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Research article

Bioremoval of copper and zinc by filamentous alga *Oscillatoria limnetica*

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ABSTRACT

In this study, the ability of *Oscillatoria limnetica* was evaluated in the adsorption of copper and zinc within the optimum growth conditions of these algae species. The algae exposed to different concentrations of copper and zinc, for testing ability of algae in removal of both elements. The results showed the significant ability of *O. limnetica* to remove the copper ion from the aqueous solution. The removal percentage was 85.71, 65.71, 69.1, 84.78, and 88.35 for the concentrations 0.3, 0.5, 1, 2, and 3 ppm, respectively. There was a complete removal of the copper on the day 11 of the experiment. The removal percentage of zinc was 97.23, 97.73, 98.28, 98.73 and 98.3 for the concentrations 3, 5, 7, 9 and 10 ppm, respectively. The results suggest that the possible of using *O. limnetica* in removal heavy metals from wastewater.

Keywords: Bioremoval, Copper, *Oscillatoria limnetica*, Zinc.

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INTRODUCTION

Water pollution is one of the most serious problems because inorganic and organic wastes are discharge to the aquatic environment either in water soluble or insoluble forms [1,2]. Among the inorganic pollutants, heavy metals are the most serious because of their high solubility in the aquatic environments; living organisms can absorb heavy metals. Once they enter the food chain, large concentrations of heavy metals may accumulate in the human body. If the metals ingested beyond the permitted concentration, they can cause serious health disorders [3].

In addition, they are non-biodegradable and have the ability to accumulate in living organisms. Therefore, it is necessary to treat metal contaminated wastewater prior to its discharge to the environment. Bio-treatment with microalgae has been particularly attractive because of their photosynthetic capabilities converting solar energy into useful biomasses and incorporating nutrients such as nitrogen and phosphorus which, cause pollution and eutrophication [4]. Previous study [5] stated that the algae have many features that make them ideal for the selective removal and reducing the concentration of heavy

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metals, which include high biosorption capacity, high tolerance to heavy metals, ability to grow both autotrophically and heterotrophically large surface area, volume ratios, phototaxy, phytochelatin production and its potential for genetic manipulation. The use of microalgae for removal of nutrients from different wastes has been described by a number of authors [6,7]. Therefore, attempts were made to use microalgae, living or their dead biomass for removing heavy metals from contaminated waters [8-10].

In addition, biodegradation and biosorption capacity of some potential cyanobacterial species like *Osillatoria* sp*., Synechococcus* sp*., Nodularia* sp*., Nostoc* sp. and *Cyanotheca* sp*.* dominated the effluents and mixed cultures showed varying sensitivity and the contaminants were removed by all the species either as individuals or in mixtures [11]. *Oscillatoria* is a filamentous cyanobacterium, which morphologically vary from small isolated filaments, to filaments densely arranged in a mucilagenous film. The aim of the study was investigate the ability of *Oscillatoria limnetica* to remove Zn and Cu from the aqueous solution and evaluate this possibility to use this type of algae in the treatment and removal of heavy metals from polluted water.

MATERIALS AND METHODS

Algae

The culture of *O. limnetica* was obtained from botany laboratory/ Biology Department/ College of Science/ University of Baghdad. *O. limnetica* was cultivated in Chu Medium No.10 after preparation. The preparation of the medium was by suspended 123.0 mg in 1000 ml distilled water and heat up if necessary to dissolve the medium completely. It was sterilized by autoclave (Labtech) at 1.5 (inch/cm^2) pressures and 121ºC for 15 min and mixed well and dispensed as desired.

