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BIOSORPTION OF HEAVY METALS BY *SCENEDESMUS* SP. ISOLATED FROM THE TEMPORARY WATERS OF ENDAU ROMPIN, JOHOR, MALAYSIA

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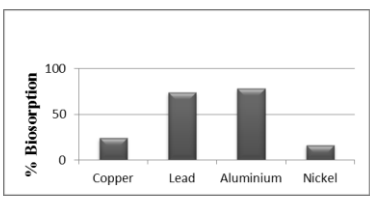
Graphical abstract



Abstract

Contamination of soil and water by heavy metals threatens the well-being of humans and the natural environment. The need for a cost-effective and efficient method for their removal has led researchers to develop interest in microorganisms that show resistance to these toxic metals. In this work, we used inductive coupled plasma mass spectroscopy to detect the presence of heavy metals Aluminum (Al), lead (Pb), Nickel (Ni) and Copper (Cu) in the wild pond *Sungai Buaya*, in Johor Malaysia. This research shows the biosorption ability of living cells of micro algae *Scenedesmus* sp. as a function of metal concentration for these metals. It was found that 78% of Al, 74% of Pb, 24% of Cu and 16% of Ni was taken up by the microalgae. This shows that *Scenedesmus* sp. has potential for use in further research works particularly in bioremediation of contaminated water and also biosynthesis of nanoparticles.

Keywords: Biosoption, Biosorbents, Heavy metals, *Scenedesmus* sp., Water contamination

1.0 INTRODUCTION

Water contamination is, indeed, a great cause for worry considering the fact living things generally survive on water. Beside our food and drinks, most industries, involved in manufacturing our clothes, shoes and other products we use to better our life, require constant supply of water to function. This explains why contamination of our sources of water certainly threatens our well-being in particular and that of the natural environment in general.

Heavy metals are regarded as among the hazardous contaminants of water source mainly due to their non-degradable, recalcitrant and often soluble characteristics (1). Therefore, efforts have been going on for decades to remove heavy metals from water, especially when they occur in high amounts. These efforts which involves mainly physico-chemical removal methods, such as chemical precipitation, electro winning, membrane separation, evaporation or resin ionic exchange, have often been expensive and sometimes, ineffective. (2, 3) The search for better decontamination methods have led to the development of new technologies, involving the use of microorganism, as a promising alternative due to their ability to achieve different transformation and immobilization processes one of which is biosorption. (2, 4). The application of biological system in the treatment of wastewater containing heavy metals is regarded as pertinent, cost effective and an efficient approach (5).

Biosorption, based on living or nonliving microorganisms or plants, has the distinct advantages of low cost, environmentally friendly renewable nature, no secondary pollution and easy to operate. (3, 6). In this regard, algal biomass, among the biosorbents, generates particular interest due its high metal-binding capacity owing to the algal cell wall polymers (7), ubiquitous nature and high growth rate with simple growth requirements (8).

The bioaccumulation potential of microalgae can be explained by their resistance mechanism against heavy metal toxicity (9). Some microalgae strains (green algae and cyanobacteria) were reported to exhibit varying efficiency in their cadmium removal ability (10; 11; 12; 13). Although *Chlorella* sp. and *Scenedesmus* sp. are said to be the two common algae species used for removal of heavy metal (14), *Scenedesmus* has, however, gained importance as a result of it been an efficient hybrid biosorbent for removal of various metals (15), its phenotypic adaptability towards a wide range of heavy metals in addition to its ability to survive in anthropogenically disturbed ecosystems (16). Researchers have also reported that *Scenedesmus* sp. can sequester cadmium both in living and nonliving condition (17).

In this work, our aim is to observe the ability of *Scenedesmus* sp. in removal of selected heavy metals from the water of a wild pond. The objective is to investigate the removal capacity of *Scenedesmus* sp. for each of the heavy metals.

2.0 EXPERIMENTAL

Water Sample Collection and Heavy Metal Analysis

Water sample for this work was collected from the wild pond, *Sungai Buaya*, in Johor Malaysia. The presence and quantity of selected heavy metals namely; aluminium (Al), copper (Cu), lead (Pb) and nickel (Ni), was determined in the water sample, before and after treatment with microalgae, using PerkinElmer SCIEX Inductive Coupled Plasma Mass Spectrometer (ICPMS) ELAN 9000 at the Analytical Laboratory of FKASS, UTHM Johor, Malaysia.

Microorganism, Growth and Mass Culture

The *Scenedesmus* sp. used was obtained from microbiology laboratory of the Faculty of Science, Technology and Human Development, University Tun Hussein Onn Malaysia. It was earlier isolated from the rocky ponds of Endau Rompin in Johor, Malaysia.

Prior to the experiment, 0.5 litres of Bold Basal Medium (BBM) were prepared in three Erlenmeyer flasks each. The isolate was cultured for seven days in the media under natural sunlight and frequent agitation. Growth was monitored through cell count on the day of preparation (day 0) then subsequently on the 3rd, 4th, 5th and 6th day. Algal cells were harvested with centrifugation at 6000 rpm for 15 minutes followed by washing three times with ultra-pure water and then determination of cell concentration. The cells were counted using the Neubaeur Haemocytometer with the aid of a compound microscope.

