minutes of contact time in pH=4 (Figure 3).

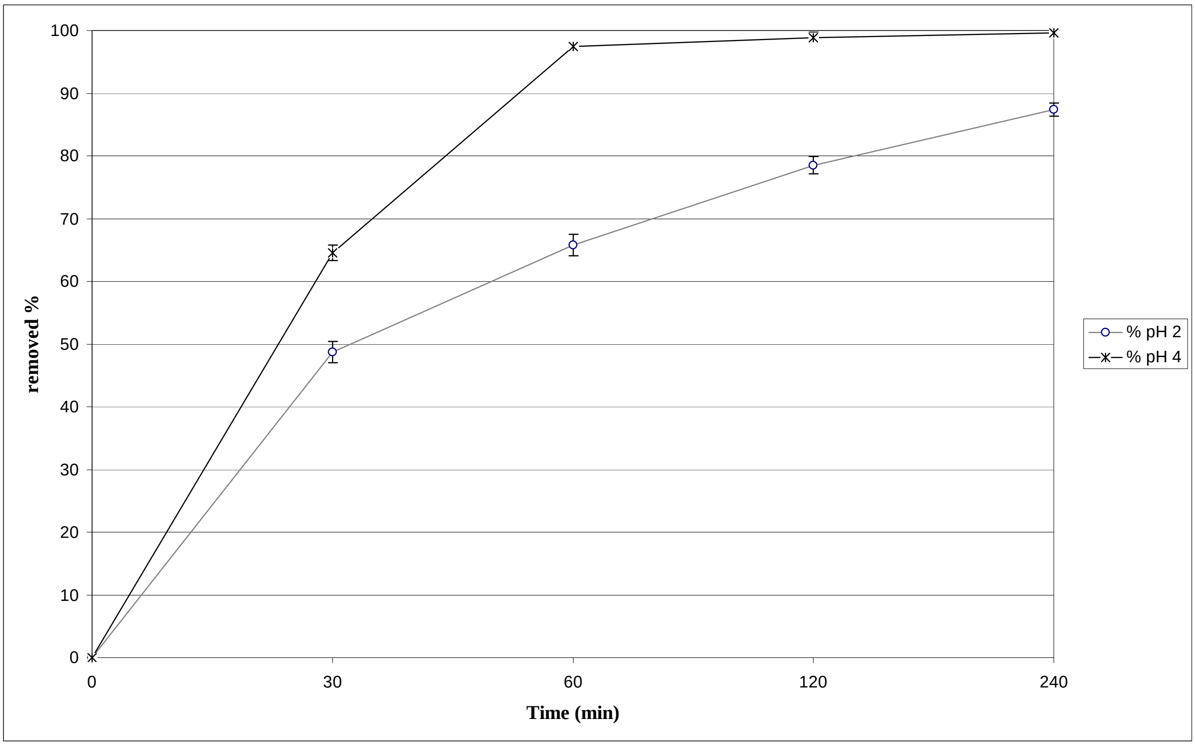

Figure 3: Biosorption of americium-241 with initial activity of 300 Bq/ml at pH 2 and 4 by calcium alginate beads.

Carboxylic group tends to be ionized at pH values over 4. As pH reaches lower values, the competition between H^+ and cations species in solution affects the process, decreasing the metal uptake [14]. This statement corroborates the results obtained in this work where the pH value around 4.5 was found to be the ideal to the americium-241 removal from aqueous solution using alginate beads.

4. CONCLUSIONS

The objective of this study was to investigate calcium alginate beads as biosorbent for the treatment of radioactive liquid wastes. The results suggest that biosorption process is more efficient at pH 4 and for 75, 150, 300 Bq/mL and 120 minutes were necessary to remove almost 100% of the americium-241 from the solution. Additional experiments must be conducted, however, it is possible to conclude preliminarily that alginate is a promising biosorbent and may be used for treating large amount of radioactive waste considering its low cost.

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