Tolerance of *Vallisneria* sp. for Different Concentrations of Cadmium and Lead

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Abstract

This study was done to recognize the tolerance of *Vallisneria* sp. for different concentrations of cadmium and lead in aqueous ecosystem. The concentrations of 30, 40, 50 mg/L were used for Cd and Pb in three replications for each concentration for 30 days.

The results found that the plant was tolerated 50 mg/L of Pb, and 40 mg/L of Cd. Significant differences were found in removing capacity by plant for Cd and Pb, in all concentrations 30, 40, 50 mg/L during experiment period. There were no morphological changes in the first day of the experiment period, but it was appeared after the threeth days of the experiment, and it continued till the end of the experiment.

The highest removal ratio for Pb was 97.66% in the concentration 30 mg/L, and the lowest removal ratio was 57.4% in the concentration 50 mg/L. For Cd the highest removal ratio 80.06% in concentrations 30 mg/L and the lowest removal ratio was 76.2% mg/L in concentrations 50 mg/L.
Keywords: *Vallisneria* sp., Heavy metal

Introduction

The contamination of soils and aquatic systems by toxic metals and organic pollutants has recently increased and this due to anthropogenic activity (Mejare *etal*., 2001).

Phytoremediation is defined as a process of decontaminating soil and aquatic systems by using plants, fungi or algae to absorb heavy metals. Recently, the use of aquatic plants has received much attention because of their ability to absorption of metals and taking up toxic elements from the environment or rendering them less harmful (Mitra *etal*., 2012).

The plant used in the phytoremediation technique must have a considerable capacity of metal absorption, its accumulation, and reducing the time of decontamination of an ecosystem (Mudgal *etal*., 2010).

Metals are introduced into the aquatic ecosystems as a result of weathering of soil and rocks, from volcanic eruptions and from a variety of

human activities involving mining, processing and use of metals and/or substances containing metal contaminants (Jian, 2004).

Cd is a relatively rare element and it is not found in a pure state in nature. It easily reacts with carbon dioxide, water vapor, sulphur dioxide, sulphur trioxide, or hydrogen chloride and produces cadmium carbonate, hydroxide, sulphide, or chloride. Cd can undergo weak bonding to carbon and other more electronegative atoms (Jain , 2004).

Small amounts of lead may enter rivers, lakes, and streams when soil particles are moved by rainwater. Small amounts of lead from lead pipe or solder may be released into water when the water is acidic lead (Pourrut *et al.*, 2011).

Vallsneria sp. occurs in both fresh and brackish water habitats and can sustain a relatively high biomass even in turbid, brackish systems. Thus, *Vallsneria* sp. is often found in waters with relatively high light attenuation and salinities >12 ppt (Doering et al., 2001).

Materials and Methods

Collection and Growing of *Vallisneria* Plant

Vallisneria Plant samples were collected from Diyala River in Diyala, Iraq. Plants were well washed and placed in two glass containers (40cm *50cm *80cm) filled with water from the same river. After a month period plants put to experimental containers (15cm *10cm *20cm) and capacity 2L of water . Care was taken to prevent the decrease in water level by adding the same oxygenated water.

Physical and Chemical Measurements

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

1-Temperature was measured by 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).

Plant Acclimatization

Plants were transferred to laboratory and put in glass container contain 30L of distilled water, the laboratory temperature was adjusted to 20 ± 2 C°. 100 plant samples were put in each container.



Preparation of Heavy Metals Concentration

Heavy metals solutions were prepared by using $Cd(NO_3)_2$ (BDH, England) and $Pb(NO_3)_2$ (BDH, England), to prepare 1 liter of concentrations 30, 40, 50 mg\ L of Cd and Pb. After that the plants were transfer to these solutions for about 21 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 plants dry sample was digested by 16ml of mixture from HNO_3 (64%) (BDH, England) and H_2O_2 (30%) (BDH, England) in ratio 6:2 and the mixture was put in the oven at 120 C° for two hours. After cooling, 10 ml of distilled water were added, and the mixture was filtered through filter papers (0.45µM,Whatman) and diluted to 50 ml (Senila *etal*., 2011). Flame Atomic Absorption Spectrophotometer type (VGP 2010 Buck, England) was used to measured the heavy metal concentrations in plants sample.

