Vol. 3, No. 1: 14-17.
(2015).
ISSN: 2313-3937

WORLD JOURNAL OF EXPERIMENTAL BIOSCIENCES

Research article

Phytoremediation of Cadmium in river water by *Ceratophyllum demersum*

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ABSTRACT

The current study included an assessment the ability of *Ceratophyllum demersum* Phytoremediation of cadmium in accumulative concentration by measuring the heavy metal in the tissues of the plant to check the ability of *C. demersum* to reduce or eliminate the harmful and toxic effect, which resulting from this type of pollutants in the most important ecosystem. In present study the plant was grown in natural conditions for two months and treated to two concentrations of cadmium (3.714, 4.952 mg/l). The samples of water and a certain weight of the plant were taken before and after treating with cadmium chloride in order to estimate the level of cadmium in these samples before and after treatment. The residual amount of cadmium in the water and also in the plant has also been calculated at different time intervals (3, 6 and 9 days). The present study showed that cadmium accumulated rapidly in the plant and increased dramatically with time, thus the highest level of cadmium was observed at day nine. *C. demersum* showed high ability to remove cadmium and was at the ninth day of the experiment and that was 1.53, 1.089 mg /l) when exposed to 3.714, 4.952 mg /l of cadmium respectively. The current study proved strongly the ability of C. demersum to eradicate the cadmium in ecosystem.

Keywords: Cadmium, *Ceratophyllum demersum*, Phytoremediation, River.

Citation: Al-Ubaidy HJ, Rasheed KA. (2015) Phytoremediation of Cadmium in river water by *Ceratophyllum demersum*. *World J Exp Biosci* **3:** 14-17.

Received January 19, 2015; Accepted February 6, 2015; Published February 12, 2015.

INTRODUCTION

The civilized, industrial, agricultural, economical and scientific progress of man led to appearance of destroying pollutants in the environment especially in aquatic environment. The human normally cause damage in the normal balance of environment that happen during industrial progress, which adds new materials into ecosystem [1]. Al-Aney, (2012) showed that the most dangerous types of environmental pollution [2]. Other studies reported the biological pollutants in the surfaces water of Iraqi providences [3, 4]. The water covers a wide area of the globe, and each of air and soil pollutants are doomed final to water either directly or indirectly, as water consists a greater part of the composition of different living cells and any vital process cannot take place without an aqueous medium. Heavy metals represent the most important

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sorts of contaminant in the environment. Heavy metals are conventionally defined as elements with metallic properties and an atomic number >20. Most of industrial activities are potentially contributing to produce heavy metals [5]. The most common heavy metal contaminants are Cd, Cr, Cu, Hg, Pb and Zn. Previous study [6] mentioned that the cadmium is one of the most toxic heavy metals. Cadmium, a non-essential toxic metal, enters into the aquatic environment through industries like electroplating, batteries, chemicals and various other applications [7].

C. demersum can be sorted as a bio-filter for heavy metals, such as Cd, pb and Ni [8-13]. The previous study showed the efficiency of *C. demersum* as a metal phytoremediation [14]. The high contents of heavy metals in the tissues of *C. demersum* are due to the ability of this species to adsorb heavy metals [15, 16]. The accumulation of Cd in aquatic plants and their subsequent toxic effect has been reported by several investigators [8]. According to the importance of water and aquatic plants in the aquatic system and for the existent many pollutants that damage the aquatic system and decrease the nutrient levels. It is important to find out a new method to stop or even to decrease this damage. The method is phytorem-ediation.

