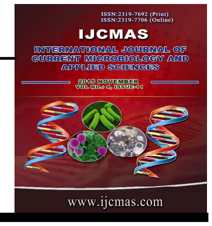
Int.J.Curr.Microbiol.App.Sci (2015) 4(11): 45-51

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 4 Number 11 (2015) pp. 45-51**
http://www.ijcmas.com



Original Research Article

Removal of Lead from Water by Using Aquatic Plants (*Ceratophyllum demersum* and *Eichhorina crassipes*)

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A B S T R A C T

Keywords

Eichhorina crassipes, *Ceratophyllum demersum*, Phyto-remediation, Lead

This study was conducted in the laboratory to identify the capability of aquatic plants *E. crassipes* & *C. demersum* on the removal of Pb and used different concentration (10, 15, 20, 30 and 50) ppm and the duration of exposure (4, 7, 14, 21 and 28) day for each concentration and was estimated plant efficiency to remove Pb as a percentage removal. Results of statistical analysis showed significant differences between concentrations and days at the level of a probability ($P < 0.05$) and recorded significant differences from the fourth day to 28th day in all concentration. Both plants *E. crassipes* & *C. demersum* can be utilized in phytoremediation of lead from polluted water.

Introduction

Water Contamination by heavy metals in some area is practically inevitable due to natural process (Weathering of rocks) and anthropogenic activities (industrial, agricultural and domestic effluents) (Sugiyama, 1994). Environmental exposure to toxic heavy metals is one of the main important issues on environment and public health (Kanoun-Boule *et al.*, 2009).

At least 23 metals have been classified as heavy metals the most common lead (Pb), cadmium (Cd), cobalt (Co), chromium (Cr) mercury (Hg), which have the toxic effects of high concentration as well as low concentrations of plants.

Lead is accounted significant pollutant due to solubility in water, which results in wide distribution in aquatic ecosystems lead is strongly toxic to organisms the excessive amount of lead in water cause many physiological and biochemical stress symptoms in plants, such as growth reduction, disturbed mineral nutrition, water imbalance and growth productivity and root elongation when they enter inside the cell wall like any other heavy metals they produce an oxidative stress in plant and lead to cell damage (Sharma and Dubey, 2005). Phytoremediation refers to the use of green plants to clean up contaminated soil and ground water the plants used in phytoremediation technique must have a considerable capacity of metal absorption its accumulation and strength to decrease the treatment time (Mudgal *et al.*, 2010).

Ceratophyllum demersum is a completely submerged plant and commonly seen in ponds, lakes, ditches and quiet, streams with moderate to high nutrient levels (Johnson *et al.*, 1995).

Water hyacinth (*Eichhorina crassipes*) is one of the world most commonly invasive aquatic plants, it is vascular plant and commonly forms dense mats with a well-developed fibrous root system and large biomass. It can adapt easily to various aquatic conditions and plays an important role in extracting and accumulating metals from water (Villamagna, 2009; Hammad, 2011). The plant grows in moderate temperature and the perfect degree its growth is between 20–30°C and when the temperature drops about 15°C, the plant starts to wilt and studies indicate that it contains water by 95% (Ramey, 2001).

Materials and Methods

Collection and Growing of *Ceratophyllum demersum* & *Eichhorina crassipes* plants

The submerged plants of *C. demersum* (Hornwort) and floating plants Water hyacinth (*E. crassipes*) from the Tigris River/Jadiriyah complex Plants were well washed and placed in two glass containers (40cm *50cm *80cm) filled with water From the same site. After a month period the plants were placed in glass basins suited for the experiment capacity 4L of water and by (10g) fresh weight per plant. Care should be taken to prevent any decrease in water level by adding the same oxygenated water.

Physical and chemical measurements

Some Physical and chemical measurements were done for Channel water directly as following:

1.Temperature was measured by a thermometer.

2.Electrical conductivity and salinity were measured by Conductivity meter type (MILWAUKEE, ROMANIA).

3.pH was measured by pH meter type (MILWAUKEE, ROMANIA)

4.Total dissolved solids (TDS) were measured by TDS meter type (MILWAUKEE, ROMANIA).

Plants acclimatization

Plants were transferred to the laboratory and placed in glass tanks containing 30 liters of distilled water. Temperature was adjusted by using aquarium heater to 27°C. And oxygen was provided using compressors. 100 plant samples were kept in each tank.

Preparation of lead metal concentration

A lead metal solution was prepared by using $Pb(NO_3)_2$ (BDH, England), to prepare 1L concentrations (10, 15, 20, 30, 50 mg\L) of Pb. After that, the plants were transferred to these solutions for about 4, 7 and 14 days.

