

Removal of cadmium (II) ion from aqueous system by dry biomass, live and heat-inactivated *Scenedesmus quadricauda* isolated from fresh water (Apa Dam Lake)

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Abstract:

Today various organisms are increasingly used to remove toxic heavy metals from waters. In particular, studies in which various species of hydrophilic organisms are used for metal removal report various results. In this study, *Scenedesmus quadricauda* which has wide distribution in natural waters was used. The alga sample used in the study was isolated from Apa Dam Lake (Konya/Turkey) and was reproduced in culture. After the pure culture obtained, the removal of Cadmium in water was examined in three different conditions of the organism. In the stages of study, direct living organism, inactivated biomass and dead biomass were used, respectively. The rate of Cd ion in the water was diluted down to 0,02-0,30mg/l so that the amount of Cd ion measured can match with the measuring range of the spectrophotometer used. At stable temperatures, the pH was kept between 6 and 8. The measurements were conducted periodically: every six hours for four days. As a result, the highest biosorption was in inactive biomass, which is followed by dead biomass and living organisms. Moreover, it was also found out that this species is very effective in the removal of heavy metal. Besides, the samples mentioned above were filtered in appropriate filter paper and their weight was measured to increase the reliability of the study. It was observed that the masses of the samples increased in parallel with absorption amount.

Keywords: Cadmium (II) removal; Biosorption; Bioremediation; Heavy metals

INTRODUCTION

The industrial developments which became widespread in recent years have as many positive sides as negative sides. Especially, in places where industrial development is widespread there is severe soil, water and air pollution. This case affects environmental and human health negatively. When pollution elements are considered, heavy metals are among them. Trace amount of heavy metals is cofactor of enzymatic reactions. However, high amounts of them lead to highly toxic results for organisms and can slow down metabolic reactions [1].

In the removal of heavy metals from industrial drain waters and environmental water resources contaminated with heavy metals various chemical and physical process are used [2]. Methods like chemical precipitation, adsorption, electrochemical refinement and ion change are used [3]. However, as these methods are not economic and the level of rectification is not sufficient, it is seen that microorganisms which have a great potential are preferred and used effectively [4].

In recent years, biosorption method is used as an alternative to chemical methods. Biosorption means the adsorption of metal ions by metabolically inactive biomass [5]. It is known that various species of bacteria, fungi and algae are used for this purpose [6]. In this method, besides organisms' cell feature, the pH, temperature and metal concentration of the medium.

Many studies have been performed on metal uptake by microorganisms, both living and non living. Although that

algae have been utilized successfully in heavy metal adsorption experiments [7, 8].

In studies by Elmacı et al [1], the biosorption of dried Chara, Cladophora and Chlorella species in water solutions of Zn, Cd, Co and remosal Turkish- G coloring agent and it was seen that these three algae can be used in the removal of heavy metal. In another study on algae, heavy metal removal with dry mass of Cd ion, *Oscillatoria* sp. species which live plain alginate immobilize and inactivated under heat, immobilize living *Oscillatoria* sp. H1 showed higher biosorption capacity compared to dry mass and heat inactivated *Oscillatoria* [9]. Terry and Stone [10] investigated biosorption using *Scenedesmus abundans* species in waters contaminated with Cu and Cd. In this study, live form of *S. abundance* performed better biosorption compared dead biomass.

Metal absorption ability and toxicity can give different responses in different aquatic organism groups. Therefore, every kind of different responses can be given. Most of the studies on this issue focused on only one metal absorption in aquatic system. However, these metals can coexist and interact with each other. In case there are more than one metal, there can be competitive environment. For example, Aoyama and Okamura [11] examined interactive effects of Cd and Cr ions on algae culture.

In this study, *Scenedesmus quadricauda* was cultured. The biosorption of Cd heavy metal by this cultured species in three different forms (live, inactive and death biomass) in liquid medium was investigated.

MATERIALS AND METHODS

The test organism *Scenedesmus quadricauda* was collected from freshwater (from Apa Lake in Konya, Turkey), previously isolated and pure culture was grown according to procedure given by Rippka, [12] on BG-11 medium [NaNO₃, 15; K₂HPO₄, 0.4; MgSO₄ · 7H₂O, 0.75; CaCl₂ · 2H₂O, 0.36; citric acid, 0.06; iron(III) ammonium citrate, 0.06; Na₂-EDTA, 0.01; Na₂CO₃, 0.2 g/L, 1 mL; trace elements solution, (H₃BO₃, 61; MnSO₄ · H₂O, 169; ZnSO₄ · 7H₂O, 287; CuSO₄ · 5H₂O, 2.5; (NH₄)₆Mo₇O₂₄ · 4H₂O, 12.5 mg/L) pH: 6.8] commonly used for growing bluegreen algae in flasks. This medium contains only trace amounts of metal ions and allows rich growth. The cells were grown in sterile shake flasks containing 100 mL of BG 11 [12]. The cultures were grown under cool white fluorescent light intensity of 3000 lux at 25 °C, in 12 h–12 h light–dark cycle and were incubated for 15–20 days in an incubator (Minitron) which is suitable for photosynthesis. Tamp solution was prepared to adjusted medium pH. Doubly distilled deionized water was used throughout the study. Cadmium stock solution (1000 mg/L) was prepared by dissolving a calculated amount of CdCl₂ (Merck). The working solutions were prepared by diluting the stock solution to appropriate volumes. Britton-Robinson (B-R) buffer solution was prepared by dissolving 2.3 mL of glacial acetic acid, 2.7 mL of phosphoric acid and 2.4720 g of boric acid in doubly distilled water and diluted to 1.0 L. 100 ml portions of this solution were taken and the desired pH was adjusted between 2.0 and 8.0 by addition of appropriate amount of 2.0 M NaOH [13]. Algae which were cultured were prepared within 20-25 days. They were taken to erlenmeyers of 80 ml and experimental groups were formed. The first experimental group is composed of live algae cultures. The second group is composed of inactivated algae boiled in double boiler at 100 °C for 10 minutes. In the third experimental group, algae were dried by keeping in an oven at 120 °C and dead algae mass was formed. pH measurements were made with Hange- Lange brand pH meter. In spectrophotometric analysis Hange- Lange brand DR 2800 spectrophotometer was used. To make CdCl₂ amount used in the experiment suitable for the spectrophotometer's measurement interval,

