Adsorption of heavy metals from Industrial effluent using Sargassum sp.

1. INTRODUCTION
Pollution on the environment and on public health has become an important social and political issue. The environment and public health effects of heavy metals have been well documented and range from genetic malformation to death (Volesky and Holan, 1995). Metals discharged into water bodies are not biodegraded but undergoes chemical or microbial transformations, creating large impact on the environment and public health (Volesky, 1990). At present, environmental protection is the main need of the society. Thus, it becomes necessary to study the composition of sewage waters and heavy metals accumulation, with the help of advance techniques (Volesky et al., 1993). Among the most promising types of biosorbent studied the algae possess a high metal-binding capacity. This is due to the presence of various functional groups such as carboxyl, amino, sulphate and hydroxyl groups, which can act as binding sites for metals (Prakasham, et al., 1999). The objective of the present work was to analyze the heavy metals present in the effluent and evaluate the percentage of removal using the biomass by column study and also study the structural changes of the biomass before and after metal adsorption using Scanning Electron Microscope (SEM).
CHARACTERISTICS OF THE BIOMASS

- Algae collected from rocky seashores were packed in a glass column.
- To optimize the sorption studies, effluent were passed into the column and the outlet were collected at regular intervals.
- Dried biomass, uptake the metals more rapidly due to free ion-exchange and the slow process of fresh algae may be due to metabolic dependence.
- Structural changes of the algae may be due to the replacement of cations present in the cell wall matrix and created stronger cross linking.

### 2. MATERIALS AND METHODS

#### 2.1. Sample Collection - Brown algae

Fresh samples of brown marine macro alga, *Sargassum sp.* were collected from rocky seashores near Uvari, Tirunelveli District, Tamilnadu (Fig. 1). The macro alga samples were rinsed with distilled water for the removal of external salts and sand and then with acetone solution. The samples were again washed and rinsed in distilled water.

The algae samples were then roughly chopped and dried at 60°C overnight and stored in a dry cabinet (Da costa and De franca, 1996). Few fresh samples were stored at -20°C for future usage.

#### 2.2. Effluent collection

The effluent used was obtained from Electroplating Metal Finishers, SIPCOT Industrial Estate, Chennai, Tamilnadu. The pH of the waste water was determined on the spot using portable pH meter. The physico-chemical characteristics of the effluent were determined using standard analytical methods (APHA, 19th edn.). The concentrations of heavy metals were detected using AAS.

#### 2.3. Column studies

Fixed bed biosorption experiments were conducted in a glass column and a known quantity of biomass was packed in the column to yield the desired bed height of the sorbent. To optimize the sorption studies it was carried out in a glass column of 8.3, 8.5 and 12.5 cm of column height with the diameter of 1.2, 1.8 and 3.2 cm respectively. The bed height of the column is 6.5, 7.0 and 9.0 cm and the flow rate was adjusted to 5, 10 and 15 ml/min and the effluent concentration was varied between 50, 75 and 100 mg/l. Experiments were conducted to study the effect of bed height, flow rate and the effluent concentration. The aliquot of the effluent at the outlet of the column was collected at regular time intervals. Column effluent samples were analyzed by atomic absorption spectroscopy.

### Table 1  Optimized Column at Different Bed Heights, Flow Rates and Metal Ion Concentrations Using Dried Biomass (% Yield)

