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PHYTOREMEDIATION OF ZINC AND CADMIUM FROM POLLUTED WATER BY USING *POLYGONUM* SP PLANT IN AQUATIC ECOSYSTEM

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Abstract

The study was carried out to know the capacity of *polygonum sp.* in removing some of the heavy elements from water, which are zinc and cadmium. Different percentage were used from the elements zinc and cadmium separately, they are (100, 80,60,40) ppm for zinc element and (16,12,8,4) ppm for cadmium elements for 21 days for each concentration.

The result showed that *Polygonum* sp. concentrates elements in large quantities and there was a significant difference between the two elements at the possibility level ps 0.05 at most studied concentrations during the experiment period until 21 days.

The plant can be used in biological treatment for polluted water with heavy element because the plant showed high removal percentage for zinc element and the percentage average for the removal of all the studied concentrations after 21 days from the experiments were (22.49, 62.38,60.84 ,58.37) for the concentration (100,80,60,40) ppm successively whereas the removal percentage for cadmium element was 100% for all studied percentage except for 16 ppm it was 79.68% also elements concentration were measured after (1 hour,14, 7, 3) days from the experiment for each concentration.

It was also noticed that the leaves withered after 18 days from the experiment for plants treated with zinc element for the concentration (100,80) ppm whereas with cadmium element the leaves withered slightly at the 16th day of the experiment. The green color started to change to yellow for all the studied concentrations and the results showed that cadmium element is higher in toxicity on plats of zinc element as the leaves began to wilt when treated with cadmium in away faster than it is when treated with zinc.

Key words : *Polygonum* sp, cadmium, zinc.

Introduction

Although, heavy metals are naturally occurring elements that are found throughout the earth's crust, most environmental contamination and human exposure results from anthropogenic activities such as mining and smelting operations industrial production natural phenomena such as weathering and volcanic eruptions have also been reported to significantly contribute to heavy metal pollution (Tchounwou *et al*., 2014).

The term heavy metal refers to any metallic chemical elements that has a relatively high density that more than 5gm/cm^3 and is toxic or poisonous at low concentrations heavy metals cannot be degraded or destroyed some heavy metals such as, copper, zinc, iron are essential to maintain the metabolism of the human body, high concentration of this element can lead to poisoning (Bagular *et al*., 2015).

Recent concerns regarding the environmental contamination have initiated the development of appropriate technologies to assess the water and mobility of metals in soil water and waste presently phytoremediation has become an effective and affordable technological solution used to extract or remove inactive metals and metal pollutants from contaminated soil. phytoremediation in the used of plants to clean up a contaminated from soil and water or sediment this technology is environmental friendly and potentially cost effective plants with exceptional metal accumulating capacity are known hyper accumulator plants (Tangahu *et al*., 2011).

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Hyperaccumulators include many aquatic plants grew in wetl and such as *Ceratophyllum demersum, Polygonnm* sp. and *Eichhornia crassipes* these aquatic plants are unchangeable biological filters it is considered as important component of the aquatic ecosystem not only as food source for aquatic invertebrates and fishes but also act as an efficiency accumulators of nutrients elements and heavy metals (Alaa and Alsayed, 2015).

Hyperaccumulators accumulate 10 to 500 times more metals than ordinary plant hence they are very suitable for phytoremediation. An important characteristic which makes hyperaccumulation possible is the tolerance of these plants to increasing concentrations of these metals (hyper – tolerance).

This could be a result of exclusion of these metal ions, that is the metals are retained in the vacuolar compartments or cell walls and thus do not have access to cellular sites where vital function such as respiration and cell division take place (Chibuke and Obiora, 2014). For phytoremediation technology, an ideal plant species should have at least one of two following characteristics very high metals accumulation capacity ; high biomass yield with enhanced metal uptake potential, this suggests that the suitable role of plant species to clean up contamination environment (Ha, 2014). Atomic Absorption spectrometry, theory, design and application, analytical spectroscopy.

Therefore, phytoremediation of heavy metals can be divided into three groups (Zaitca, 2013).

1. phtoextraction : the use of metal – accumulating plants to remove toxic metals from soil.

