Physiological Effects of Some Heavy Metals on Blue green Alga Oscillatoria amoena (Kuetz. Gomont)

Ahmed Shaker Abdul Jabbar Thi Qar University ,College of Science ,Dept. of Biology ISSN -1817 -2695 ((Received 4/2/2009, Accepted 7/7/2009))

Abstract

The effect of Co^{++} and Cd^{++} on the growth rate and photosynthesis efficiency of bluegreen alga *Oscillatoria amoena* was studied under controlled laboratory conditions. These metals were treated with alga at different concentrations media (1, 2 and 5 ppm) of both elements. The growth rate of alga was inhibited by different concentrations of metals. Cd^{++} was more toxic than Co^{++} .

The results concerning the effects of different concentrations of heavy metals on photosynthesis (O_2 evolution) has shown reduction of the amount of O_2 evolution by alga in response to the increase of Cd⁺⁺ and Co⁺⁺ concentrations, photosynthesis was more sensitive to Cd⁺⁺ concentration than to that of Co⁺⁺.

Keywords: Blue green algae, Heavy metals, growth rate, photosynthesis.

Introduction

Ecosystems are increasingly affected by various anthropogenic impacts such as excess of nutrition causing eutrophication, toxic contamination of industrial, agricultural and domestic origin. Typical results of human activities proved to elevate of heavy metals present in fresh water and those microelements Lead, Cadmium and Mercury, are most specific [1, 2].

They are considered to be among the most important pollutants to the aquatic ecosystems due to their environmental persistence and tendency to

Materials and Methods

Filaments of bluegreen alga *O.omoena* were collected from Euphrates River in Nassiriyah city, about 1000 m far from Al-Nassiriyah electricity station, south of Iraq. These myxophyta were isolated and identified according to Smith and Prescott [6, 7], while purification and mass culturing of these alga were carried out according to Stein [8], and were modified according to Weideman *et al.* [9] and grown axenically in modified Chu-10 medium [10], at pH 7.5 and subjected to light of 72 Em⁻² S⁻¹ supplied by cool white fluorescent tubes with photoperiod of 14:1, light and dark cycle was at 28 ± 2 C° [11]. Stock solution of CdCl₂ and Cocl2 was prepared in double distilled water passed through a Millipore

be concentrated in aquatic organisms [3]. Heavy metals are dissolved in water or sorbet to particulate matter and become hazardous to the human health either by drinking water or through food chain [4]. Also, heavy metals showed harmful effects even at low concentration on the aquatic organisms including plankton and aquatic plants [5]. The present investigation reveals the effects of Cadmium and Cobalt on some physiological aspects of *Oscillatoria amoena*

membrane filter (0.45 μ m). For each metal, a range of concentrations has been used (1, 2 and 5 ppm). Very careful techniques have been used in the preparation of these media.

Chlorophyll-a was extracted in 90% acetone and is determined according to Marker *et al.* [12]. The measurement of photosynthetic activity (O_2 evolution) by oxygen electrode was enclosed in 10 ml reaction vessel and connected to an oxygen analyzer [13]. ANOVA test, and analysis of variance were considered for statistical analysis purpose.

Results and Discussion

Figures (1) and (2) show the growth curves of O.omoena that were grown in the medium containing test metals in different concentrations enriched with Co⁺⁺ and Cd⁺⁺ respectively.

The growth rate of alga was inhibited by different heavy metal concentrations, the degrees of inhibition were correlated to the different concentrations of the metals. In figure (1), the growth rate results show that the highest growth response of alga was significantly (P < 0.01) at 1ppm Co⁺⁺ media after 9 days as compared to the growth rate control, while the lowest growth rate was registered at 5ppm Co⁺⁺ media after 12 days of the incubation.

