

Original Research

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Removal Lead, Nickel and Cadmium by *Coelastrella* Sp. in Waste Water

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ABSTRACT: Three concentrations (10, 20, and 30 ppm) of lead, nickel, and cadmium were used to assess the efficiency of *Coelastrella* sp. (MH923012) to remove heavy metals from aqueous solution. The experiments were performed under controlled laboratory conditions across different exposure durations. Algal growth was continuously monitored by measuring optical density (O.D.) throughout the study period. The results demonstrated a clear reduction in the concentrations of all tested metals in the treated samples. The removal rate for lead was 100% for all concentrations that represent the highest percentage, and the removal rate for cadmium was 95.7% for the concentration of 30 ppm, while for nickel, 83% represented the highest removal for the concentration of 30 ppm along with noticeable adaptive responses in algal growth. Overall, these findings highlight the strong tolerance of *Coelastrella* sp. to heavy metals and its effective potential for metal uptake and removal.

INTRODUCTION

Heavy metals (HMs) are defined as metallic elements with a greater density than water [1]. HMs are naturally occurring elements with a large atomic weight and at least five times the density of water [2]. Assuming that heaviness and toxicity are intertwined, HMs also include metalloids, such as arsenic (As), that can induce toxicity at low exposure levels [3]. Various heavy metals, such as chromium (Cr), cadmium (Cd), nickel (Ni), copper (Cu), zinc (Zn), lead (Pb), mercury (Hg), and As, are recognized as biologically dispensable and detrimental to the aquatic ecosystem [4]. Anthropogenic sources, including but not limited to the nonferrous metallurgical industry, mining, mineral processing, electroplating, leather tanning, and chemical industries, are commonly attributed to the discharge of hazardous metals such as HMs [5]. The level of toxicity exhibited by these hazardous materials is contingent upon the amount and length of time that living organisms are exposed to them. depicts the origins and impacts of HMs on humans through the food chain. Prolonged exposure to HMs through dermal contact, ingestion of contaminated food, and inhalation can result in the development of diverse disorders in both humans and other organisms [6]. In addition, the issue of soils contaminated with HM has become an increasingly significant environmental concern worldwide [7].

In this study *coelastrella* sp. was used to remove lead,nickel and cadimium ions from contaminated water under laboratory conditions in order to assess the ability of this alga for removing. So later it can suggest to use it in bioremediation programmer to treat polluted water with heavy metals.”

Classification of *coelastrella* sp.

Phylum: Chlorophyta

Class: Chlorophyceae

Order: Chlamydomonadales

Genus: *Coelastrella* (Abed et al.)

Materials and methods

Isolation of *Coelastrella* sp.(MH923012)

A specific strain of Microalgae (MH923012) was used throughout the whole experimental work. The strain was isolated from the Tigris River and recorded under No. MH923012 by Abed et al.[8].

Preparation and Sterilization of Culture Media

BG-11 was used as culture media, media prepared by using 1 L of D.W to dissolve 1.627 g of BG-11, pH value was adjusted to 7 by using either 0.1 N of NaOH or HCl. Autoclave was used for the media sterilization 121°C/1.5 bar of pressure for 15 minutes; this step is considered a critical action for the disposal of any microorganisms [9].

Preparation of Stock Solution

The following pure salts $[Pb(NO_3)_2, NiCl_2 \cdot 5H_2O, \text{ and } Cd(NO_3)_2]$ were utilized for the preparation of a heavy metals stock solution. Each salt was dissolved in deionized D.W to gain a final concentration of 1000 ppm, and dark bottles were used for the storage. Heavy metal concentrations were calculated according to the following equation: $M_1V_1 = M_2V_2$ where M_1 was the stock solution concentration, M_2 the required concentration, V_1 the volume of the stock solution, and V_2 the volume of the solution at the required concentration. Three concentrations (10, 20, and 30 ppm) of each heavy metal were prepared.

RESULTS AND DISCUSSIONS

The results showed that the growth of *Coelastrella sp.* was affected by the presence heavy metals in waste water at different concentrations (10, 20, and 30 ppm) .

