Release Cumulative Power between (*Ceratophyllum demersum* L) and (*Hydrilla verticillata)* plant to Phytoremediation lead in the polluted water aquatic ecosystem

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Abstract

This study was conducted in the laboratory "to identify the ability of the plant *C. demersum* and *Hydrilla verticillata* to remove heavy metals from water which is lead element and the concentration of 20 mg.L^{-1} was used for a period of twenty-eight days for each plant, and plant efficiency removal of heavy metals from water was estimated as percentages of removal and the results showed that the plant concentrates the elements in its tissues in large quantities. And significant differences were found between the concentrations on the third day until the end of the twenty eighth day of the experiment for both plants at the level of the probability $P \leq 0.05$. The study indicated that the plant *Hydrilla verticillata* has more vital capacity compared to the plant *C. demersum* and the amount of the remaining element indicates that the plant Hydrilla verticillata has the ability to intake a larger amount of the element in its tissue more than *C. demers*um so the plant can be used in the biological treatment of polluted water with heavy metals as the plant ratios showed high removal percentage of the lead element, was between (79.8 -31.1)% for the concentrations studied during the days of the experiment respectively for the plant Hydrilla verticillata, while the removal ratios of the lead element ranged between (7.87 - 29.2%) for the concentrations studied respectively, after the twenty-eighth day of the experiment for the plant *C. demersum* the concentrations of the elements were measured after (3, 7, 14, 21 , 28) days of the experiment for each concentration. As noticed during the experiment that the leaves of the plant *C. demersum* began wilting faster at the concentration of 20 mg $L^{-1.}$ compared to the plant *Hydrilla verticillata*.

Introduction

The environmental pollution is defined what the human adds by his various activities from materials and compounds to environment which negatively effects the quality of the environment (Castro and Huber, 1992). Any disturbance in the balance of any environmental system is considered one of the pollution types that led to environmental pollution (Cock et al., 2000).

The focus has been on water-pollution particularly because it is the most dangerous type of environmental pollution as the water covers about71% of the earth and 98% is in a liquid state. The studies refer that 97% of the water in the world is not suitable for human use because of its salinity and the remaining of its 3% is almost fresh water but it is often not available because a large part of it is found either as ice or stored as groundwater (Reddy, 2012). A study published that 80% of world population is exposed to the threat of water scarcity as a result of population growth and industrial renaissance that produces a lot of pollutants (Vorosmarty, 2010).The final fate of air and soil pollutants are into the water bodies whether directly or indirectly and water forms a large part of the structure of various living cells and any vital process can only take place in an aqueous medium (AL-WAAILY, 2008). So the aim of the experiment was a comparison between the two plants, which are among the most common plants in Iraqi waters and also to find out the efficiency of vegetarians in bioremediation.

World Health Organization (WHO) and the United State Environmental Protection Agency (USEPA) have shown an interest in the diseases caused by water-pollution and controlling them, and gave a special importance to the studies of public health (Al-Joburi, 2005).

The aquatic environment is exposed to many pollutants such as agricultural fertilizers, heavy elements, pesticides, thermal and radiation pollution. Heavy elements are the most important pollutants as large amounts of them are released into the environment from industrial waste and sewage causing many environmental problems and some of these elements are Lead, cadmium, copper, nickel, chrome, silver, mercury and vanadium,etc which are in-organic pollutants in the environment. The zinc element is one of the basic elements in plants, and animals, growth as it is one of the cell components, especially in the nucleus. The tissues rich in zinc are adrenergic glands, skin, and some parts of the brain, pancreas, eyes and placenta (Neis, 1999).

The water-pollution due to industrial and urban waste as well as the presence of organic and in-organic elements are considered one of the main

causes of environmental pollution, so it is important to treat it to reduce organic compounds that are biodegradable before throwing it into the water resources (Wang *et al.*, 2004). The heavy elements enters the water bodies in many ways either by dry deposition or washed by rainwater (air wash or wet deposition) as well as well as urban, industrial and agricultural wastes, or shifts by sedimentation in water bodies in to plants through root absorption or deposition from the air (Al-Omar, 2000).

