Removal of Lead and Copper Elements from a Laboratory Water Ecosystem by Using Semi-aquatic Plant (Polygonum sp.)

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Abstract

This present study demonstrated the phytoremediation potential of Polygonum sp. for the removal of Copper (Cu) and Lead (Pb) from contaminated water and using different concentration (10, 20 and 30) ppm. The duration of experiment time (3, 6, and 9) days for each concentration and estimated the plant efficiency to remove (Cu) and (Pb) as a percentage removal. Result of the statistical analysis showed significant differences between concentrations and days at a probability level ($p > 0.05$) and recorded significant differences from the 3rd day to 9th day in all concentration plant. The experiment showed that both (Cu) and (Pb) have effects on plant. The plant at all the concentrations used in the experiment had percentage removal of (Pb) more than percentage removal of (Cu).

Key Words: Polygonum sp., Phytoremediation, Copper and Lead.

إزالة عنصري الرصاص والنحاس من نظام بيني مختبري باستخدام النبات شبه المائي (عصا الراعي)

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الخلاصـــة

في الدراسة الحالية تحديد إمكانية المعالجة النباتية لنبات عصا الراعي .Polygonum sp لإزالة النحاس والرصاص من المياه الملوثة وباستخدام تراكيز مختلفة من كلا العنصرين كل عنصر على حدة (10, 20 و 30 ppm) جزء في المليون. وقت التجربة (3, 6 و 9) أيام لكل تركيز وقدرت كفاءة النبات لإزالة (النحاس) و (الرصاص)، كنسبة إزالة مئوية. وأظهرت نتائج التحليل الإحصائي وجود فروق معنوية بين التراكيز والأيام في مستوى احتمالية ($P>0.05$)وسجلت اختلافات معنوية من اليوم الثالث إلى اليوم التاسع لكل تركيز وأظهرت التجربة أن كلا من النحاس والرصاص يكون لها تأثيرات على النبات. اظهر النبات في جميع التراكيز المستخدمة في التجربة نسبة إزالة الرصاص أكثر من نسبة إزالة النحاس.

الكلمات المفتاحية: عصا الراعي، المعالجة النباتية، النحاس والرصاص.

Introduction

Heavy metal pollution poses a great threat to the environment and human health worldwide due to the persistent nature and toxicity of heavy metals and their accumulation in the food chain (Bahadir, *et al.*, 2007). Both essential and non-essential metals are present in fresh water at low concentrations (Le Faucheur, *et al.*, 2006). Heavy metals such as Cu^{+2}, Zn^{+2}, and Fe^{+2} is essential micronutrient for plant metabolism but when present in excess they can become extremely toxic (Williams, *et al*., 2000). Water pollution with heavy metals have many effects on aquatic organisms, in addition to the bioaccumulation and bioconcentration of these metals in the aquatic food chain put the consumers such as humans in risk (UNEP, 2008). The contamination by heavy metals causes a serious problem different part of the food chain may be due to low degradable in nature compared with organic pollutants and they accumulate in different parts of the food chain (Hejabi, *et al*., 2010).

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). Pb is a strong neurotoxin metal, the pollution of this material is of high concentration. The occurrence of Lead in drinking water, however, in low concentration, may cause diseases such as anemia, hepatitis, and nephrite syndrome. aquatic plant species are very specific for the uptake of nutrients. Thus, the selection of the aquatic plant species is one of the skilled tasks prior to the design of the system (srivastava, 2008).

The *Polygonum* sp., a relatively large genus, belongs to the family *Polygonaceae* consisting of eight genera (*Aconogonon, Koenigia, Persicaria, Reynoutria, Bistorta, Fallopia, Polygonum* and *Fagopyrum*) (Haraldson, 1978).