2. phytostabilization : the use of plants to eliminate the bioavailability of toxic metals in soils.

3. phytorhizofilteration : the use of plant roots to remove toxic metals from polluted waters.

Polygonum sp. with a beautiful red flower can be found as one dominant species approximately most water bodies and wetland in the Tigris River, it is annual plant belonging to the family polygonaceae (Kim *et al*., 2016).

We choose this species because it grows ubiquitously and vigorously in this polluted area *Polygonum* sp. also has arelatively fast growth rate from the parts of parental plant (Kai *et al*., 2015)

The objective of this study to determine the potential of *Polygonum* sp. to take up heavy metals (cd and zinc) from aquatic system.

Materials and Methods

The plant samples used in this study were collected from agriculture area in Al-Zafarania city in Baghdad, it was washed gently with deionized distilled water for approximately 3 mint to remove soil particles and algae adhered to the plants (Kalac and Becirovic, 2015).

Assessment of heavy metal tolerance of plants was done b put of the above ground parts in the water treated in the chamber with a diameter of 20x30 cm and a high of 35 cm^2 were filled with 10 liters of water. The concentration of zinc represented (40, 60, 80, 100) ppm thumper of pots 4 represent edconcentration of cadmium (4,8,12,16) ppm plants were growth in chamber at a thermoperid and photoperiod (22c / 16 h) at the experiment duration (3, 7, 14, 21) days (Norouznia and Hossein, 2014).

After each duration of experimental (3, 7, 14, 21) days, plant were dried at 180 c for 12 hour and ground with a mortar and pestle plant samples (2g dry weight) were digested with 20 ml nitric acid and 10 ml hydrogen peroxide, and impurities were removed by filtration the final volume of each sample solution was made up with deionized water and analyzed by flame atomic absorption spectrometry (Dark *et al*., 2014).

Water analysis

Water samples were collected from water champers that plant *Polygonum* sp. grew in it and then filtered with Whatmanashless paper after that added 1 ml nitric acid 5% and that last prepared blank solution in the same procedure without sample (Ha, 2014). In addition, measurement the concentration of element zinc and cadmium as a percentage of the removal of the plant (Sheetal *et al.,* 2016).

Results and Discussion

Zinc element

The plant showed a high efficiency in removing zinc element from the medium as the concentration percentage was (100, 80, 60,40) ppm for (13.61, 49.66, 49.30, 50.12), respectively. After 3 days from the of the experiment, it was noticed there was an increase in the removal percentage by an increase in the compensation period except for the element 100 ppm where the removal percentage decreased after 7 days for the concentrations (100, 80, 60, 40) ppm was (19.24, 68.80, 68.21, 64.45) respectively. After 14 days, the removal percentage for zinc element for the same studied percentage were (28.76, 85.62, 80.73, 76.3%), respectively and was (40.53, 97.61, 97.48, 94.75) 21 days for same studied percentage, respectively.

The study showed that removal percentage increase with the increased compensation period and increase with

Table 1 : show the percentage removal of zinc from aqueous solution by use *Polygonum* plant.

Duration	Control	40 ppm	60 pmm	80 pmm	100 pmm
After 1 hour	30.11	6.27	8.5	10.25	10.31
3 days	0.63	50.12	49.30	49.66	13.61
7 days	0.43	64.45	68.21	68.80	19.24
14 days	0.75	76.3	80.73	85.62	28.76
21 days	0.22	94.75	97.48	97.61	40.53
Mean	6.428	58.378	60.844	62.388	22.49

the increased element concentrations at the experiment beds. This indicates the efficiency of the *Polygonum* sp in vital removal except for the concentration ppm 100 when the removal percentage decrease at this concentration and accordingly the remaining concentration of the element increases in the medium. The reason might be is that zinc element is considered as one the small basic elements needed for the plants with small quantities but it becomes toxic in high percentage (Jepkoech *et al*., 2013). The reason might be the ability of some of the water plants accumulates zinc element largely due to the existence of the IZNT in plants that binds to zinc ion and converts it into less effective compounds stored in the plant cells (Kachout *et al*., 2009).