Result and Discussion

The results showed that the range of water temperature was 18-22 C° in glass container, average 20 C° as shown in the table 1. This results was agree with Raehetti *etal*., 2010 as he found the temperature in which the plant can grow was 18.1- 39 C°. This result also agrees with Turpin and Brotone 2000 as he declares that this plant can tolerate the cold weather in winter, but it is flowering and flourishing in the last summer.

The pH values were between 7.3-7.7, as average 7.5 for both elements (Cd, Pb) as showm in the table 1. The results are a same result achieved by Rai and Tripathi 2009; AL-Asadi *etal*., 2007; Mukhopadhuay and Dewanji 2005 on the same plant , becauce they found that the pH range 4.3-8.8.

The average of electrical conductivity for the experiment water was (720-770) µS cm^{-1} in average was 745 µS cm^{-1} as showm in the table 1. Ali

etal., 2011; Hussner & Losch 2005; Rachetti *etal*., 2010 reported similar findings in their studies on same plant.

Salinity value for experiment water was between 0.443-0.475 ppt , as average 0.459 ppt for both metals as shown in the table 1 . These results are agreed with observations reported by Ronald *etal*. 2010; Doering *etal*. 2001.

Table 1: Physiological and Chemical Tolerances of *Vallisneria* sp. In The Other Studies and This Study.

Parameter	Published data	References
Water temperature (°C)	18.1-39	Raehetti *etal*., 2010 ; Turpin and Brotone 2000 .
	18-22	This study
Ph	4.3-8.8	Rai and Tripathi 2009; AL-Asadi *etal*., 2007; Mukhopadhuay and Dewanji 2005.
	7.3-7.7	This study
Conductivity(µS cm^{-1})	104.17-1990	Ali *etal*., 2011; Hussner & losch 2005.
	720-770	This study
Salinity (ppt)	≥12 15	Ronald *etal*., 2010; Doering *etal*., 2001.
	0.443-0.475	This study

The concentrations of Pb and Cd in *Vallisneria* sp. were measured for plants taken directly from Diyala River. The results showed that the concentration of Pb higher than Cd, the average of the concentration of Pb was 0.55 mg/kg and the concentration of Cd was 0.52 mg/kg as shown in the table 2 and figure 1. These concentration are lower than other plant in the same area for example *Typha domingensis* has 0.97mg/kg pb (Alkam, 2002), *Ceratophylum demersum* has 0.77mg/kg Pb (Salman, 2006), *Phragmitis australis* has 1.03mg/kg Pb (Salman, 2006).

Found that there is increase in the concentration of Pb in libratory plants (5.1, 5.8, 6.3) mg/kg at average 5.73 mg/kg and in 19.1% accumulation percentage in concentration 30 mg/kg, and (18.1, 14.8, 18.9) mg/kg at average 17.26 mg/kg and in 43.15% accumulation percentage in concentration 40 mg/kg, and (26.1, 30.1, 28.2) mg/kg at average 28.13 mg/kg and in 56.26% accumulation percentage in concentration 50 mg/kg , as shown in the table 2 and figure 1.

The result also proved that the *Vallisneria* sp. could uptake high concentrations of Pb reach to 30.1mg/kg and it is higher than other plants for example *Lemna* sp. plant can uptake 1.03 mg/kg (Salman, 2006),

Nordostachys uptake 5 mg/kg, *Vitis vinifera* uptake 5.1 mg/kg (Pethkare *etal*., 2001).

It is found that the *Vallisneria* sp. uptake high concentration of Cd, (25.2, 27.1, 22.5)mg/kg in average 24.93 mg/kg and in 83.1% accumulation percentage in concentration 30 mg/kg and (33.7, 36.0, 30.3) mg/kg in average 33.33 mg/kg and in 83.32 % accumulation percentage in concentration 40 mg/kg and (46.1, 40.3, 52.0) mg/kg in average 46.13 mg/kg and in 92.26% accumulation percentage in concentration 50 mg/kg ,as shown in the table 2 and figure 1 , in spite of death the plant after 14 days in concentration 50 mg/kg Cd, the plant cannot tolerate this concentration, this plant have high uptake of Cd compare with other plant for example *Nordostachys jatamansi* and *Vitis vinifera* have uptake of cadmium 5 and 5.1 mg/kg respectively (Pethkare *etal*., 2001*), Vertic illata* have uptake 79.2 µg/g fresh weight , *C. demersum* have uptake 53.3 µg/g fresh weight(Al-mayah, Al-asadee, 2012).