MATERIALS AND METHODS

Four samples were collected from the water channel of Baghdad University; this channel is provided with water from the Tigris River. The samples were collected from the station near the Graduate Institute of Accounting Studies. The collected plant (*C. demersum*) put in three conical flasks filled with one liter of the water. The flasks, which have been the plant grow, adapted and acclimated before and after treatment with salt cadmium chloride. In this experiment the two conical flasks put outdoor of the laboratory to expose to natural environmental conditions for the plant growth. The plant treated with two concentrations of cadmium chloride (3.714 and 4.952 mg/l). 0.5 gm of the plant was dried in oven at 70 ºC for overnight. The plants were collected at different time intervals (3, 6, 9 days) the standard previous method was followed [16]. Many environm-ental conditions were measured such as pH, tempera-ture, electrical conductivity and salinity according to previous study [17]. The following equation was used to measure the percentage of salinity:

$$salinity\ S‰ = \frac{conductivity - 17.78}{1589.08}$$

The method of Evan and Engal [18] was used to measure the bio-concentration factor (B.C.F), the following equation was applied for this purpose:

$$B.C.F = \frac{\text{The concentration of the element in the plant tissue}}{\text{The original concentration of the element in the solution to the original}}$$

RESULTS AND DISCUSSION

Ranges of these parameters were studied out the door, where the water temperature ranged from 10 to 19 ºC, and the average values of electrical conductivity ranged from 888 to 889 µS/cm. The salinity was from 0.5530 to 0.550 ppt and the range of pH from 7.3 to 7. All these results coincided with many studies undergo with the same conditions [18-22].

ANOVA test was used to estimated the differences in case of both applied concentrations (3.714 and 4.952 mg/l) of cadmium chloride, which treated the plant in natural conditions. The result of accumulation of cadmium in plant tissue was shown in **fig 1.**

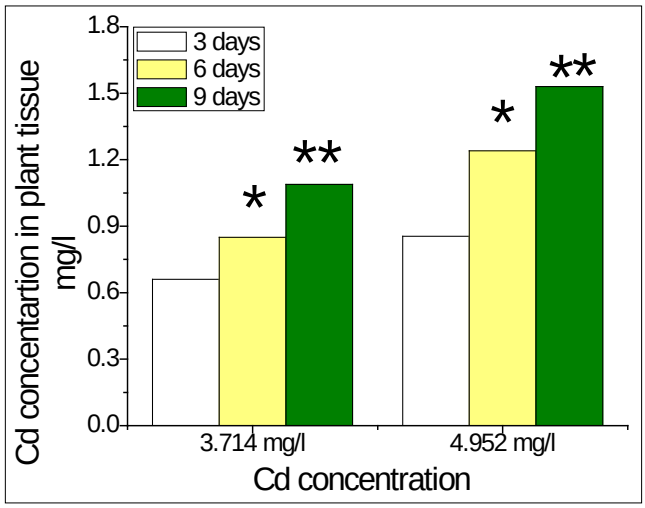

Fig. 1 The concentration of accumulative Cd in plant tissue at different time intervals. *, P<0.05; **, P<0.001.

The results show that when the level of Cd in plant tissue in creased dramatically with time. The highest level of deposited Cd was observed at day nine. The significant increase of Cd level in plant tissues was observed at time point of 6th (P<0.05) and 9th (P<0.001) day post plant exposing to Cd. Moreover, the level of deposit Cd in plant tissue related positively with concentration of Cd in experimental area. In contrast, the level of Cd in water was decreased dramatically with time thus the lowest level of Cd was observed at day nine (**fig. 2**). The highest accumulative of Cd in water was at the 3rd day. The statistical analysis showed high and significant accumulation of cadmium in water at the day 6 (P<0.05), and highest decrease in the accumulative of

cadmium was appeared at day nine (P<0.001) as compared with the concentration of Cd at zero time.

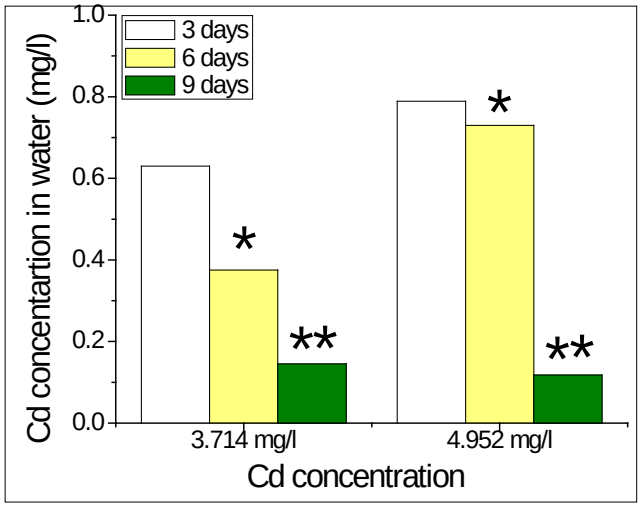

Fig. 2 The concentration of accumulative Cd in polluted water at different time intervalus. *, P<0.05; **, P<0.001.