<table>
<thead>
<tr>
<th>Column Height(cm)</th>
<th>Bed Height(cm)</th>
<th>Flow Rate(ml/min)</th>
<th>Amount of algae(g)</th>
<th>Inlet Conc.(mg/L)</th>
<th>Dia of Column(cm)</th>
<th>%Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.3</td>
<td>6.5</td>
<td>5</td>
<td>3.0</td>
<td>100</td>
<td>1.2</td>
<td>44.44</td>
</tr>
<tr>
<td>8.5</td>
<td>7.0</td>
<td>5</td>
<td>6.0</td>
<td>100</td>
<td>1.8</td>
<td>50.00</td>
</tr>
<tr>
<td>12.5</td>
<td>9.0</td>
<td>5</td>
<td>8.0</td>
<td>100</td>
<td>3.2</td>
<td>62.50</td>
</tr>
<tr>
<td>12.5</td>
<td>9.0</td>
<td>10</td>
<td>8.0</td>
<td>100</td>
<td>3.2</td>
<td>75.00</td>
</tr>
<tr>
<td>12.5</td>
<td>9.0</td>
<td>15</td>
<td>8.0</td>
<td>100</td>
<td>3.2</td>
<td>54.45</td>
</tr>
<tr>
<td>12.5</td>
<td>9.0</td>
<td>5</td>
<td>8.0</td>
<td>75</td>
<td>3.2</td>
<td>40.00</td>
</tr>
<tr>
<td>12.5</td>
<td>9.0</td>
<td>5</td>
<td>8.0</td>
<td>50</td>
<td>3.2</td>
<td>85.74</td>
</tr>
<tr>
<td>12.5</td>
<td>9.0</td>
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<td>8.0</td>
<td>75</td>
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<tr>
<td>12.5</td>
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<td>5</td>
<td>8.0</td>
<td>50</td>
<td>3.2</td>
<td>42.85</td>
</tr>
</tbody>
</table>
2.4. Scanning Electron Microscope (SEM)
The surface morphology of the dried algae before and after adsorption was observed using Scanning Electron Microscope (SEM). The samples (0.71 to 1.0 mm) were covered with a thin layer of gold (10nm) using a sputter coater and observed using the scanning electron microscope (20kV) under vacuum of 1.33 × 10–6mBar. The objective of this analysis was qualitative, not quantitative.

3. RESULTS AND DISCUSSIONS
3.1 Column studies
The column packed with fresh and dried biomass were optimized and shown in Table 1. The maximum percentage yields were observed as 85.74% in dried biomass and 40% in fresh biomass. From the table it was observed that dried biomass uptake the metals more rapidly than the fresh biomass. The slow process of fresh biomass might be due to metabolic dependence. After treatment, the samples collected from the exit were analyzed for physico-chemical characteristics. The concentrations of the heavy metals before and after treatment using column process were depicted in Table 2. The concentrations were found to be decrease after biosorption.

3.2 Scanning Electron Microscope (SEM)
The surface morphology of algae before and after metal adsorption is observed using Scanning Electron Microscope (SEM) and were shown in Fig. 2a and 2b. The structural changes were observed in the metal adsorbed sample; probably it may due to the exposure of heavy metal solution to the algae. The cations replaced some of the cations initially present in the cell wall matrix and created stronger cross-linking. Due to ion-exchange mechanism, the heavy metal ions occupied the available free binding sites. It is evident from the micrographs that the biomass presents an uneven, compacted structure, crossed by large canals in the treated sample. The number of canals crossing the biomass is higher than in the initial case.

4. CONCLUSION
Biosorption of heavy metals is one of the promising technologies involved in the removal of heavy metals from waste waters. Sargassum sp. is selected for studying biosorption due to its originality and to assess the possibility of utilizing a waste biomass for the removal of toxic heavy metals. The results from this research shows that the utilization of dried Sargassum sp. play a vital role in the adsorption of heavy metals from the industrial waste waters than the fresh algae. This may be due to the metabolic changes happened in the fresh algae. The industrial effluent was treated effectively and successfully by this selected biomass Sargassum sp. Based on the results obtained, it can be concluded that the dried biomass Sargassum sp. has higher affinity towards the adsorption of metals. Hence, the results obtained are very promising for further large-scale biosorption studies.

SUMMARY OF RESEARCH
1. The selected non-living biomass is growth-independent and not subjected to toxicity limitations of the cells.
2. No costly nutrient is required for the growth of cells in the feed solutions. The process is not governed by the physiological constraint of the living microbial cells.
3. The selected biomass behaves as an ion exchanger and hence, the process is very rapid and takes place between few minutes and few hours.
4. Metal loading is often very high, leading to very efficient metal uptake. No aseptic condition is required for this process.

FUTURE ISSUES
1. Whether the metal adsorption affects the molecular status of the algae?
2. Whether the genetic variation of the algae can improve the adsorption of metal?

DISCLOSURE STATEMENT
There is no financial support for the proposed research work.
ACKNOWLEDGEMENT
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REFERENCES

2. Da Costa ACA, De Franca FP. Biosorption of Zinc, Cadmium and Copper by a Brown Seaweed (Sargassum sp.) in a Continuous Fixed-Bed Laboratory Reactor. Biosep., 1996, 6(6), 335-341

RELATED RESOURCE