Table 2: Accumulation of Lead and Cadmium in the *Vallisneria* sp. (In ppm) at the End of The Experiment .

Concentration / Element		Control	30 ppm	40ppm	50 ppm
Pb	Plant	0.55	5.73	17.26	28.13
	Accumulation Ratio		19.1%	43.15%	56.26%
Cd	Plant	0.52	24.93	33.33	46.1
	Accumulation Ratio		83.1%	83.32%	92.26%

Figure 1: Accumulation of Lead and Cadmium in the *Vallisneria* sp. (In ppm) at The End of The Experiment .

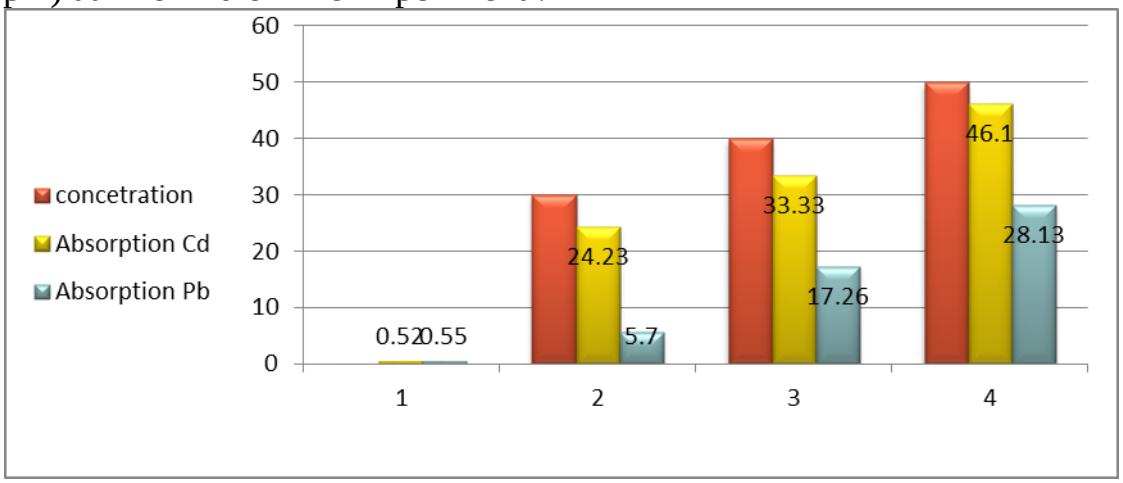
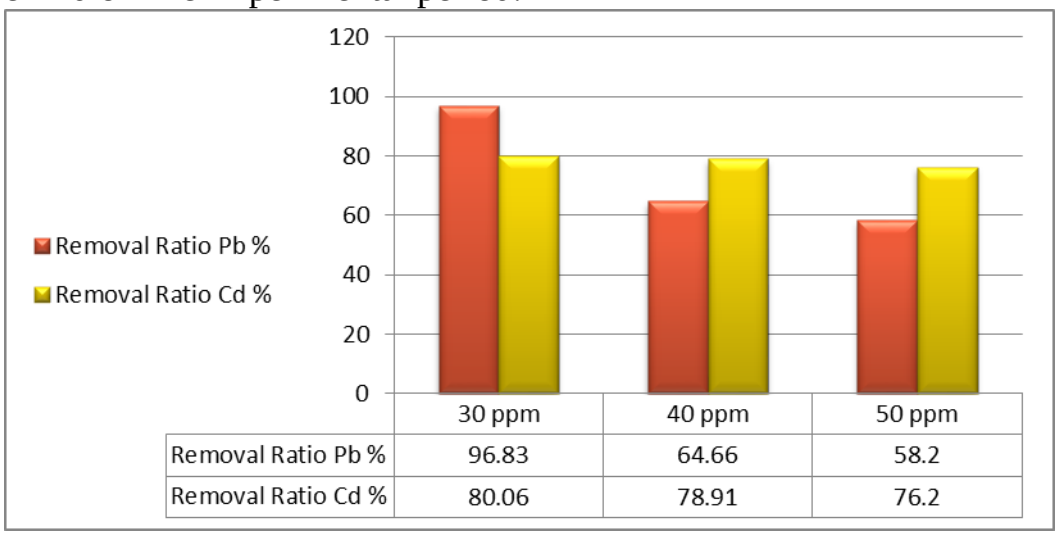


Figure 2: Removal Ratio of Lead and Cadmium in The Water (In ppm) at The End of The Experimental period.



