REMOVAL OF NICKEL IONS BY *Scenedesmus quadricauda* FROM CONTAMINATED WATER UNDER LABORATORY CONDITIONS

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Abstract

The algal species *Secenedesmus quadricauda* was used to remove nickel ions from contaminated water (under laboratory conditions). It was exposed to different concentrations of nickel (2, 4, 6 and 8) ppm in order to measure it capacity to remove and tolerate this metal.

The results showed that the alga was able to remove this metal with percentages of 98, 53.5, 55.33 and 43% for the concentrations 2, 4, 6 and 8 ppm, respectively, in the eighth days of the experiment period, while this ability was decreased in the fourteen days of the experiment period to: 80, 43.25, 36.83 and 26.62 % for the concentrations 2, 4, 6, and 8, ppm respectively, as a result of death for some algal cells. So, it was concluded that this alga can tolerate nickel till 6 ppm, because it can remove more than 50 % from its concentration till the eighth day of the experiment period (8 days represents the life cycle of the studied alga according to some related references and most of the studies which used the same alga). This means that the algal cells of this species can tolerate and live till the end of the life cycle with the 6ppm of nickel (this concentration-6ppm- usually exceed the acceptable values of nickel in water -0.05ppm- according to Iraqi rivers protection system.No.25\1967).

ازالة ايونات النيكل من المياه الملوثة من قبل طحلب *Scenedesmus quadricauda* تحت ظروف مختبرية

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الخلاصة

تم ازالة ايونات النيكل من المياه الملوثة به من قبل طحلب *Scenedesmus quadricauda* في ظروف مختبرية، وقد تم تعريض هذا الطحلب إلى التراكيز 2 و 4 و6 و8 جزء بالمليون من النيكل وذلك لاختبار قدرته على الإزالة و مدى تحمله للعنصر. أظهرت النتائج إن للطحلب المدروس القابلية على ازالة العنصر بالنسب المئوية التالية:98 و53.5 و 55.33 و43% للتراكيز 2 و 4 و 6 و 8 جزء بالمليون على التتالي، وذلك حتى اليوم الثامن للتجربة (و هي دورة حياة الطحلب). بينما تقل هذه القابلية في اليوم الرابع عشر من التجربة الى: 80 و43.85 و36.83 و 26.62% للتراكيز 2 و 4 و 6 و 8 جزء بالمليون على التتالي، كنتيجة لموت الخلايا. وعليه يمكن الاستنتاج بأن الطحلب قد يكون له القابلية على تحمل العنصر هي 6 جزء بالمليون وذلك لقابليته على ازالة اكثر من 50% منه حتى اليوم الثامن من التجربة (8 ايام تمثل دورة حياة الطحلب المدروس بالاعتماد على بعض المصادر ذات العلاقة ومعظم الدراسات التي استخدمت هذا الطحلب)، وهذا يعني ان خلايا الطحلب لها القابلية على العيش في مياه حاوية على تركيز 6 جزء بالمليون من النيكل حتى نهاية حياته (6 جزء بالمليون تتجاوز عادة الحد المسموح به للنيكل بالمياه وهو 0.05 جزء بالمليون) بالاعتماد على نظام صيانة الانهار العراقية رقم 25 لسنة 1967.

Introduction

Water pollution with heavy metals is one of the pollution kinds which needs additional efforts to treat, because these metals precipitate or diffuse in water without degradation, usually lead to impact on aquatic ecosystem (1).

Also, the metals were removed by algae or some aquatic plants (accumulate in their bodies) may return to ambient water after the death of algae or aquatic plants (2).

The accumulation of heavy metals in algae bodies in labrotary culture is one of the important subjects in scientific field, because some algae have the ability to remove these metals from the industrial waste (3). Uusually the removal percentage of heavy metals by algae depends on the species of algae which used for this purpose, their ability to tolerate is determined according to the removal percentage (1).

The ability to accumulate these metals by algae and some aquatic plants which led to understand the bioremediation concept which depends on using some organism like algae, bacteria and fungi to accumulate (in their bodies) or break down some pollutants in the environment (4).

Scenedesmus quadricauda is one of the green algae, classified to:

Division: Chlorophyta
Class: Chlorophyceae
Order: Chlorococcals
Family: Scenedesmaceae
Genus: *Scenedesmus*
Species*: quadricauda* ……. (5)

Usually, this alga found in fresh water and would be with coenobium, the number of cells about 2-8 or till 16 cells, arranged in one or two rows, may some of terminal cells contain processes or spikes. The cells be with oval or lunar and have one wall plastid with one starch center (5).

Materials and Methods

Chu-No-10 medium which was described by (6) and modified by (7) was used to culture the green alga *Scenedesmus quadricauda* (it was isolated from Tigris river).