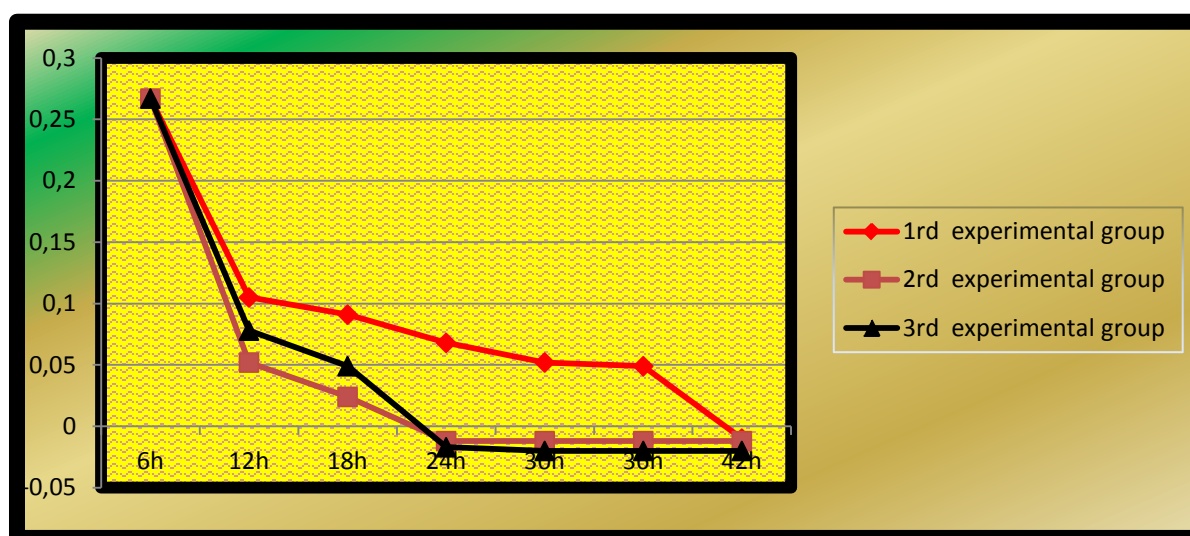
1 mg of CdCl₂ was added to 1 liter of water. 4 ml of NaOH was added to previously prepared 100 ml B-R tamp solution and pH was measured to be 6,26. 10 ml was taken from this tamp solution and it was added to 100 ml CdCl₂ and pH was measured to be 6,5. Thus, CdCl₂ solutions were prepared and 80 ml of this solution was added to each experimental group. In the first experimental group, pH was measured to be 7,85 after CdCl₂ solution was added. In the second experimental group, pH was 6,66, and it was measured to be 6,64 in the last experimental group. Measurements were made at every 6 hour for 96 hours. In each measurement, 15 ml of solution was taken and filtered through Whatman GF/C filter paper with 0,125µm pores and this supernatant was measured with proper kits at spectrometer. Filter papers used in filtration were dried in incubator for 1-2 hours. Dried papers were weighed to see whether there was mass increase.

RESULT AND DISCUSSION

Ph amounts measured at every 6 hours for 96 hours are given in. Ph values between 4 and 8 are widely accepted as an optimum for metal uptake for almost all types of biomass [14].

Cd biosorption was prepared in the same way in all three experimental groups. 15 ml of sample was taken from the 1st experimental group, and was filtered through filter paper. Filtrate obtained was prepared with proper procedures of kits and read on spectrometer. The first 7 measurements made at every 6 hours are given in Graphic 1. These procedures were continued till Cd in the medium is completely removed. The first measurements were 0,267 mg/L, 0,105 mg/L, 0,091 mg/L, 0,068 mg/L, 0,052 mg/L, 0,049 mg/L, -0,010 mg/L, respectively. After the last measurement, the process was completed as values were minus (-).

The Cd ion amount in the 2nd experimental group is shown in Graphic 1. This experimental group was inactivated with and Cd biosorption was investigated with the same method. The amount of Cd ion was 0,267 mg/L, 0,052 mg/L, 0,024 mg/L, -0,012 mg/L, respectively. As the next values were found to be minus (-), the experiment was terminated.



Graphic. 1 7 measurements made at every 6 hours are given in.

The Cd ion amount in the 3rd experimental group is shown in Graphic 1. This group was dried in incubator. Later on double distilled water (80ml) was added to dead mass and values were read on the spectrometer as in other experimental groups. Cd ion amounts were found to be 0,267 mg/L, 0,078 mg/L, 0,049 mg/L, -0,017 mg/L,, -0,002 mg/L, respectively. As the next values were found to be minus (-), the experiment was terminated.

The aim of the study is to determine Cd(II)bio-sorption characteristics of *Scenedesmus quadricauda* and the best Cd(II) removal among 3 three differently processed alga cultures was determined. As a result of experiments, it was seen that the absorption was inactive biomass, which is followed by dead mass and live mass, respectively.

CONCLUSIONS

As a result, this species of alga can be used in the removal of heavy metals in industrial waste water. Using organisms to remove heavy metals from water systems is much more advantageous for the protection of the environment and minimization of side effects compared to other methods.

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