Heavy Metals Measurement

Leaves and roots were put at 40°C in oven (MEMMERT, GERMANY) until the sample dry weights were fixed. 1 gram of the plants dry sample was digested by 16ml of mixture from HNO_3 (64%) (BDH, England) and H_2O_2 (30%) (BDH, England) in the ratio 6:2 and the mixture was put in the oven at 120°C for two hours. After cooling, 10 ml of distilled water was added, and then leave the solution to cool down the degree lab temperature for 24 hours, and the mixture was filtered through filter papers (0.45µM, Whatman) and diluted to 50 ml (Senila and Roman, 2011). Flame Atomic Absorption Spectrophotometer type (VGP 2010 Buck, England) was used to measure the lead metal concentrations in plants sample.

Results and Discussion

The results showed that the range of water temperature in glass container was 20–24°C and the average was 22°C. This result was agreed with Jafari (2010) as he found that the temperature suitable for growth of *Eichhorina cassipes* was in the range of 28–30°C but temperature above 33°C inhibits the plant growth. This result also agrees with Ping *et al*. (2013) as he found that the temperature was in the range of 20–25°C which was most suitable for the growth of *Ceratophyllum demersum*. pH values ranged between 7.3–8.0 as average 7.7, this result is suitable for growth of aquatic plants (*Ceratophyllum demersum* and *Eichhorina crassipes*). Convergence of these values with the value of pH between 7.8–8.0 and the average as 7.6 at the site of sample collection. This value agrees with Crossley (2012) he found that the most aquatic macrophytes prefer pH in the range of 5–7.5 and can also tolerate a range of pH levels but they vary in their tolerance. Jafari (2010) was found that, the water hyacinth plant can tolerate a pH in the range of 4–10. Electrical conductivity values ranged between 510 and 760 µS cm^{-1} in the current study in Tigris River. And these values converge with previous studies, such as study of Tawfig (2014) as the values of EC 895 µS cm^{-1}, while values conductivity ranged 2069 µS cm^{-1} in the study (Hussein, 2008) which is higher than the values recorded in the current study, has low electrical conductivity in the Tigris river is due a decline in the positive and negative ions to the fact that the region failed to conduct industrial activities.

Lead element was removed by using two aquatic plants *E. crassipes* and *C. demersum*, the percentage removal of Lead in solution was 98.6% at concentration 10 mgL^{-1} after 28 days of exposure and 96.33% at concentration 15 mgL^{-1} after 28 days of exposure and 85.50% at concentration 20 mgL^{-1} after 28 days of exposure and 63.33, 18.76% at concentration 30, 50 mgL^{-1} respectively after 28 days of exposure, as it shown in the table 1 and figure 3. From these results observed that the percentage removal of Lead from the solution when used two aquatic plants *E. crassipes* & *C. demersum* are high. These results are in accordance with Majid and Siddique (2013) who found that the *E. crassipes* removed 84%, 87%, and 48% of Copper from the tanks containing 2 mg/L, 4 mg/Land 6mg/L respectively within 18 days of exposure, also indicated that the percentage removal reached the maximum values after approximately 11 days.

Table.1 Percentage removal of Pb at different concentrations using *E. crassipes & C. demersum*

Concentration. / Days	Control	10 ppm	15 ppm	20 ppm	30 ppm	50 ppm	Mean
4	0	54.30	53.86	50.80	40.36	8.00	34.55
7	0	63.70	62.93	6.65	48.23	14.16	41.77
14	0	83.50	81.93	72.20	54.26	19.96	51.97
21	0	93.70	91.93	80.50	61.43	19.36	57.82
28	0	98.60	96.33	85.50	63.33	18.76	60.42
Mean	0	78.76	77.39	70.13	53.52	16.01	---

The value of LSD: the concentrations: 13.051 *, for days: 8.32 *,
Overlap between the concentrations and days 19.63*; * ($P < 0.05$)

Figure.1 *Ceratophyllum demersum*

Figure.2 Water hyacinth

Figure.3 Percentage removal of Pb at different concentrations using *E. crassipes* & *C. demersum*