The growth rate of alga in media enriched with Cd^{++} is shown in figure (2) and it appears that Cd^{++} is more toxic than Co^{++} ; there was a higher reduction in the growth rate at 2 ppm and a higher concentration, and there was no growth rate detected of alga in 12 days. A reduction in O_2 evolution was inhibited by heavy metals in table (1). Cd was also the inhibitoriest element among the tested metals; the lowest inhibition of O_2 was clear in 1 hr. Co was non effective at 1hr; however, culture growth in the medium with the highest concentration of metals showed a marked O_2 evolution after 12 hrs.

This studv shows the growth rate and photosynthesis efficiency of heavy metals were reduced with an increase in $\mathrm{Co}^{\scriptscriptstyle +\!+}$ and $\mathrm{Cd}^{\scriptscriptstyle +\!+}$ concentrations in the growth media, probably accumulation of these metals, which were taken up by the alga tissue, was responsible for the observed inhibition of growth rate and photosynthesis. Concentration of these metals in the growth rate was directly proportional to the inhibition of growth rate and photosynthesis.Stauber and Florence [14] pointed out that copper may interfere with cell permeability or the binding of essential metals. Sorentino [15] again mentioned, again, that when ionic concentration increases. Co⁺⁺ is bound to chlorophyll and other cell proteins, causing degradation of chlorophyll and other pigments. At higher concentrations metals produce irreversible damage chloroplast lamella preventing photosynthesis [16]. The mechanism proposed for this inhibition is the Magnesium in the chlorophyll molecule. Consequently, accumulate cells protophyrin and synthesis of chlorophyll is blocked. The effect of different concentrations of metals on photosynthetic O_2 evolution showed a tendency towards reducing the amount of O_2 evolution by alga in response to Co++. The magnitude of inhibitory action was found to increase with higher metal concentrations.

 Table (1): effect of Lc50 concentrations of tested metals on photosynthesis rate in Oscillatoria omoena.values are means ± standard error.

Metal	O_2 evolution (mg/l).		
	1 hr.	12 hrs.	24 hrs.
Control	4.623 ± 0.183	8.620 ± 1.074	9.870 ± 1.170
Со	3.950 ± 1.831	3.471 ± 1.175	3.130 ± 0.670
Cd	3.640 ± 1.137	3.110 ± 1.021	2.810 ± 0.723

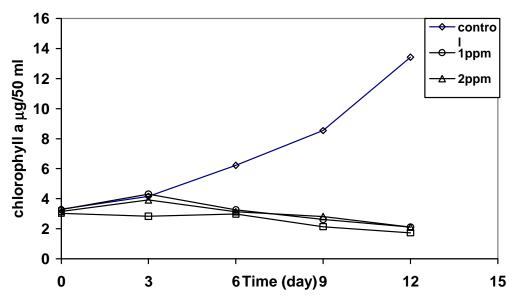


Figure (1): Effect of different concentration of Cobalt on growth rate of Oscillatoria omoena.

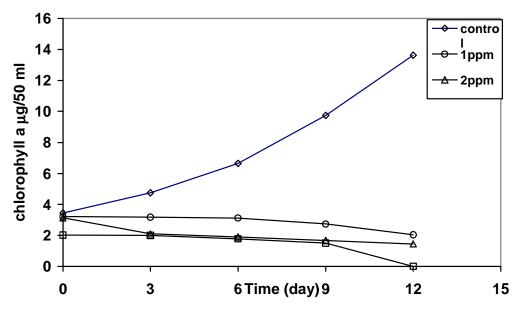


Figure (2): Effect of different concentration of Cadmium on growth rate of Oscillatoria omoena.