Biosorption Experiment

Algal cells were grown in suitable medium. After 7 days, cells were harvested by centrifugation at 6000rpm for 15min at 4 ◦C and washed three times with distill water. The harvested cells were used in the biosorption experiment; 15ml algae suspension was added to 25ml of the fresh water and kept at room temperature for two (2) weeks. This experiment was carried out in triplicate.

3.0 RESULTS AND DISCUSSION

Scenedesmus sp. cells were counted for five days (Table 1). The rapid growth obtained is a quality of *Scenedesmus* (19) and in this instance, for most of the seven days of culture, there was availability of much sunlight which is an essential requirement for algae growth (20, 21).

Table1 Growth of Scenedesmus sp. in Bold Basal Medium

Number of days grown	Algae cell count (cells/ml)
0	1×10^3
1	2.4×10^5
2	1.7×10^6
3	4.4×10^6
4	4.7×10^6
7	5.2×10^6

ICPMS was used for the heavy metals quantification (Table 2). From the mean values obtained, percentage biosorption of the heavy metals were plotted (Figures 1). This result is in agreement with several reports on the biosorption capacity of the microalgae *Scenedesmus* sp. for heavy metals from solution (3, 14, 15, 16, 17). However, a preference for some metals, when compared to others, can be observed in the biosorption characteristics. Al and Pb were absorbed the more when compared to the metal with the highest concentrations(Cu) and lowest concentrations(Ni).

Table 2 Heavy metals biosorption determination in living cells of *Scenedesmus* sp. (µg/ml).Values are Mean±SE

Metals	Concentration before biosorption	Concentration after biosorption
Copper	36.6±0.416	26.6±2.078
Lead	0.226±0.056	0.059±0.028
Aluminum	8.04±0.95	1.76±0.25
Nickel	6.39±0.037	5.37±0.043

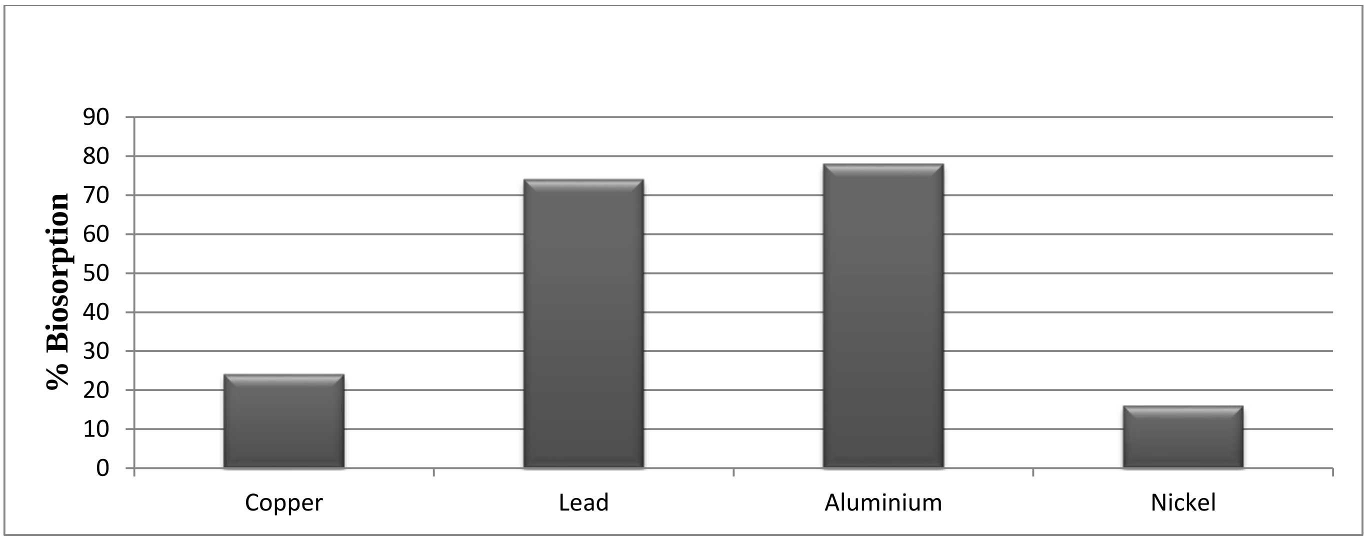


Figure 1 Percentage of heavy metals biosorption in living cells of *Scenedesmus* sp.

4.0 CONCLUSION

Based on the result of this work, it is proven that *Scenedesmus* sp. can be used to remove metal pollutants. The effectiveness of the microalgae to do this was observed through the biosorption experiment carried out. The maximum of the removals, 78% and 74% for Al and Pb respectively proves that the *Scenedesmus* sp. gives good indication for treatment of aluminium and lead contaminations based on percentage of removal. Further research is required to find out the influence of both natural and artificial factors, such as nature of environment and pH of bearing solution etc., on the biosorption process. The reason for preference by the microalgae for more of one metal than others also needs to be studied.

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