All experiments occurred in natural conditions (batch system), where the plant in the stagnant water can absorb the real amount of its capacity. Previous study [23] showed that the viability of *C. demersum* in accumulating Ni at different concentrations (0, 1, 2, 4, and 6 mg/l), the results also showed that C. demersum was highly effective in removing Ni from the constructed running medium. But in slow removal rate (50%) and when plant grows more, with increasing of its biomass, it can accumulate more Ni in its body. Great removal efficiency and high Ni accumulation capacity make *C. demersum* an excellent choice for heavy metal phytoremediation.

The Bio-concentration factor

The bio-concentration factor has decreased with increasing of cadmium concentration in water basins and bio-concentration factor in the treatments for each experiment increase within the tissue of a plant at the same time the cadmium concentration decreased in water basins growing over day experience and this view is consistent with previous study [24], which focused on Cu, Ni and Zn phytoremediation and translocation that most coefficient bio-concentration values of nickel and zinc increase in the Nile flower plant whenever the concentrations of the mentioned elements decreased coefficient values.

Khan *et al.* [9] showed that the bio-concentration factor (B.C.F.) is more significant than the amount accumulated in plants since it provides an index of the ability of the plants to accumulate metal element with respect to the element concentration in water. The present study showed that the bio-concentration factor of cadmium in *C. demersum* was shown in **table 1**. Where, *C. demersum* exposure to the treated concentrations of cadmium (3.714 mg/l and 4.952 mg/l) at different time intervals (3, 6, 9 days) led to an increase in the bio-concentration in the plant tissue. The increase in bio-concentration was concomitant with increase in the duration of exposure to Cd. The concentration of Cd in plant tissue was 0.308 mg/l at the day nine at exposure concentration of Cd 4.952 mg/l. The lowest bio-concentration (0.178 mg/l) was observed at 3 day of experiment and at the lowest exposure concentration of Cd (3.714mg/l) (**table 1**). The present study provides strongly the affectivity of *C. demersum* in Cd bioremediation in the natural environmental condition.

Table 1. The bio-concentration factor of Cd in *C. demersum* at different time intervals and at different concentrations of Cd. The experiment was done under natural environmental conditions.

Duration of exposure	3.714 mg/l	4.952 mg/l
3 days	0.178	0.173
6 days	0.229	0.251
9 days	0.293	0.308

Conflict of interest

The authors declare that they have no conflict of interests.