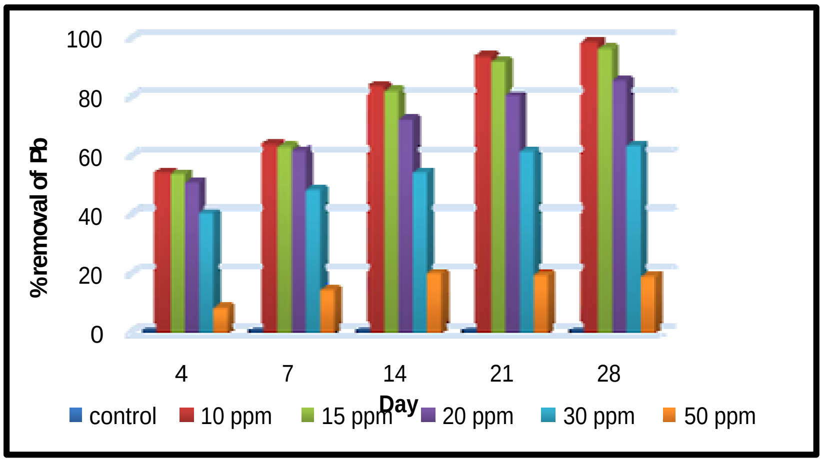
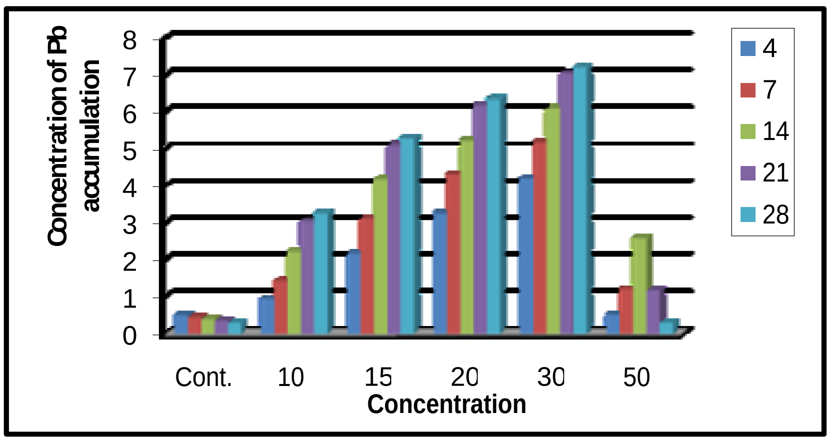


Figure.4 Pb accumulation in *E. crassipes* plant tissue in existence of *C. demersum*

Figure.5 Pb accumulation in *C. demersum* plant tissue in existence of *E. crassipes*



The present study was also accordance with other workers such as Aurangzeb *et al.* (2014) who indicated that *E. crassipes* is a better bio filter for phytoremediation of (Pb, Cu, Cd, As) in a percentage removal (82.80%, 78.6%, 74%, 73%, 73%) respectively.

The results showed a variance analysis and examination Less significant differences at the level ($P <0.05$) to the existence of significant differences in the concentration (10, 15, 20, 30, 50) ppm and between days this result indicated that the ability of aquatic plants *E. crassipes* & *C. demersum* to accumulation Lead increase with decrease the concentration added in water treatment basins.

E. crassipes was accumulation concentration of Lead in their tissue higher than *C. demersum*, it was ranged at concentration 10 mgL^{-1} between 2.85–5.85 mg/kg as average 4.35 mg/kg and 3.90–6.38 mg/kg as average 5.14 mg/kg at the concentration 15 mgL^{-1} and 4.42–8.01 mg/kg as average 6.22 mg/kg at the concentration 20 mgL^{-1} and 6.22–10.02 mg/kg as average 8.12 mgL^{-1} and 7.30–11.19 at the concentration 30mgL^{-1} as average 9.25 mg/kg and 2.10–8.02 mg/kg as average 5.06 mg/kg at the concentration 50 mg/kg. While the concentration of Lead in

C. demersum at 10mgL^{-1} 0.93–3.25 mg/kg as average 2.09 mg/kg and 2.17–5.30 mg/kg as average 3.74 mg/kg at 15 mgL^{-1} and 3.25–6.35 mg/kg as average of 4.80 mg/kg at 20 mgL^{-1} and 4.21–7.21 as average of 5.71 at 30 mgL^{-1} 0.51–0.30 mg/kg as average of 0.41 at 50 mgL^{-1}as shown in figure 4 and 5. These results confirmed that the aquatic plants *E. crassipes* & *C. demersum* possess the ability to remove Lead element and decreases this ability at high concentrations, but the largest decrease in *C. demersum* was observed in the ability of plants to absorb lead at a concentration of 50 mgL^{-1} in duration of exposure 21 and 28 days. These results are accordance with Schneider and Rubio (1999) who indicated the result obtained low metal adsorption in *C. demersum* compared to other aquatic plants, but Keskinkan *et al.* (2004) who compared the values of heavy metals in *C. demersum* with values in other research and found that *C. demersum* can be very effective in remove heavy metals compared with other aquatic plants and this does not agree with the current study.

In conclusion, the result obtained in this study proved that the *E. crassipes* is the best plant in phytoremediation of Pb from polluted water than *C. demersum* the plant ability to absorb Pb associated with the concentration in aqueous media as observed inability *C. demersum* plant to tolerate high concentration of Pb while *E. crassipes* was ability to absorb Pb even at high concentration, but less than in the few concentration from this it can be concluded that the *E. crassipes* has been successfully used as the bio sorbent for removal of different concentrations of Pb.

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