	30 ppm	40 ppm	50 ppm
Removal Ratio Pb %	96.83	64.66	58.2
Removal Ratio Cd %	80.06	78.91	76.2

The *vallisneria* sp. Tolerated the concentration of 50 ppm of Pb it also tolerated a 40 ppm of Cd. The plant did not die at the concentration of 50 ppm of Pb , but it died at the concentration of 50 ppm of Cd , so the lethal concentration was 50 ppm for Cd and sub lethal was 40 ppm , but the sub lethal concentration was 50 ppm of Pb as shown in the figures (3, 4, 5, 6, 7, 8, 9) and table 3 .

There were no morphological changes on plant in the first day of experimental period , but it appeared after three days of experiment , and it continued till the end of the experiment, this result agree with other study were shown the *Vallisneria* sp. can decrease the concentration of the lead of water from 48 mg/L to 4.6 mg/L in the second day of the experiment period and from concentration 89 mg/L to 44.5 mg/L for cadmium in the same period (Dumitrescu, 2013) as shown in figure (3,4,5,6,7,8,9) and tables 3 and 4.

Table 3: Morphological Changes on Leaves and Roots in the Plant Through Experimental Period in Different Concentration of Pb .

Experimental Days	Concentration / Plant tissues	30ppm	40ppm	50ppm
1	Leaves	Not effected	Not effected	4
	Roots	Not effected	Not effected	Not effected
3	Leaves	Not effected	4	12
	Roots	Not effected	Not effected	Not effected
7	Leaves	5	12	29
	Roots	Not effected	3	4

Table 4: Morphological Changes on Leaves and Roots the Plant Through the Experimental Period in Different Concentration of Cd.

Expermental Days	Concentration / Plant tissues	30ppm	40ppm	50ppm
1	Leaves	Not effected	Not effected	Not effected
	Roots	Not effected	Not effected	Not effected
3	Leaves	Yellowing	Yellowing	Yellowing
	Roots	Not effected	Not effected	5
7	Leaves	5	10	12
	Roots	All the roots are withered	All the roots are withered	All the roots are withered

Figure 3:control

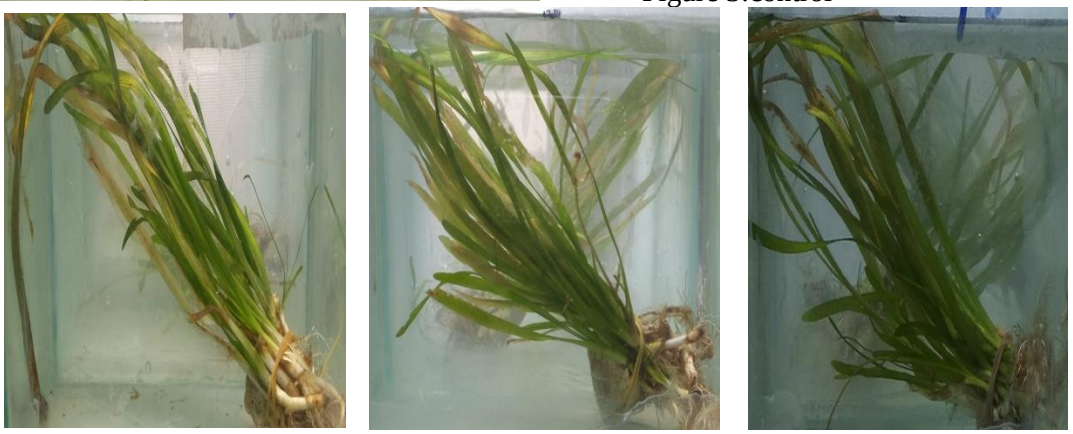


Figure 4: morphological changes of the Plant in Concentration 50,40,30 ppm of Lead Respectively in the 1 Day of the Experiment period .