Materials and Methods

Collecting and Growing of *Polygonum* sp. *plants*

The semi aquatic plants *Polygonumsp*. were collected from the Tigris River /Baghdad-aL-zaafrani plant samples were well washed and placed in two glass containers (36, 35 and 75) cm filled with water from the same site of collection as showed in Fig 1. After a few periods the plants were placed in glass basins suited for the experiment, it is capacity 5L of water and put (10 g) fresh weight per plant. Care should be taken to prevent any decrease in water level by adding the same oxygenated water it like Fig. (1). Filled with water from the same site of collection .After two week the plant were placed in glass basins suited for the experiment, it is capacity 5 L of water and plant weighed (205) were placed, if the stem and leaves were taken it is a method similar to the method described by the researcher (Guo-xin, *et al*.,2005.), where his results were agreed upon with many researchers, with three basins for each concentration (10, 20 and 30) ppm for each of the lead and copper salts during the days of the experiment.

Statistical Analysis

Factorial arrangement experiments were used within (The complete Randomized Design (C R D) .in the laboratory experiments the results were statistically analyzed by using the ANOVA technique in treating the absorption of copper and lead from water, the lowest significant difference was used. (LSD) comparison is the

averages of the transactions, as all indicators were examined at a significance level of (0.05) using statistical analysis system (SAS) program according to (Stell and Torrie, 1980).

Fig (1) *Polygonum* sp. in Natural in Collection Site Showed the Flowers

Physical and Chemical Measurements

In present study Some Physical and chemical measurements were recorded from water directly as Temperature was measured using simple mercury thermometer. Electrical conductivity and salinity were measured by conductivity meter and pH meter type (Milwaukee, Romania).

Plants Acclimatization

Polygonum sp. were transferred to the laboratory and placed in glass tank containing 25 liters of distilled water. Temperature was adjusted by using Aquarium heater to 27 °C. And provide oxygen using water compressors. Approximately 100 plants samples were kept in the two tanks.

Preparation of Lead and Copper Metals concentration

1000 ppm the storage solution of copper and lead were prepared $Pb(NO_3)_2$ and $Cuso_4.5H_2O$. if (3.926) gm of aqueous copper sulfate was dissolved in 100 ml distilled water with continuous stirrer for 30 minutes, then complete the volume to 1 liter. As for the storage solution of lead nitrate it was prepared by dissolving 1.599 gm of lead nitrate in 100 ml and volume was completed to 1 liter of distilled water, and this was done according to (APHA, 1998), the three concentrations were prepared for each component of the stock solution (stock solution). With for the two components separately, by performing the necessary dilution with distilled water, depending on the following chemical law, as follows: c*v1=c2*v2c2, v1=c2*v2Ic1
Where: - v 1: The required volume of the storage solution that is added to the experiment parameters, v2: the fixed pond water volume (5000) ml, c1 the caliber required for the purpose of the experiment (10, 20 and 30). ppm, c2: the standard of the storage is equal to 1000 ppm.

Heavy Metals Measurement

Leaves and stem were putting at 75 °C in an oven (MEMMERT, ERMANY) until the sample dry weights were fixed. 1 gram of the plants dry sample was digested by 12ml from HNO_3 (64%) (BDH, England), then leave the solution down the degree lab temperature for 24 hours and covered by glass plate and added 4ml of H_2O_2 (30%) (BDH, England) in the ratio 6:2 and the mixture were put in the oven at 120 °C for two hours. After cooling, 10 ml of distilled water was added, and the mixture was filtered through filter papers (0.45µM, Whatman) then diluted to 50 ml (Senila, *et a*l., 2011). Flame Atomic Absorption Spectrophotometer type (VGP 2010 Buck, England) was used to measure the Lead and Copper metals concentration in the plant samples.