The subject of the accumulation of heavy elements in plants got significant interest from many researchers because the plants have the ability to remove the heavy elements from industrial wastes (Zahed *et al*., 2010).

The researches proved that plants have the ability to adsorb heavy elements and there might be a few differences between these plants in the ability of adsorbing certain minerals than other kinds (Mudgle *et al*., 2010). The use of plants in industrial sewage treatments is cheap compared to instruments and chemicals that are used for this purpose (Mojiri, 2012).

The idea of using plants that are able to absorb and accumulate the pollutants is called phytoremediation ,which is a form of Bioremediation that means using of certain plants having the ability to reduce pollution levels by the removal or analysis of various pollutants (Rai,Singhal and 2006) The use of plants in treatment is one of the important techniques in removal of the pollutants because of the genetic, chemical and physiological properties of some plants that have no adverse effects on the environment and are not expensive , unlike the chemical and physical methods that are harmful to the environment when it is used in treatment of polluted water (Turan and Esringu, 2007: Singh et al , 2009 : Saier and Trevors ,2010: Revathi et al , 2011)

Iraq is one of the few countries that has two freshwater rivers passing through its lands, also it is one of the agricultural and industrial countries that uses various types of chemical compounds whether in the form of pesticide, agricultural fertilizers or industrial raw materials that most of it enters the river which caused major pollution cases whether bacterial or chemical affecting human health that depends on the water of these two rivers (AL-Saadi and Maulood,1991). Aquatic plants play an important role in the wetlands, marshes land, rivers and in the protection of freshwater. It has been focused on this role by a lot of searchers and emphasized on its important role of the recovery of rivers and marshes (UNEP, 2004).

The aquatic plants have the ability to accumulate the necessary and unnecessary elements, this ability was used in the removal of the metals from the aquatic environment. (Kara et al., 2003)

C. demersum is one of the aquatic submersible group plants, they are dark green plants, and the length of a single plant ranges from 20-100 cm. with complex bilateral leaves once or twice their length ranges from 1-2.5 cm. Leaves are thickly clustered at the end of the branches of the plant to give them the appearance like the tip of the tail (the tail of a cat), and they are perennial plants with newly formed side branches. The flowers aren't clear to the eye (Saup, 2003). The plants have the ability to accumulate the heavy elements in their tissues which make them a good vital evidence of water-pollution therefore they were used to repair high polluted aquatic systems with heavy materials (Dhir et al., 2005).

Hydrilla verticillata is one of a widespread aquatic plants in different parts of the world, it has invaded large areas of the world and controlled a lot of different ecosystems because of having the ability to survive in the aquatic environment that allows it to become a strong competitor in environments in which it grows .(Cook., 1982). *Hydrilla verticillata* grows down to the water surface forming a dense mat and where noticed its high efficiency of heavy metal absorption by roots to the rest of submerged plants (Singh et al., 2012).

Many botanists were interested in this kind of plants for having many important features for the environment if they were used in a correct way, and under controlled circumstances, therefor many researchers started studying its environmental features (Nethernland, 1997). It is considered one of the important submerged plants that proved its efficiency in many fields such as aquatic environmental treatments from different kinds of pollutants whether toxic chemical compounds or heavy metals and used to rehabilite deteriorating environments caused by floods and various environmental disasters (Meetu, 1998).

Materials and Methods:

The plant *C. demersum* and *Hydrila verticillata* were collected from the water of Baghdad University Channel in Al-Jadriyah Complex. The plants were transferred to the lab and washed very well and were put in glass tanks (25×35 cm width and 30 cm height) ,and 10 liters of water-free from clor (left for 24 hours and exposed to sunlight) were added to the tanks . 35 gm. from the plant were used in each tank and the individuals had approximate weights and the tanks were put in a System prepared for the development of the plants in the laboratory ;it is a wooden box provided with doors prepared to provide the plants with its same natural conditions

from the intensity of light and ventilation by using Fans and air ventilators , and supplying it with dissolved oxygen by using air compressors that are used in fish aquariums and providing electricity for 24 hours (three light bulbs 40 watts) and six tanks were used for each concentration as well as doing the test for the periods of (3,7,14,21,28).