The optical density of *coelastrella sp.* was demonstrated when exposed to lead decrease in the growth rate of algae at a concentration of 10 ,20, where it was 0.1371 nm on the first day, until it reached 0.0896 nm on the eighth day for a period of 10 days.

At a concentration of 20, it was 0.1504 nm on the first day, becoming 0.1198 nm in the tenth day . As for the increase in 30 ppm of lead , the growth rate was 0.1439 nm to become 0.1610 nm. This means an increase in the growth rate, and the increase in biomass provides more binding sites for metal ions, which increases the efficiency of the algae (Kumar *et al.*, 2016). Cadmium showed a decrease in the growth rate at all concentrations on the second day of algal exposure, as the optical density reached 0.0791 nm, 0.087 nm, and 0.077 nm for concentrations of 10, 20, and 30 ppm, respectively. As for the element nickel, the results of the optical density showed the highest growth at a concentration of 10 ppm, as it rose at the beginning of the experiment by 0.2119 nm, then stabilized at 0.1378 nm on day 10 At a concentration of 20 ,30 ppm a gradual decrease in optical density and fluctuation in values were observed, indicating an inhibitory effect that depends on the dose of nickel.

Optical density of Microalga *Coelastrell* MH923012 exposure to different concentrations, where Figure 1=Pb, Figure 2 = Ni, This study is consistent with previous studies that have shown that the efficiency of algae removal occurs through combined mechanisms of bioabsorption and bioaccumulation, where absorption is the dominant process, as the algae wall contains functional groups characterized by a high ability to bind to heavy metal ions. These groups act as active sites for metal absorption, which leads to a decrease in concentration (Danouche *et al.*, 2021).

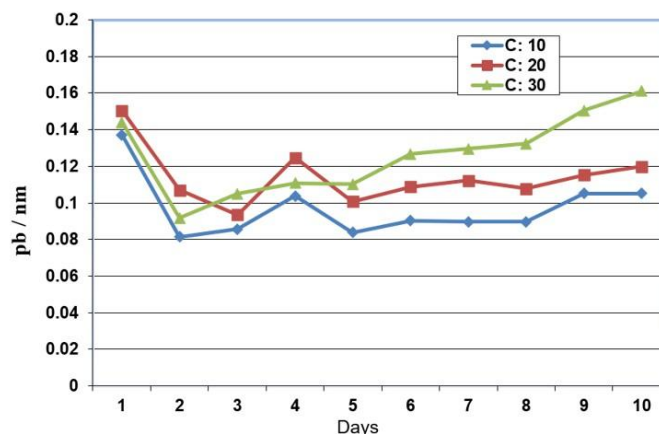


Figure 1: Optical density of *Coelastrella sp.* through experiment days .