Preparation of copper and zinc standard solutions

A standard solution of 1000 parts per million for copper was prepared by dissolving 3.92 gm of $CuSO_4.5H_2O$ in one litre of de-ionized distilled water (DDW). From this standard solution different concentrations of copper (0.3, 0.5, 1,2 and 3) ppm were prepared for further analysis. Standard solution of 1000 parts per million for zinc was prepared by dissolving 4.39 gm of $ZnSO_4.7H_2O$ in one liter of de-ionized distilled water, then different concentrations of zinc (3, 5, 7, 9 and 10) ppm were prepared from this standard solution. Fifty milliliter of algal culture was added to 1000 ml of the medium containing copper or zinc ions. Three replicates were used for each concentration.

Growth conditions

The *Oscillatoria limnetica* was cultivated in 25ºC with 50 eniestien /m^2/s2 [12]. The growth was calculated depending on the total account of algae.

Measurements of the heavy metal concentration in the filter of the cultures of the algae

The algae was exposed to different concentrations of copper and zinc to find out the ability of algae to remove and tolerate copper and zinc ions by comparing to the initial concentrations and measured the concentrations of copper and zinc in filtrate. Usually, the algae separated from the solution of culture by filtration with fiberglass filter papers (Millipore filter paper) with diameter of 0.45 micron, then measured the concentration of the heavy metals in filtrate using Flame Atomic Spectrophotometer to test the efficiency of algae in removing and decreasing the concentrations of heavy metals.

A continuation in the algae growth to compare between the numbers at zero time until the end of the experiment. The statistical analysis system- SAS [13] was used to study the effect of different factors in study parameters. Least significant difference –LSD test was used to significant compare between means and in this study.

RESULTS AND DISCUSSION

The present study showed that the removal percentage of copper ions was increased through the experiment from the first day until the eleventh. It reached 85.71, 65.71, 69.71, 84.78 and 88.35 % for the concentrations 0.3, 0.5. 1, 2 and 3 ppm, respectively (**Table 1**).

This increase was concurrent with the increase in biomass since the biomass provides binding sites for metal ions sorption, and the concentration strongly affects the sorption of metal ions from the solution [14].

Table 1. Removal percentage of copper ions by *O. limnetica.*

Day	Percentage of copper removal (%)				
	0.3ppm	0.5ppm	1ppm	2ppm	3ppm
1st	50	40	54	69	79.4
4th	50	40	54	77	79.4
5th	100	70	70	85	84.7
6th	100	70	70	85	90
7th	100	70	70	85	90
8th	100	70	70	92.5	95
11th	100	100	100	100	100
Mean	85.71	65.71	69.71	84.78	88.35

While the removal percentage of zinc ions Zn^{+2} concentrations 3, 5, 7, 9 and 10 ppm was 97.23, 97.73, 98.28, 98.37 and 98.3 respectively (**Table 2**). There was an increase in the rate during the days of experiment since the first day.

The results showed that the removal percentage increased with increased of concentration, as a rule, increasing the initial metal concentration results in an increase in the biosorption capacity, because it provides a driving force to overcome mass transfer resistance between the biosorbent and biosorption medium [15].

Table 2. Removal percentage of zinc by *O. limnetica*.

Day	Percentage of zinc removal (%)				
	3ppm	5ppm	7ppm	9ppm	10ppm
1st	95.7	98.8	98.2	98.6	97.4
2nd	98	97.4	98.2	98.6	98.7
3rd	98	97.4	98.2	97.9	98.1
6th	98	97.4	98.2	97.9	98.1
7th	98	96.2	98.2	97.9	98.1
8th	95.7	97.4	98.2	97.9	98.1
9th	98	98.8	98.2	99.4	99.4
10th	98	98.8	99.2	98.6	98.7
11th	95.7	97.4	98	98.6	98.1
Mean	97.23	97.73	98.28	98.37	98.3

The result proved that ability of *O. limnetica* to remove both copper and zinc ions with high efficiently. There was continuous removal until the last day of the experiment and complete removal of copper was found by day 11 of the experiment. That is why; it can be use this alge in cleaning water of pollution with Zn and Cu.

Conflict of interest

The authors declare that they have no conflict of interests.

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