Cadmium element

The study showed high percentage for the removal as 25% were removed at the 3rd day of the experiment at 4ppm and after 21 days of the experiment the elements were removed completely and the percentage were 100% where as other concentration were after removal percentage after 3 days of the treatment (28.87, 43.08, 39%) for the percentage (16,12,8) ppm respectively, also noted the increase of removal percentage after 7 days of the experiment was noticeable but less that zinc element as it was (39.43, 59.03, 53.5, 48.00%) for concentration (16, 12, 8, 4) ppm respectively and were (59.12, 91.81, 87.5, 83.25) at the 14th day for concentration (16,12,8,4) respectively, whereas after 21 days the removal percentage for all studied percentages 100% except 16ppm the removal percentage were 79.68% as shown in table 2.

Table 2 : show the percentage removal of cadmium from aqueous solution by used *Polygonum* plant.

Duration	Control	4 pmm	8 ppm	12 ppm	16 ppm
After 1 hour	0.00	0.75	0.62	0.50	0.56
3 days	0.00	25.00	39	43.08	28.87
7 days	0.00	48.25	53.5	59.03	39.43
14 days	0.00	83.25	87.5	91.81	59.12
21 days	0.00	100	100	100	79.68
Mean	0.00	51.45	56.12	58.88	49.53

From the results, we deduce that removal percentage increases with the increase of the medium concentration except 16 ppm where the percentage decreased for the removal slightly compared with other concentrations. The reason was the high percentage as *Polygonum* sp a plant that accumulate heavy elements and have the ability to remove elements from the medium in addition to the existence of a carrier (atnramp 3) that moves cadmium from the medium and collect it in root vascular bundles, leaves, water plant stem (Alish *et al*., 2013).

The remaining concentration of elements in the medium during the experiment time.

Zinc element

Zinc element was removed noticeably during the experiment as it was removed at 40 ppm concentration and the remaining during the 14th day of experiment was 21.82. The concentration was very little during the 21 day since, it was 4.72%, which means the element was removed almost completely at the last day of the experiment due to the high ability of the plant to remove heavy element from the medium (Alish *et al*., 2013). At concentration 60ppm the remained of the element at the bed 2.16% at the 21 days while the concentration 80ppm then what remained was 2.12%. The remained quantity from 100ppm concentration was 59.47 as shown in table 3.

Table 3 : show the residual concentration ratios zinc in solution during experimental day.

Duration	Control	40 pmm	60 ppm	80 ppm	100 ppm
After 1 hour	0.00	92.27	90.16	89.10	97.11
3 days	0.00	45.1	50.1	49.92	86.39
7 days	0.00	35.04	31.56	30.66	80.76
14 days	0.00	21.82	19.23	14.11	71.24
21 days	0.00	4.72	2.16	2.12	59.47
Mean	0.00	39.79	38.64	37.18	78.99

The experiment showed that the percentage at the beds increased by the increased concentration and reduced by days, which indicated that *Polygonum* sp is a plant accumulates highly heavy elements (Sheetal, 2016) also it capability to use the plant in the biological treatment for polluted water.

Cadmium element

It was noticed that the percentage of cadmium element left in the bed at the 3rd day of the experiment was 75% at 4ppm concentration. After 21 days, the remaining cadmium element percentage was 5.5% for all studied concentration at 16 ppm as the remaining at the experiment bed was 20.43%. It was noticed a drop of the percentage by days, it was (60.56, 40.61, 50, 51.75)

after 7 days for the concentration (16, 12, 8, 4) ppm respectively. After 14 days, the remaining percentage in beds were (40, 87, 12, 12.5, 21.75%) respectively for the same studied concentration. From this, we conclude that the remaining percentages at experiment beds lessen by days, which lead to the capability of using the *polygonum* sp plant in biological removal.

From the results, we notice the increase of bio concentration factor in plant tissues for the 2 elements except the concentration at 100 ppm for zinc and concentration 16ppm for cadmium element and the reason for that might in stopping the metabolism operations like photosynthesis.