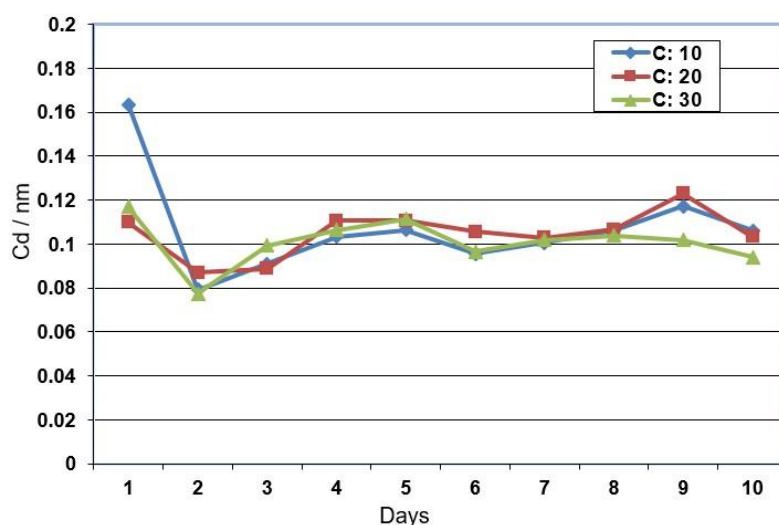


Figure 2 : optical density of *Coelastrella sp.* through expermint days

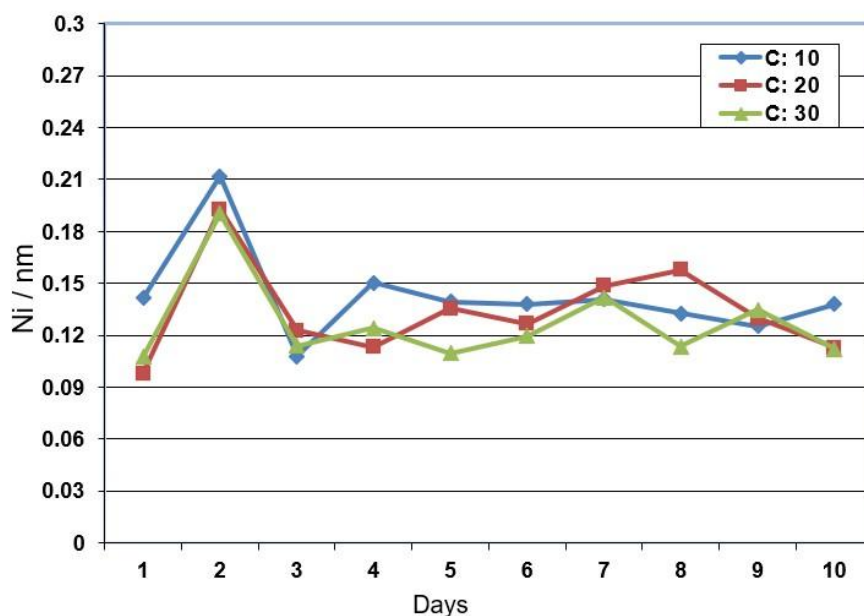
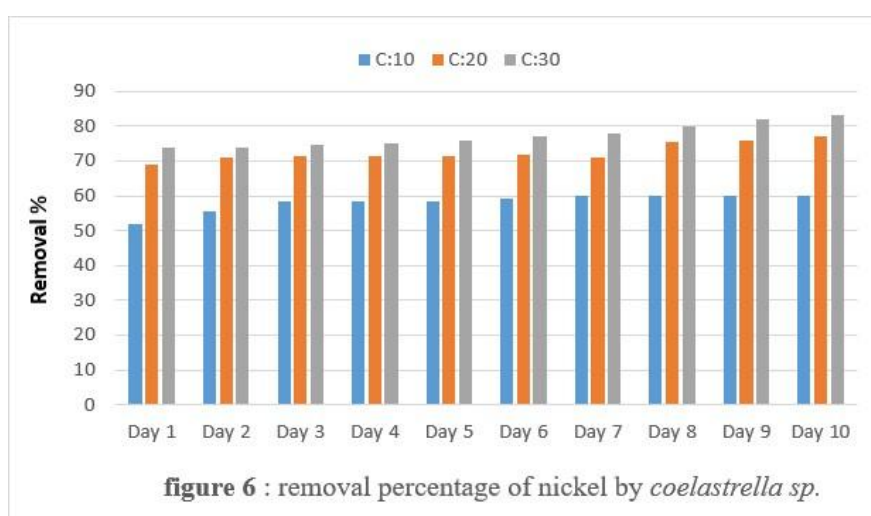
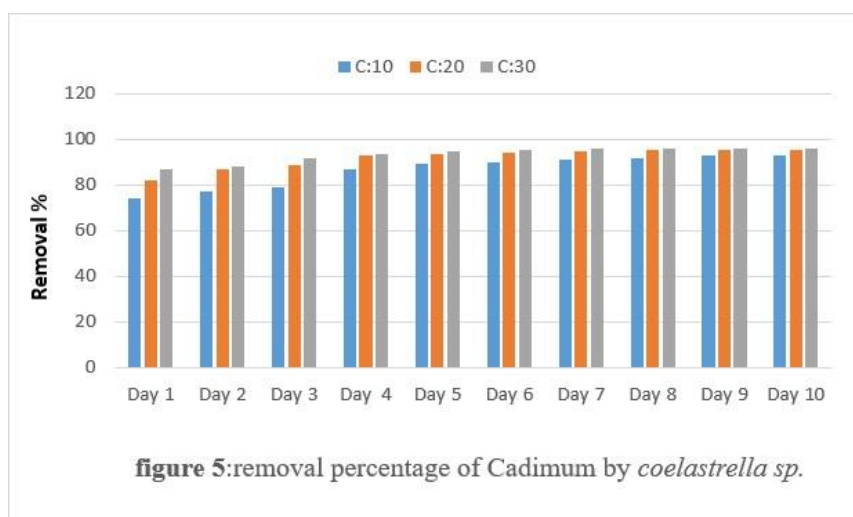
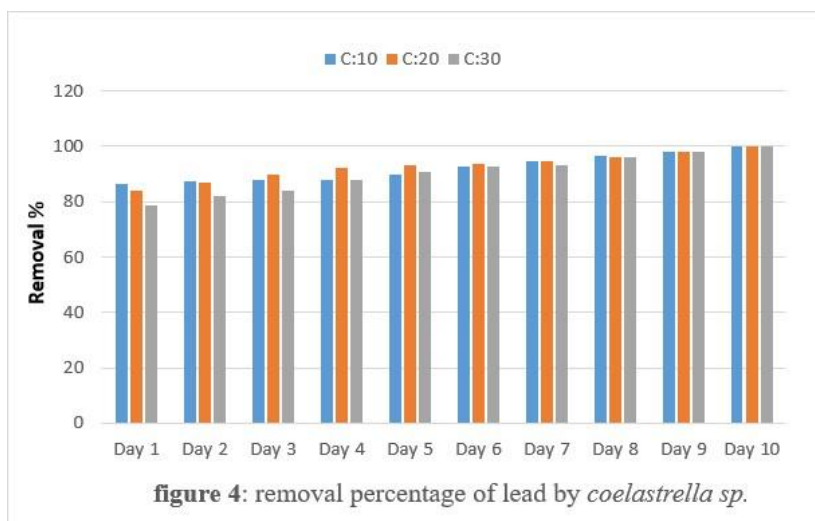


