Biosorption of uranium and thorium by Marine micro algae

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Different concentration of uranium and thorium uptake by algal biomass was studied. *Chlorella salina* and *Isochrysis galbana* was used to uptake the uranium and thorium in the present study. Different concentration of live cells of algae was also used to uptake the uranium and thorium. Increasing concentration of uranium and thorium showed decrease in absorption by *Chlorella salina* and *Isochrysis galbana*. Increase in biomass concentration has the ability to uptake more amounts of uranium and thorium. *Chlorella salina* absorbed more amount of metal than the *Isochrysis galbana*. Amount of uranium was uptake more than the thorium by *Chlorella salina* and *Isochrysis galbana*. *Chlorella salina* absorbed more amount of thorium.

**Keywords:** *Chlorella salina*, *Isochrysis galbana*, Uranium, Thorium.

**Introduction**

The presence of heavy metals in aquatic environments is known to cause severe damage to aquatic life, beside the fact that these metals kill microorganisms during biological treatment of waste water with a consequent delay of the process of water purification. Most of the heavy metal salts are soluble in water and form aqueous solutions and consequently cannot be separated by ordinary physical means of separation. Physico-chemical methods, such as chemical precipitation, chemical oxidation or reduction, electrochemical treatment, evaporative recovery, filtration, ion exchange, and membrane technologies have been widely used to remove heavy metal ions from industrial wastewater. These processes may be ineffective or expensive, especially when the heavy metal ions are in solutions containing in the order of 1-100 mg dissolved heavy metal ions/L. Biological methods such as biosorption/bioaccumulation for the removal of heavy metal ions may provide an attractive alternative to physico-chemical methods.

Uranium forms more than 160 mineral species and accounts for 5% of all known minerals. Thorium is estimated to be about three to four times more abundant than uranium in the earth's crust. Thorium was successfully used as an alternative nuclear fuel to uranium in the molten-salt reactor experiment. Once released, environmental fate of these radionuclides is significantly controlled by microbial activity as natural microbial flora often executes fascinating mechanisms of interaction with such metallic pollutants, viz., reductive/enzymatic precipitation, solubilization, bioaccumulation/biosorption, etc., which ultimately determine their environmental mobility and toxicity. Some authors looked for but could find no evidence of an active uptake in diatoms or *Chlorella*. *Chlorella* cells grown under different culture conditions, autotrophic, heterotrophic, and mixotrophic had same ability to accumulate uranium. Henceforth, mixotrophic culture is most effective to produce a algal mass as adsorbent for uranium recovery in higher yield.

Present investigation was to evaluate the efficiency of Marine micro algae to absorb uranium and thorium. It is inexpensive alternative method to the existing technologies, to remove and recover radionuclides from low-level activity wastes and to trap uranium from new promising areas.

**Materials and Methods**

*Algae cultures Chlorella salina, and Isochrysis galbana* were collected from CMFRI, Tutucorin, Tamilnadu, India. The stock culture was maintained by using Walne’s culture media. Walne’s media was prepared by using the composition given in Table 1. Four conical flasks were taken with 90 ml sterile sea water. About 55µl of solution A, 50µl of solution B and 25µl of solution C of Walne’s media was added to the respective four conical flask. Then to each conical flask 10% algae *Chlorella salina* and *Isochrysis galbana* was used to uptake the uranium and thorium. **Received 22 December 2009; revised 24 February 2010**
galbana were added respectively. Stocks were maintained at a temperature of 20°C and pH of 8.5. Cultures were illuminated with fluorescent lamps. Growth of algae cultures were daily checked and appropriate dilutions were given when required.

Microscopically Identification
Algae (Chlorella salina, and Isochrysis galbana) maintained in stock solution were then viewed microscopically. The nomenclature of Chlorella salina and Isochrysis galbana were given below respectively.

Nomenclature of Chlorella salina
It is spherical in shape, about 2 to 10 µm in diameter, and is without flagella. Chlorella contains the green photosynthetic pigments chlorophyll-a and -b in its chloroplast. Through photosynthesis it multiplies rapidly requiring only carbon dioxide, water, sunlight, and a small amount of minerals to reproduce. Chlorella is a single-celled alga originally rich as a source of protein, Vitamins, minerals and essential amino acids.

Kingdom: Plantae
Division: Chlorophyta
Class: Chlorophyceae
Order: Chlorococcales
Family: Oocystaceae
Genus: Chlorella
Specific descriptor: Salina
Scientific name:- Chlorella salina

Nomenclature of Isochrysis galbana
Isochrysis galbana is a microalgae originally from the chrysophyte algal group. It is now classified in a new phylum of algae called haptophytes (Prymnesiophyta or Haptophyta). It was first identified by Bruce, Knight and Parke (1939) it is a small round to ovoid cell that has two flagella for locomotion. It was discovered to have high lipid content and thus a good food source for various bivalve larvae. It is now widely cultured for use in the bivalve and other aquaculture industry.