In this study it was noticed the low percentage for the removal compared to zinc element, as 25% were removed at the 3rd day of the experiment at concentration 4ppm and after 21 days passed, the elements were removed completely. The percentage was 100% where as at other concentrations, the removal percentage after 3 days of treatment was (28, 87, 43.08, 39) for the concentrations (16, 12, 8), respectively. It was noticed that there is an increase at the removal percentage 7 days of the experiment but less than zinc element since it was (39.43, 59.03, 53.5, 48.00%) for the concentrations (16, 12, 8, 4ppm), respectively and were (59.12, 91.81, 87.5, 83.25) the 14 day for the concentrations (16, 12, 8, 4ppm), respectively where as after 21 days passed the removal percentage for all concentrations were 100% except 16ppm the removal percentage was 79.68%. From these results, we noticed that the removal percentage increases with the increased of the compensation period and increase medium concentration except concentration 16ppm where the removal percentage dropped slightly compared with other concentrations. The reason for high percentage is that *Polygonum* sp is a plant of high heavy element accumulative and has the ability to exclude elements from the medium in addition to the existence of carrier ATNRanp3 that transfer cadmium from the medium and collect it in vessels for root and leaves and water plant stems.

It was noticed that the removal percentage for zinc element from the experiment beds by using *Polygonum* sp. were 50.12 at concentration 40ppm. We notice the increase of removal percentage after 21 day where the percentage of concentration (100, 80, 60, 40 ppm) were (13.61, 49.66, 49.30, 50.12), respectively after 3 days of the experiment and it was noticed the increase of the removal percentage with the increase of compensation period except 100ppm where the removal percentage

Table 4 : show the residual concentration ratios of zinc in solution during, experimental days.

Duration	Control	4 ppm	8 ppm	12 ppm	16 ppm
After 1 hour	0.00	98.75	99.25	99.33	99.37
3 days	0.00	75	60	56.91	71.12
7 days	0.00	51.75	50	40.61	60.56
14 days	0.00	21.75	21.5	12	40.87
21 days	0.00	0	0.2	0.00	20.43
Mean	0.00	49.45	44.39	41.77	58.47

Table 5 : show Bsf for zinc element in the *Polygonum* plant for different concentration.

Days	40 ppm	60 ppm	80 ppm	100 ppm
3	1.13	0.99	1.00	0.15
7	1.85	2.16	2.24	0.23
14	3.57	4.25	6.12	0.40
21	18.15	38.33	41	0.68
Mean	6.17	11.57	12.59	0.36

Table 6 : show Bcf for cadmium in *Polygonum* plant for different concentration.

Days	4 ppm	8 ppm	12 ppm	16 ppm
3	0.33	0.65	0.75	0.40
7	0.93	1.07	1.44	0.65
14	3.59	7	7.56	1.44
21	4	8	12	3.92
Mean	2.21	4.18	5.46	1.60

decreased after 7 days for the concentrations (100, 80, 60, 40 ppm) were (19.21, 68.80, 68.21, 64.45), respectively. After 14 days for the same studied concentrations were (28.76, 85.62, 80.73, 76.3) respectively and were (40.53, 97.61, 97.48, 94.75) after 21 days for some studied concentrations respectively. From these studies we notice the removal percentage increases with the increased concentration at medium except at 100ppm the percentage for removal decreased at this concentration and therefore the remaining concentration increase from the element at the medium. The reason for the removal of zinc element by the plant to the existence of negative ion charge on the plant cells wall, which draw positive zinc element ions from waterbeds. Negative ions on the cell wall goes back to the carboxyl group of pickteic acid and starts to withdraw positive charges and prevent it from going back once again to the medium. The reason goes back to the decrease of zinc element accumulation at plant tissue at high concentration, which led to completion for correlation spots that increase and the correlation spots becomes saturated where as at low concentrations absorption site takes the element ions quickly.

Bioconcentration factors Bcf

Which is defined as the ratio of metal concentration in the plant to that is solution, Bcf values indicated that the plant shows good accumulation capacity, if it was greater than 1 are suitable for phytoextraction in the Experiment, Bcf values of zinc and cadmium was determined and the values are given in tables 5, 6 respectively.

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