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USE OF *SACCHAROMYCES CEREVISIAE* IN RADIOACTIVE WASTE TREATMENT

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ABSTRACT

Waste management plays an important role in reducing the volume of radioactive waste streams, minimizing the cost of the final disposal and the impact on the environment. In this context, new research should focus on the development of simpler and cheaper techniques which may improve the waste processing. The use of biomass in processes concerned with the removal of heavy metals and radionuclides offers significant potential in the treatment of waste-liquid streams. *Saccharomyces cerevisiae* is well known for its capacity of heavy metals biosorption and it also has the additional advantages such as easy availability and the possibility of genetic manipulation. The aim of this work is to study the potential of the free cell and immobilized *S. cerevisiae* in bentonite in the removal Americium-241 from radioactive liquid streams produced by Radioactive Waste Laboratory of Nuclear and Energy Research Institute (IPEN - CNEN/SP).

1. INTRODUCTION

The radioisotopes have been widely used in the industrial, agricultural, medical and, especially, in research area. The cost for the society of using this technology is the generation of radioactive waste. As the traditional wastes, the radioactive one must be treated appropriately to guarantee the safety of the man and the environment.

Americium -241 (T ½ = 433 years, Eα = 5.468 MeV, 86.6%; 5.443 MeV,12.3%; $E\gamma$ = 0.0596 MeV, 35%) is one of most concern radionuclide due to its high toxicity and its long half life. Am-241 is result from successive capture of neutrons by plutonium and it has about 20 radioisotopes or isomers. It is also the most important and widespread radioisotope used in other fields, for example, the fire alarm and lighting rods [1].

The search for new technologies involving the removal of toxic metals from waste has directed the attention to biosorption, based on the metal binding capacities of biological material [2].

Among the biosorbents, yeast *Saccharomyces cerevisiae* plays a prominent role due to its easily grown using unsophisticated fermentation techniques and inexpensive growth media. The biomass of *S. cerevisiae* can be obtained from various food and beverage industries as a by-product. In addition, it is an ideal model organism to identify the mechanism of metal ion removal, and to investigate the interactions of metal–microbe at molecular level, because it can be easily manipulated genetically and morphologically [3].

The aim of this work is to determine the bioaccumulation of Am-241 in radioactive liquid waste with inactive free cells and immobilized *S. cerevisiae* in bentonite matrix.

2. EXPERIMENTAL

In order to evaluate the capacity of Am-241 removal by the inactive *S. cerevisiae,* the experiments were carried out using inactive free cells of *S. cerevisiae* and immobilized in bentonite.

The parameters evaluated were the biosorbent state (free cells or immobilized), contact time between the Am-241 solution and biosorbent, and the variation of pH.

2.1. Biosorbents

For all assays, commercial dehydrated *S. cerevisiae* had been used and the cells inactivation was performed by gamma irradiation (25 kGy). The cellular death was determined by methylene blue method [4]. The immobilization of the *S. cerevisiae* was carried out by mixing the inactivated biomass with bentonite (0.6/1 w/w). The bentonite was supplied by the União Brasileira de Mineração.

2.2. Solution of Am-241

The solutions of Am-241 were prepared from standard $AmCl_3$ in 0,5 M HCl supplied by North American Scientific with an activity of 2.002 MBq (54,12 μCi) in 5 mL.

The samples were diluted with deionized water until final activity of 15 $Bq.mL^{-1}$ and pH was adjusted with 0.2N HNO_3 or 0.2N NaOH solution.

2.3. Biosorption Assay

The experiments were performed with polyethylene bottles containing 100 mL of Am-241 solution and 2% weight/volume of biosorbent at different pH (2 and 4). The mixture was shaken with rotary shaking device (200 rpm) at the room temperature. Aliquots of 60 mL were collected at 15 min, 30 min, 1h, 2h and 4h, and centrifuged at 3000 rpm per 15 minutes. The supernatant was analyzed in automatic counter HPGe (Canberra, model GX2518) in order to determine the Am-241 activity concentration (in $Bq.mL^{-1}$). Bentonite without biomass was used as control. All experiments were performed in triplicate.