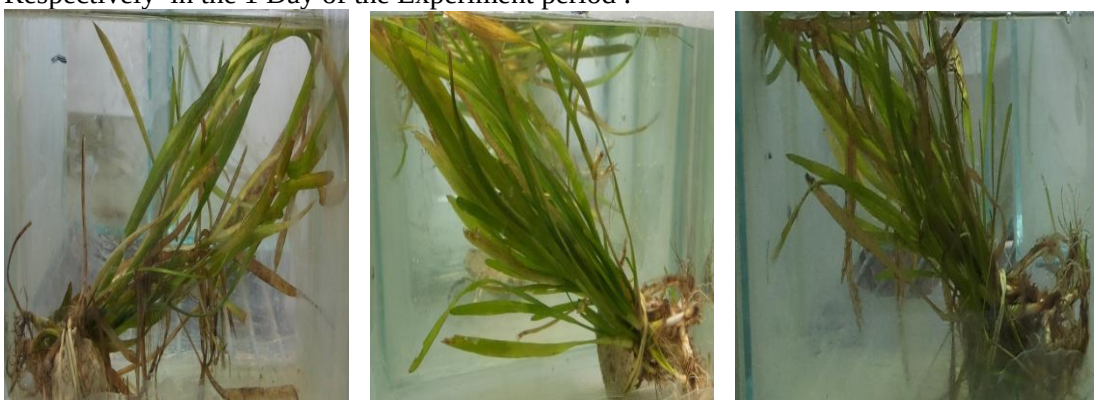


Figure 5 : Morphological Change of the Plant in Concentration 50,40,30 ppm of Lead Respectively in the 3 Day of the Experiment period .

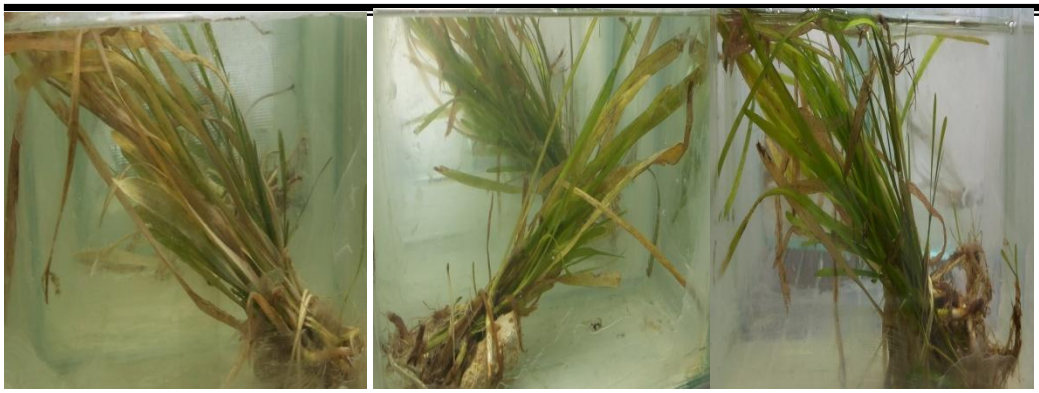


Figure 6 : Morphological Change of the Plant in Concentration 50,40,30 ppm of Lead Respectively in the End of the Experiment Period (30 Days).