Kingdom: Chromista
Phylum: Haptophyta
Class: Prymnesiophyceae
Order: Isochrysidales
Family: Scarabaeoidea
Genus: Isochrysis
Specific descriptor: Galbana
Scientific name: Isochrysis galbana

Preparation of the uranium and thorium solutions
All uranium (Merck Ltd) and thorium (Merck Ltd) solutions were prepared form uranyl nitrate and thorium nitrate. Uranium and thorium solutions of different concentrations were prepared.

Uranium and thorium uptake experiment
Experiment of metals uptake, the algal cells in the linearly growing phase was collected by centrifugation at 6000 rpm for 5 min. Cells were then washed three times sterile distilled water and re-suspended in 10 ml water. A known volume of each cell suspension, equivalent to one mg dry mass per ml of uranium or thorium solution, was added, mixed well and incubated at 20°C after 12 h of shaking at 150rpm and 20°C. Biomass was separated by centrifugation at 6000rpm for 5 min and supernatant used for metal estimation.

Different concentration of live cells of algal biomass to uptake uranium and thorium
To study the effect of biomass concentration, the experiment of metals uptake, the algal cells in the linearly growing phase was collected by centrifugation at 6000 rpm for 5 min. Cells were
then washed three times sterile distilled water and re-suspended in 10 ml water. A different volume of each cell suspension was added per ml of uranium or thorium solution, different algae cell concentrations ranging from 0.2–3 mg dry mass per ml were added to the solutions containing 30 µg U mL\(^{-1}\) and 16 µg Th mL\(^{-1}\).

Results and Discussion

Algae cultures *Chlorella salina*, and *Isochrysis galbana* were procured from CMFRI, Tutucorin, Tamilnadu, India. Algae was maintained in Walne’s media at 20\(^{\circ}\)C.

In Table: 1 showed the different concentration of uranium uptake by *Chlorella salina*. Two mg of cell mass was added per ml of solution. The 100% of uranium was removed at 10 µg U ml\(^{-1}\). The 80% of uranium was absorbed at 15 µg U ml\(^{-1}\). The 60 and 40% removal was achieved at 20 and 25 µg U ml\(^{-1}\). Lowest concentration of uranium of 30% was observed at 30 µg U ml\(^{-1}\). Uptake of different concentration of uranium by *Isochrysis galbana* was showed in the Table: 2. It uptake 80% uranium at 10 µg U ml\(^{-1}\). The 70 and 40% uranium was uptake at 15 and 20 µg U ml\(^{-1}\). Lowest absorption of 30% was achieved at 25 and 30 µg U ml\(^{-1}\). Uptake of different concentration of thorium by the *Chlorella salina* was shows in the Table: 3. Highest concentration of 90% of thorium was uptake at 4 µg Th ml\(^{-1}\). Lowest absorption of 50% achieved at 20 µg Th ml\(^{-1}\). In Table: 4 showed different concentration of thorium uptake by the *Isochrysis galbana*. The highest absorption of 70% of Thorium was achieved at 4 µg Th ml\(^{-1}\). Uptake of 20 µg Th ml\(^{-1}\) was achieved at 30%. In the above results, observed that the increasing the metal concentration is to decrease the uptake ability of algae. *Chlorella salina* has the ability to remove the uranium and thorium than the *Isochrysis galbana*. Low uranium and thorium concentration there was a small number of metal ions compared to the large surface area with active site. Thereby, it was easy for each metal ions to find it place on the cell surface on the other hand, not all metal ions could be absorbed by increasing the metal concentration, living a the residual amount of free metal ions.

The different concentration of cell mass was used to uptake the 30 µg U ml\(^{-1}\) and 20 µg Th ml\(^{-1}\). Live cell of algal bio mass of *Chlorella salina* to uptake the uranium was shown in the Table 5. Lowest uptake of uranium was achieved at 0.2 g of cell mass. Highest concentration of uranium was achieved at 3 g of cells per ml of solution, it uptake 60%. Uptake of uranium by the different cell mass of *Isochrysis galbana* was shown in the Table: 6. The 0.2 g of cell mass absorbs lowest uranium from the solution. The 60% of uranium uptake was achieved at 3 g of cells. To study the effect of cell biomass of *Chlorella salina* to uptake the thorium was shown in the Table: 7. The 0.2 g of cell uptake the 10% of thorium. The 90% of thorium was uptake by the 3 g of algae cell mass. Thorium uptake by the different concentration of cell mass of *Isochrysis galbana* was shown in the Table: 8. The 0.2 g of cell uptake the 10% of thorium and the 3 g of cell absorbed the 70% thorium. Above results showed the, increasing the cell mass concentration has the ability to uptake uranium and thorium from the solution. Cell mass of *Chlorella salina* to absorbed more metals from the solution than the *Isochrysis galbana*. There was a large surface area with active site.
Table 6—Different concentration of live cells of *Isochrysis galbana* to uptake the uranium

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<th>Sl No</th>
<th>Cell mass conc. mg</th>
<th>Uranium absorbed %</th>
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<tr>
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<td>0.8</td>
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<tr>
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</tr>
<tr>
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Table 7—Different concentration of live cells of *Chlorella salina* to uptake the Thorium

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<tr>
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Table 8—Different concentration of live cells of *Isochrysis galbana* to uptake the Thorium

<table>
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References