3. RESULTS

Figures 1 and 2 show the results obtained with inactive free cells of *S. cerevisiae* and bentonite in pH 2 and 4, respectively. The results demonstrate a high removal capacity for both adsorbent in pH 2. It was also observed a removal of 99.9% of the Am-241 in all the contact times. In a similar research with free cells of *S. cerevisiae* and Am-241, Liu et al [5] observed the same retention capacity and optimum pH ranged from 1 to 3. In pH 4, the removal capacity increased as a function of the contact time. In this case, the maximum removal observed was 91% in 240 minutes.

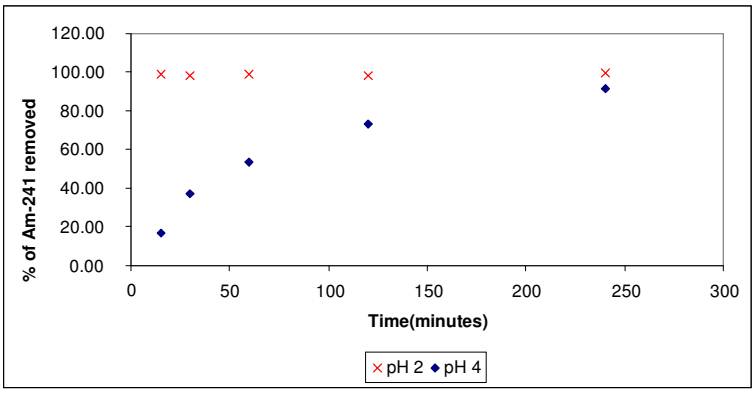

Figure 1: Bioaccumulation of Am-241 by inactive free cell *S. cerevisiae*.

A similar behavior was observed with bentonite in pH 2 in which 99.9% of Am-241 was removed in all the contact times. In pH 4, the process was less efficient, and the maximum removal observed was 80%, within 15 minutes. For the others contact times, the adsorption was lower, about 77%.

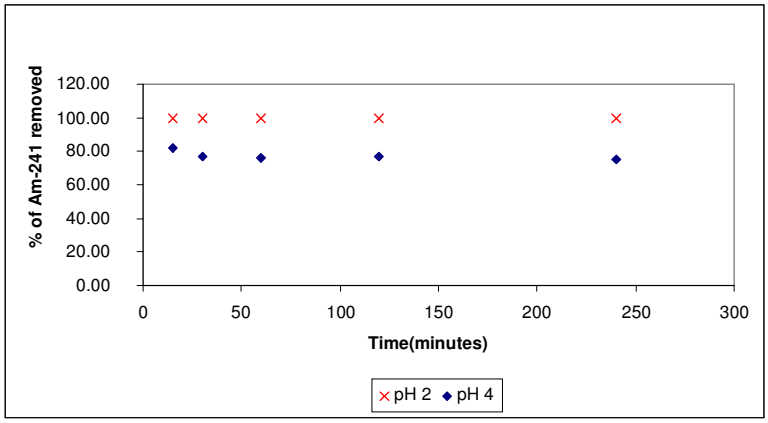

Figure 2: Adsoption of Am-241 in bentonite

The retention of the Am-241 by immobilized *S. cerevisiae* in bentonite (Fig.3) in pH 4 was better than pH 2, achieving 99.9% in 120 minutes. In pH 2, the maximum removal was 93%, within 15 minutes and after that time a slight decline was observed.