Result and Discussion

The range of water temperature in Tigris River recorded 27.4 °C in May during June 29.05 °C. This result was agreed with (Habeeb, et al., 2010) they found the temperature in Euphrates River

in Aug between (31-35) °C pH values ranged between 6.73 in May and in June 7.30 as average 7.01, this result was suitable for growth of most aquatic plants. These values agree with (Crossley, 2012) who found that the most aquatic macrophytes prefer pH in the range 5-7.5. Electrical conductivity values ranged between 774 µS cm-1 in May and 793µS cm^{-1} in June in the current study in Tigris River. And these values converge with previous studies, such as study (Agha, 2014) who recorded that the values of EC 831 µS cm-1in May and 884 µS cm-1 in June current study in Tigris River. These decrease the Tigris value of electrical conductivity in the Tigris River is due to a decline in the positive and negative ions because of the industrial activities. Lead element was removed by using semi - aquatic plants *Polygonum* sp. the percentage removal of Lead in solution was 97.85% at the concentration 10 mg. L^{-1} after 9 days and 96.71% at concentration 20 mg. L^{-1} after 9 days and 92.93% at concentration 30 mg. L^{-1} after 9 days of the experiment, too these results were illustrated in Table (1) and Fig (2). It was noted that the percentage removal of Lead from the solution when used semi-aquatic plant *Polygonum sp*. Used was high. These results are in accordance with (Swain, *et al*., 2014) who found that the *E.crassipes* caused high removal (>90%) of Copper and Cadmium during 25 days of experiment , The percent of Cadmium was removed by (100, 100, 98.76) % from the tanks containing 0.27 mg/L, 0.54 mg/Land 0.81 mg/L respectively within 25 days, also indicated that the percentage removal reached the maximum values after approximately 15 days.

Table (1) Percentage Removal of Pb at Different Concentrations Using *Polygonum* SP

Days	Concentration			
	10 ppm	20 ppm	30 ppm	mean
3	91.11	71.41	76.71	79.74
6	91.80	94.93	88.89	91.88
9	97.85	96.71	92.93	95.83
Mean	93.59	87.68	86.17	---

The value of LSD: for the concentrations: 6.44 *, for the days: 6.44 *, and for the overlapping between the concentrations and day 11.85 *. (P <0.05). The (*) means to find a significant difference.

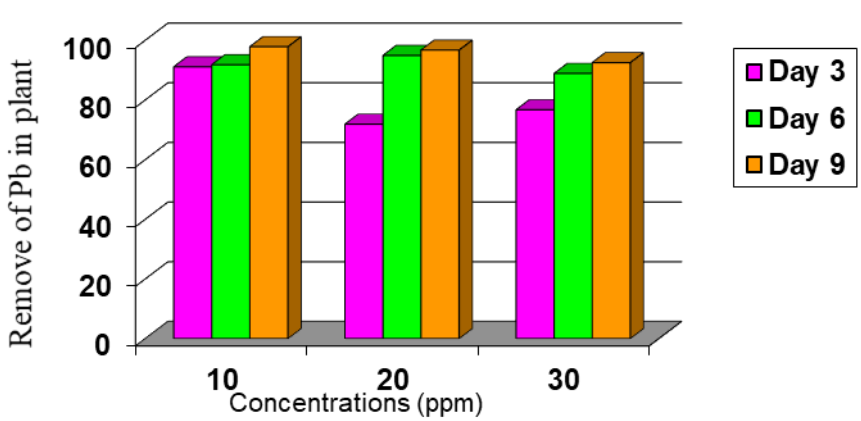

Fig. (2) Percentage Removal of Pb at Different Concentrations Using *Polygonum* sp.

Table (2) Percentage Removal of Cu at Different Concentrations Using *Polygonum sp*.

Days	Concentration			
	10 ppm	20 ppm	30 ppm	Mean
3	32.02	47.86	43.32	41.06
6	53.56	58.08	43.74	51.79
9	87.01	80.97	49.35	72.44
Mean	57.53	62.30	45.47	---

The value of LSD: for the concentrations: 8.64*, for days:8.64 *, and for the overlapping between the concentrations and day 14.79*. (P <0.05) The (*) means to find a significant difference.