Preparing solutions for heavy elements:

Pb salt was used which is represented with the chemical formula $Pb(NO_3)_2$. The stock of the element was prepared by dissolving (0.7996g) of Lead nitrate in (100ml) of Distilled water with continuous mixing by a magnetic stirrer for 30 minutes then the volume was completed to 1 liter.

Estimating the condensations of the lead:

A required dilution to the elements was made for the heavy elements and added into the tanks, and young plants were chosen to be put in the tanks after measuring the concentration of the heavy elements in the plants by making the required steps of measuring by using Flame Atomic Absorption Spectrophotometer depending on (Haswell, 1991).

The accumulation of metal of elements in plants

A quantity of plants were dried in an oven of 70 Celsius for 48 hours, after that the samples were crushed, and 0.5gm was taken from the dry ingredients in a baker and digestion operations were made on them by using Nitric acid, Sulfuric acid, Berroclorett acid $HCIO_4$ with ratio 2:1:1 respectively for (2 -4) hours with the consideration of covering the samples and completing the volume to 50ml with Distilled water (APHA, 1998) and the concentrations of the lead was estimated by using the flame atomic absorption spectrophotometer.

The statistical analysis

Statistical analysis system (SAS), (2010) was used in analyzing the data to study the effect of the different elements (concentration and time) in the studied percentages; the significant differences were compared between the averages by testing the less significant difference (LSD).

The results and Discussion:

The plant hydrilla showed a high efficiency in the removal of the lead from the aqueous medium; it removed 31.1% of the lead from the aqueous medium in the third day at the concentration 20mg/liter $^{-1}$ and after seven days the percentage of removal of the lead reached 53%, it was noticed that the rate of removal increased as the days went by, after 14 days it reached 70.9%, and after 21 days it became 79.8% and after 28 days it reached to 83.7%.

The lead was removed and what left in the water in the third day was 68.7%, in the seventh day the remaining lead was 46.0%, in day 14 was left

28.7%, in day 21 remained 19.8%, in the day 28 the concentration rate decreased from the used concentration as the remaining lead was 16.1%, also the reason of decreasing was that the plants were forming plant compounds called chelating agents while absorbing the heavy metals that links and surrounds the heavy elements and moves them to cavities inside the plant tissues (Suresh and Ravishankar, 2004).