Figure 3: Optical density of *Coelastrella sp.* through expermint days .

figure 4:Pb figure 5:Cd figure 6:Ni shows the removal efficiency of heavy metals by algae *Coelastrella sp.*. The results of this study showed that *Coelastrella sp.* Capable of removing heavy metals in water, the results showed an increase in the removal rate of lead element by 100% for all concentrations (10, 20, 30) ppm , where the highest optimum rate for the elements was achieved, while cadmium element was 92.8%, 95.2%, 95.7%, respectively, for concentrations of (10, 20, 30)ppm . As for nickel, which represented the lowest removal rate, it was 60%, 77%, 83% at tenth day .



Lead showed the highest removal rate, which may reach 100% during the initial stage of the experiment, rapid binding of Pb^{2+} ions occurs on the surface of algal cells through the biosorption process. The cell wall of green microalgae contains several functional groups such as carboxyl ($-COOH$), hydroxyl ($-OH$), and phosphate ($-PO_4$) groups that possess strong binding

affinity toward heavy metal ions. These functional groups act as active sites for metal adsorption, leading to a noticeable decrease in lead concentration during the early days of the experiment (Spain *et al.*, 2021).

This trend clearly demonstrates that increasing nickel concentrations exert a dose-dependent inhibitory effect on the growth of *Coelastrella sp.* (Martínez-Ruiz & Martínez-Jerónimo, 2015). The observed initial decline in optical density can be attributed not only to toxicity but also to metabolic reprogramming and nutrient competition mechanisms. Cadmium ions are known to compete with essential divalent cations such as Mg^{2+} and Ca^{2+} , which are crucial for chlorophyll synthesis and cellular stability. This competitive inhibition leads to reduced photosynthetic efficiency and consequently lower optical density values. Similar findings have been reported in microalgae exposed to cadmium, where disruption of photosynthetic systems and pigment synthesis resulted in growth reduction (Tukaj *et al.*, 2007) (Wang *et al.*, 2024).

CONCLUSION:

The results were proved that this algae was able to decrease the concentration of all studied types of heavy metals Pb, Ni and Cd, and the lead concentration be with higher percentage of removing by this alga, while cadmium showed an effect on algae growth through its effect on metabolism and photosynthesis. Nickel showed the lowest levels of removal due to its toxic inhibitory effect on algae

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