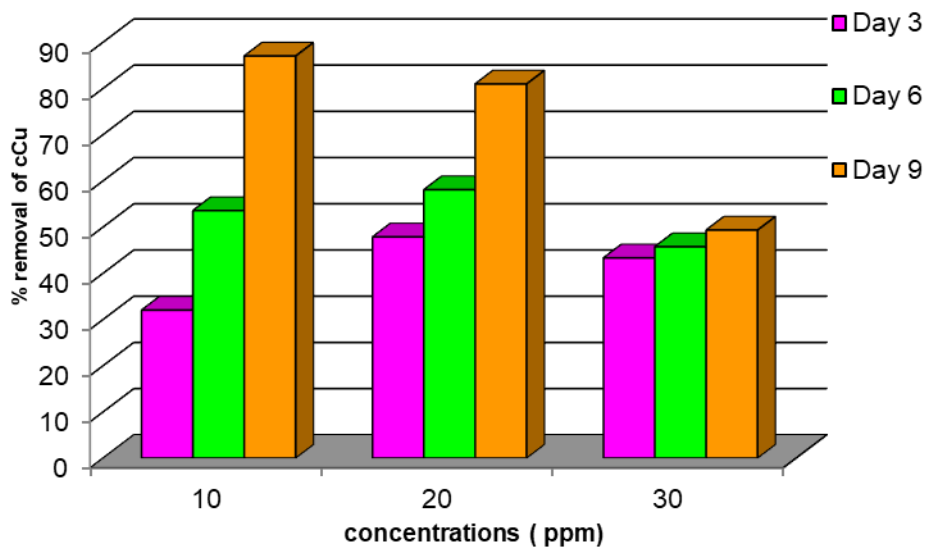

Fig (3) Percentage Removal of Cu at Different Cocentration Using *Polygonum* sp

In the present study least significant differences at the level (P <0.05) to the concentration (10, 20 and 30) ppm was 6.44 and between days 6.44 and Overlapping between the concentrations and days was 11.85, this result indicated that the ability of semi-aquatic plants *Polygonum* sp. as percentage removal of Lead increase with decrease the concentration. Copper element was removed by using semi-aquatic plants *Polygonum sp*., the percentage removal of Lead increase with a decrease the concentration. The copper element was removed by using semi-aquatic plants *Polygonum* sp., the percentage removal of copper in solution was 87.01% at a concentration of 10 mg. L^{-1} after 9 days of exposure and 80.79% at concentration 20 mg. L^{-1} after 9 days of the exposure and 49.35% at a concentration of 30 mg. L^{-1} after 9 days of exposure, as shown in Table (2) and Fig. (3).

From these results observed that the percentage removal of copper from the solution when used semi-aquatic plant *Polygonum* sp. Less than Lead. These results are in accordance with (Radulovic, *et al*., 2014), on the concentration of the tested metals show that the plant *P. aviculare* can be successfully used in plant biomonitoring, primarily because of its favorable ecological characteristics. These results are in accordance with (Swain, *et al*.,

2014) they found that the E. crassipes has high removal (>90%)

Copper and Cadmium during 25 days of the experiment, the Copper (95.23, 87.61, 83.80) % from the tanks containing 0.35 mg/L, 0.70 mg/L, and 1.05 mg/L respectively within 25 days of exposure, also indicated that the percentage removal reached the maximum values after approximately 15 days. The results showed a variance analysis and examination Less significant differences at the level ($P < 0.05$) to the found of significant differences in the concentration (10, 20 and 30) ppm 8.64 and between days 8.64 and Overlapping between the concentrations and days 14.79 this result indicated the ability of semi-aquatic plant *Polygonum* sp. To remove copper, a percentage of the removal of the copper increase with the decrease of concentration.

Conclusion

The present study was carried out to determine the ability of the *Polygonum* sp. to be used in the biological treatment of polluted water. Results were showed that the plant can accumulate Copper and Lead in stem and leaves in large amounts. Leaves' ability to accumulate heavy metals was more than stem. Results were showed the percentage removal to Lead more than Copper, but Copper was more effective for the plant than Lead, the leaves start shriveling faster when they were treated with copper and faster than those treated with Lead.

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