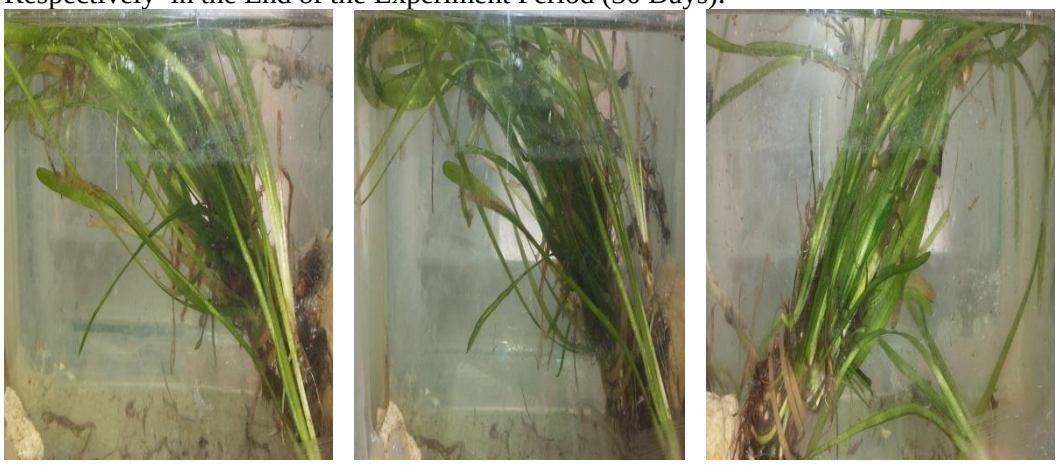


Figure 7: morphological changes of the Plant in Concentration 50,40,30 ppm of Cadmium Respectively in the 1 Day of the Experiment period .

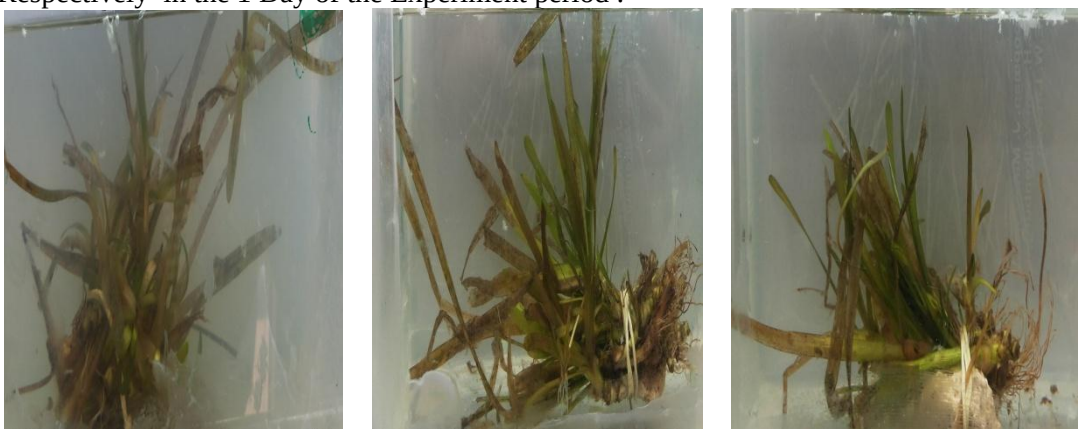


Figure 8: morphological changes of the Plant in Concentration 50,40,30 ppm of Cadmium Respectively in the 3 Day of the Experiment period .

Figure 9: Morphological Change of the Plant in Concentration 50,40,30 ppm of Cadmium Respectively in the End of the Experiment Period (30 Days).

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تحمل نبات الخويصة لتراكيز مختلفة من عنصري الرصاص والكاديوم

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الخلاصة

اجريت هذة الدراسة للتعرف على تحمل نبات الخويصة لتراكيز مختلفة من عنصري الرصاص والكادميوم , وقد استخدمت تراكيز 30, 40, 50 ملغم / لتر لكل عنصر و بمعدل ثلاث مكررات لكل تركيز ولمدة 30 يوم .

وجد ان النبات يتحمل تركيز 50 ملغم/ لتر من عنصر الرصاص, ويتحمل تركيز 40 ملغم / لتر من عنصر الكادميوم . في هذة التجربة وجدت فروق معنوية في قابلية ازالة النبات لكلا العنصرين في تراكيز 30, 40, 50 خلال مدة التجربة , ولم تسجل تغيرات مظهرية على النبات في الايام الثلاثة الاولى للتجربة ولكنها بدأت بالظهور بعد اليوم السابع للتجربة و استمرت حتى نهاية التجربة .

كانت اعلى نسبة ازالة لعنصر الرصاص كانت 97.66% في تركيز 30 ملغم / لتر واقل نسبة ازالة كانت 57.4% في تركيز 50 ملغم / لتر .اما الكادميوم كانت اعلى نسبة ازالة 82.68% في تركيز 30 ملغم / لتر واقل نسبة ازالة 74.0% تركيز 50 ملغم / لتر.

الكلمات المفتاحية :

نبات الخويصة , المعادن الثقيلة