The medium prepared as stock solutions and keep in 4 C°. 2.5 ml was taken from each stock solution and added to one liter of deionized water to prepare the medium. The pH was adjusted to 6.8-7, sterilized by autoclave with 121 C° and pressure 1.5 bars for 15 minutes, and kept at 4 C° till use.

In order to get axenic culture, Paterson method was followed (8), which represents by: the algal culture was kept in the dark for 24 hours, then about 10 ml of this culture was taken and transferred into sterilized new medium and kept in the dark again for 3 hours, try to sediment the algal cells by centrifugation at 3000 cycle\min. for 5 minutes (about 15 times), and thereafter the algal sediment as washedw with distilled water and later the algal strain was cultured in a new medium in order to activate the isolated algal species.

To ensure, there is no microbial contamination, streaking a swap of the culture was achieved on the nutrient agar medium and incubated in 37 C° for 48-72 hours.

The stock solutions of nickel concentrations were prepared with concentration 1000 ppm by dissolveing aqueous nickel nitrates Ni (NO3)2 .H_2O in deionized water and then the following concentrations were prepared: 2, 4, 6, and 8 ppm according to the following equation:

$$C1V1= C2\ V2$$

Where: C1= first concentration, V1= first volume (of standard solution), C2= second concentration (wanted), V2= second volume.

A bout 50 ml of axenic culture were added to 1000 ml of the medium containing nickel ions, about 3 replicates were used for each concentration, and then kept in 25 C° and light intensity 380 micro anchtain .m-2.sec.-1 (with light period about 16 hours and 8 hours of dark) because these conditions are the optimal factors for cultivating on this alga (9).

The alga was exposed to these concentrations and later would point the ability of alga to remove and tolerate nickel by comparing the initial concentration of nickel which is exposed to alga and the concentrations of it in filtrate (usually, the alga separate from the solution of culture and nickel by filtration) and then the concentrations of nickel in filtrate was measured by using atomic absorption spectrum.

Statical analysis: ANOVA and Duncan testes were used to assess the significant differences between the concentrations.

Results and Discussion

The concentration of Ni was decreased gradually in filtrate of the algal culture away from the initial concentrations , which related to the adsorption of the metal with the active sites was found in the cell walls of algae (10) .

The statically analysis (ANOVA and Duncan tests) indicates that there is no significant differences between the concentrations 4 and 6 ppm on one hand and also between 6 and 8 ppm on the other hand.

Also, the ability of algae to remove the heavy metals related to some physical and chemical processes which occur on the surfaces of the cells (11).

The table (2) explains the good removal percentage for the metal by the alga in 2ppm, but with less percentage for the other concentrations.

These percentages are: 98, 53.5, 55.33 and 43% for the concentrations 2, 4, 6 and 8 ppm, respectively on the eighth day of the experiment days (8 days represents the life cycle of the alga).

The higher percentage of removal is related to high number of active sites which in the algal wall have the ability to adsorb the heavy metals in the walls (12). Generally the cell wall of the microorganism (algae one of them) contains polysaccharides, proteins and fats which usually ensured with functional groups like carboxylates ,hydroxyls, sulfate, phosphate and amines, which the heavy metals connects (adsorb) with them (13).

With continuous exposure till the fourteenth day of the experiment these percentages begin to decrease to 80, 43.25,36.38 and 26.62% for the concentration 2, 4, 6 and 8 ppm , respectively , as a result of cells death , because the ability of the alga to remove the heavy metal related to some physical-chemical processes occur on the surfaces of the cells (14).

So, it can be concluded that the *S.quadricauda* may able to tolerate nickel till 6 ppm, because it can remove more than 50% of nickel concentrations till the eight day of the experiment, Therefore this alga was able to remove this metal with a good efficiency.

Table 1: Concentration of Ni in the algal culture filtrates of *Scenedesmus quadricaud*. (mean ±standard error)

Initial Concentrations(ppm)	Concentrations of Ni in the algal culture filtrate of *Scenedesmus quadricauda* .(ppm)
2	1.57(± 0.88) b
4	1.90 (± 0.13) b
6	2.69 (± 0.22) a
8	2.38 (± 0.12) a

Similar letter in same column means there is no significant differences between parameters in P>0.05.

Table 2: Removal percentage of nickel by *S.quadricauda* in different concentrations.

Days	Concentration 2ppm	Concentration 4ppm	Concentration 6 ppm	Concentration 8 ppm
2	63	29.75	27	24.62
4	67.5	50.75	50.16	26.62
6	73.5	55	52.66	36.12
8	98	53.5	55.33	43
10	84	52.75	47.16	31.75
12	83.5	48	45.16	30.37
14	80	43.25	36.83	26.62

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