REFERENCES

1. **Goodwin TH, YoungAR, Holmes MGR , Old GH, Hewitt N, et al.** (2003) The temporal and spatial variability of sediment transport and yields within then Bradford Beck catchment, West Yorkshire. *Sci Total Environ* **4**:475 – 494.
2. **Al-Aney IAMZ.** (2012) Evaluation of potable water of both East Tigris and Al-Karama purification plant in Baghdad. M.Sc. Thesis. College of Science, University of Baghdad, Iraq: 124.
3. **Ali MN, Zgair, AK.** (2014) Antibiotic susceptibility of clinical and environmental isolates of *Pseudomonas aeruginosa*. *World J Exp Biosci* **2**: 1-5.
4. **Mouhamed RS, Jafaar MM, Hafudh MH, Abbas LMR, Aziz MM, Ahmad MJ, Mohsan H, simer H, Ghafil JA, Hassan SH, Zgair AK.** (2014) Effect of water taken from different environments on the ability of bacteria to form biofilm on abiotic surfaces. *World J Exp Biosci* **2**: 19-23.
5. **Lasat MM.** (2000) Phytoextraction of metals from contaminated soil: a review of plant/soil/metal interaction and assessment of pertinent agronomic issues. *J Hazardous Substance Res* 2: 1–25.
6. **ATSDR.** (2012) Toxicological profile for cadmium. Department of health and humans services. Centers for disease control. Atlanta, GA. USA.
7. **Rai, UN, Sinha S, Tripathi RD, Chandra P.** (1995) Wastewater treatability potential of some aquatic macrophytes: Removal of heavy metals. *Ecol Eng* **5**:5–12.
8. **Aravind P, Prasad MNV.** (2005) Cadmium-Zinc interaction in hydroponic system using Ceratophyllum demersum L.: adaptive ecophysiology, biochemistry and molecular toxicology. *J Plant Physiol* **17**: 3-20.
9. **Khan S, Ahmad I, Shah MT, Rehman SH, Khaliq A.** (2009) Use ofconstructed wetland for the removal of heavy metals from industrial waste water. *J Environ Management* **90**:3451–3457.
10. **Mishra VK, Upadhyay AR, Pandey SK, Tripathi BD.** (2008) Concentrations of heavy metal s and aquatic macrophytes of Govind Ballabh Pant Sagar an anthropogenic lake affected by coal mining effluent. *Environ Monitoring Assessment* **141**:49-58.
11. **Mishra S, Srivastava S, Tripathi RD, Kumar R, Seth CS, Gupta DK.** (2006) Lead detoxification by coontail (Ceratophyllum dermersum L.) involves induction of phytochelatins and response of antioxidants in response to its accumulation. *Chemosphere* **65**:1027–1039.

12. **Mishra VK, Tripathi BD.** (2008) Concurrent removal and accumulation ofheavy metals by the three aquatic macrophytes. *Bioresource Technol* **99**:7091-7097.
13. **Saygideger S, Dogan M, Keser G.** (2004) Effect of lead and pH on leaduptake, chlorophyll and nitrogen content of Typha latifolia L. and Ceratophyllum demersum L. *Int J Agricult Biol* **6**: 168-172.
14. **Chorom M, Parnian A, Zadeh NJ.** (2012) Nickel Removal by the Aquatic Plant (Ceratophyllum demersum L.). *Int J Environ Sci Dev* **3**: 372-375.
15. **Keskinkan O, Goksu MZL, Basibuyuk M, Forster CF.** (2004) Heavy metal adsorption properties of a submerged aquatic plant (*Ceratophyllum demersum*). *Bioresource Technol* **92**: 197-200.
16. **Keskinkan O, Goksu MZL, Yuceer A, Basibuyuk M.** (2007) Comparison of the adsorption capacities of Myriophyllum spicatum and *Ceratophyllum demersum* for zinc, copper and lead. *Eng Life Sci* **7:** 192-196.
17. **Parson SR, Maite Y, Lalli CM.** (1984) Amanual of chemical and biological methods for sea water analysis. Pergamon Press,Oxford.
18. **Evan D, Engel DW.** (1994) Mercury bioaccummulation from lavage bay. Texas NOAA Technical Memorandum: 89.
19. **Tawfik RK.** (2014) Removal of Copper and Cadimium metals from wate ecosystem by *Hydrilla verticillata* plant. M.Sc. thesis. College of Science for women, University of Baghdad.
20. **Al-tmimy ASKA.** (2004) An environmental study of bacterial and waters of the Tigris south of Baghdad, Diyala message. M.Sc. College of Science, University of Baghdad.
21. **AL-Lami AA, AL-Obeidi KH.** (1996) Study some properties physical priority and chemical tank AL- Therthar Iraq. *J Faculty Edu girls*. 8: 20-28.
22. **Al-Shammari RHH.** (2006) An environmental studyoffungiovalein the Tigris River (Baghdad) and some fish Amraditha message. M.Sc. thesis, College of Science, University of Al-Mustansiriya.
23. **Hammad M.** (2011) Water Hyacinth plant at Different Aquatic Environments. *Australian J Basic Appl* Sci **5**:11-22.
24. **Khellaf N, Zerdaoui M.** (2009) Phytoaccumulation of zinc by the aquatic plant, Lemna gibba L. *Bioresource Technol* **100**: 6137–6140.

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