References

- Farkas A., Salanki J., Scpecziar A., Varanka I "Metals pollution as health indicators of lake ecosystems". Int J. Occup. Med. Environ. Health 14(2): 163-170. .(2001).
- [2] Atte R. S., "Water quality criteria in the Shatt Al-Arab River and the main drainage system with levels of some heavy metals pollutants". Ph. D. thesis, Agri. Coll. Basrah Univ. Iraq. (2004).
- [3] Veena B. R., Radhakrishnar C., Chack Okj "Heavy metals induced biochemical effects in an estuarine teleost". Indian J. Mar. Sci. 26: 74-77. (1997).
- [4] Vymazal J "Toxicity and accumulation of Lead with respect to algae and cyano bacteria". A review Acta Hydro chem. Hydrobiol. 18(15):513-535. (1990).
- [5] Schnurman G., Markert B. "Ecological fundamentals chemical exposure and biological effects". In: Ecotoxicology, John Wiley & sons, Inc. and spectrum Academi Scher Verlag. (1998).
- [6] Smith, G. M. The fresh water algae of the United States- 1st ed McGraw-Hill book comp., INC., New York and London, 719pp. (1933).
- [7] Prescott G. W. Algae of the western Great lakes area- W. M. C. Brown Corr- Publisher, Dubuque, Iow, 6th printing, 977pp. (1975) -
- [8] Stein, J. R. Handbook of Physiological Methods- Cambridge University press, Cambridge, UK. (1973).

- [9] Weidman V. E., Walne P. R. and Tainor F. R. "A new technique for obtaining axenic cultures of algae". Can-J. Bot-42: 958-859. (1984).
- [10] Al Rawie A. "Ecological & physiological study to alga *Scenedesmus* sp." Msc. Thesis, Univ. Basrah. (1999).
- [11] Marker A. F. H., Nusch E. E. and Rieman B "The measurement of photosynthetic pigments in fresh water and standardization of methods: Conclusion and Recommendations". Arch. Hydrobiol. 14: 91-106. . (1998).
- [12] Mtolera M. S. P. "Photosynthesis, growth and light induced stress responses in the red algae". PhD thesis deposited in the libraries of the Univ. Dares Salaam, Tanzania and Uppsala, Sweden.
- [13] Stauber J. L. & Florence T. M. "Mechanism of toxicity of ionic Copper and Copper complexes to algae". Mar. Biol. 94: 511-519. (1987).
- [14] Sorentino C. "The effects of heavy metals on phytoplankton review". Phykos 18: 149-161.(1979).
- [15] O'kelly J. C. "Inorganic nutrients" pp: 610-635. In: Stewart W. D. P(ed.). Algal physiology and biochemistry. Oxford: Blackwell scientific publications. (1974).
- [16] El-Najar A., Osman M. E., Dyab M. and El-Mohsenaway E. "Heavy metals toxicities on *Calothrix Sp.* and *Nostoc Sp*". J. Union Arab biol. Cairo. 7:421-441. (1999).

Oscillatoria amoena التأثيرات الفسيولوجية لبعض العناصر الثقيلة في الطحلب الأخضر المزرق (Kuetz. Gomont)

أحمد شاكر عبد الجبار قسم علوم الحياة ، كلية العلوم ، جامعة ذي قار

الخلاصة

تم دراسة تأثير عنصري (الكادمبوم والكوبلت) الثقيلين على معدلي النمو والبناء الضوئي (بدلالة إنبثاق الأوكسجين) في الطحلب Oscillatoria amoena, أحد الطحالب الخضر المزرقة في الظروف المختبرية الثابتة حيث ثبطت تراكيز العناصر المضافة (او 2 و ملغم/ لتر) معدل نمو الطحلب وإزداد معدل التثبيط بزيادة التراكيز المضافة وبزيادة فترة القياس وكان الكادميوم أكثر سمية من الكوبلت. كما ثبطت العناصر المضافة معدل إنبثاق الأوكسجين إذ أنخفض معدل البناء الضوئي للطحلب تدريجيا بزيادة التراكيز المضافة وبزيادة فترة القياس وكان الكادميوم أكثر تثبيط حيث أظهر تأثيرا في الساعة الأولى من القياس بينما لم يظهر الكوبلت أي تأثير في الساعة نفسها.