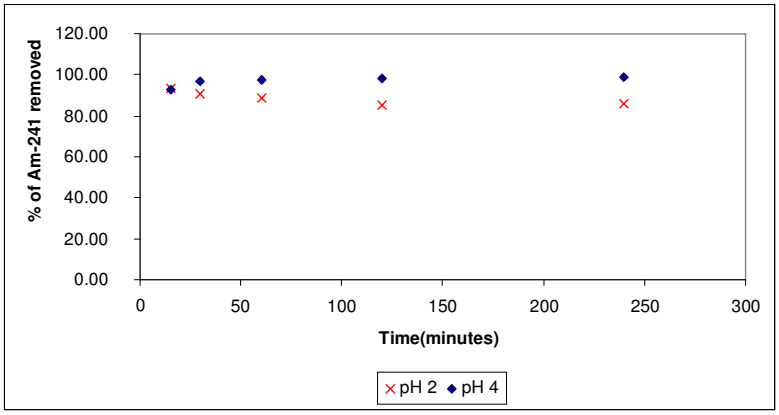

Figure 3: Bioaccumulation of Am-241 by *S. cerevisiae* immobilized in bentonite

Comparison among the adsorbents (free cell inactive *S. cerevisiae*, immobilized inactive *S. cerevisiae* in bentonite and only bentonite), in pH 2 and 4 is shown in figures 4 and 5. The results showed a higher retention with immobilized inactive *S. cerevisiae* in bentonite in pH 4, but, in pH 2, retention was more efficient, with isolated adsorbents.

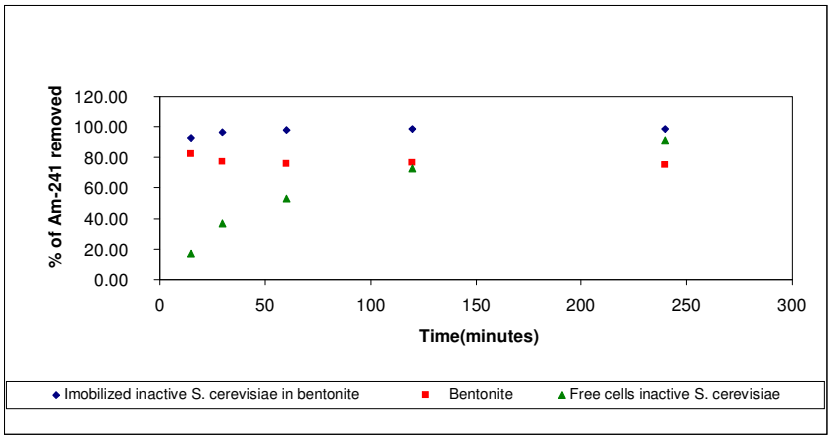

Figure 4: Efficiency of Am-241 removal for the different adsorbents in pH 4

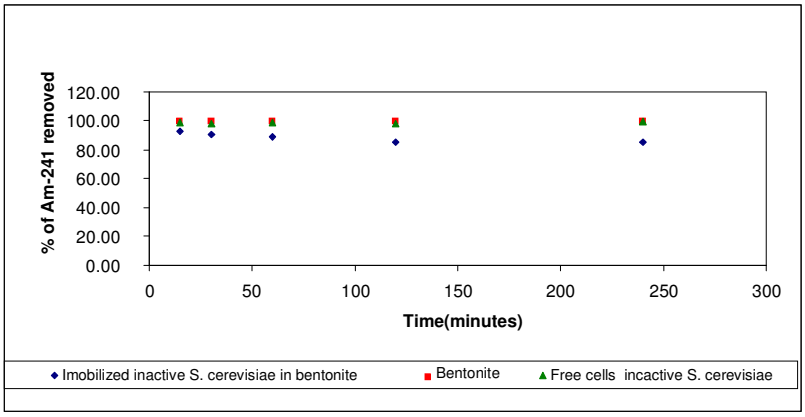

Figure 5: **Efficiency of Am-241 removal for the different adsorbents in pH 2**

4. CONCLUSION

The bioaccumulation by inactive *S. cerevisiae*, free cell or immobilized in bentonite, can be a effective technique for treatment of radioactive waste liquid contaminated with Am-241, since it was achieved a removal of 99.9%.

The pH is a very important parameter in the adsorption and bioaccumulation process, being decisive for the selection of the biosorbent: free cell or immobilized.

This study shows promising for the treatment of radioactive liquid waste, but it is necessary more assays to establish the ideal conditions.

ACKNOWLEDGMENTS

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