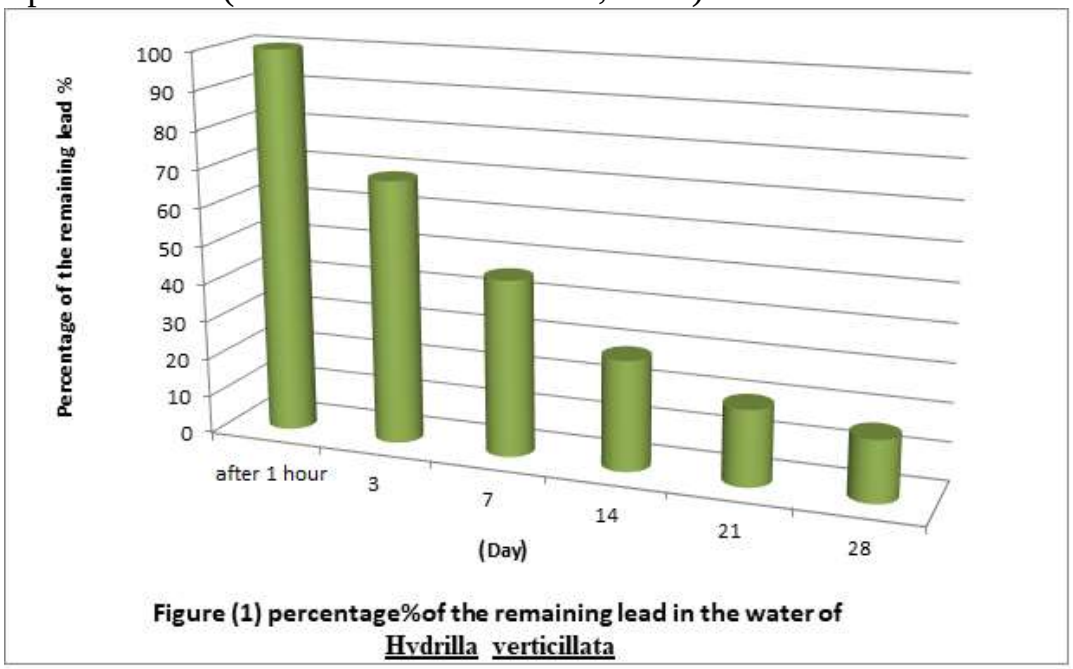

Figure (1) percentage%of the remaining lead in the water of Hydrilla verticillata

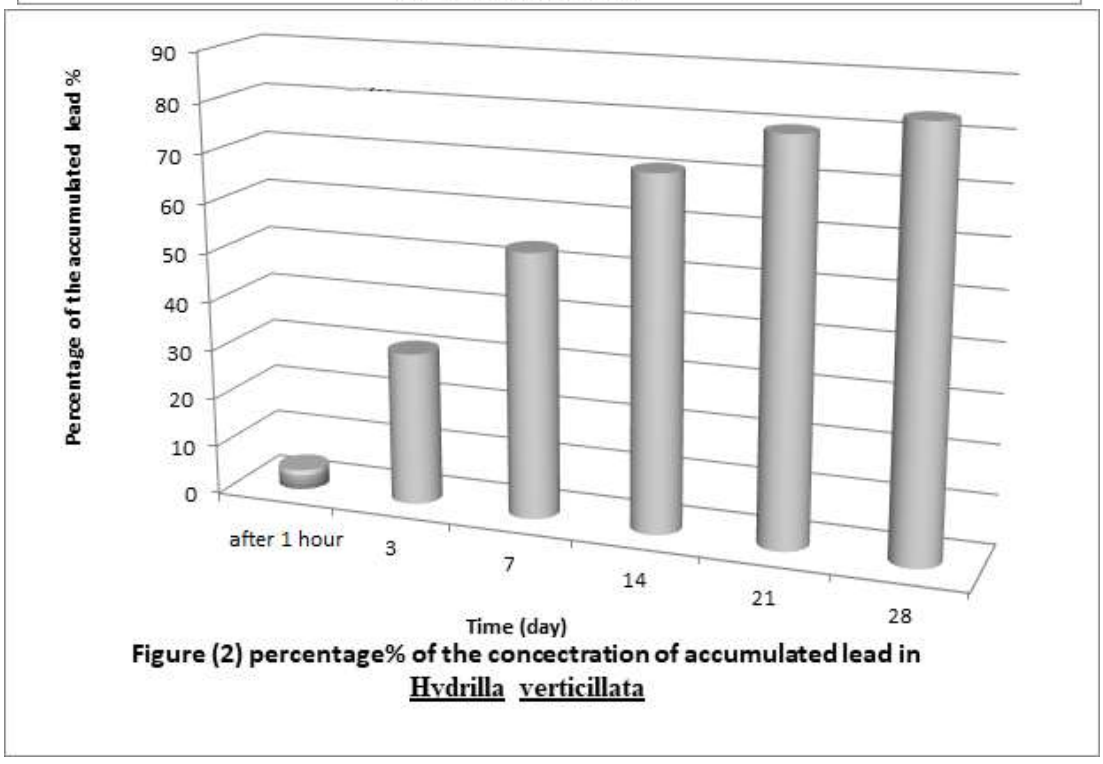

Figure (2) percentage% of the concectration of accumulated lead in Hydrilla verticillata

The results of the statistical analysis and less significant difference (LSD) on the level of possibility $p \leq 0.01$, $p \leq 0.05$ referred to the existence of significant effect of the elements involved in the study (time and concentration) at the level of absorbing the dissolved lead in the water by the plant.

The results showed significant differences at the level $p \leq 0.05$ for the concentration (20mg)/liter $^{-1}$ in the third day of the experiment in the two plants that were treated with lead , also significant differences were found between the concentrations for each day of the experiment, as shown from the experiment the gradual ascending removal ,and it was noticed there are significant differences in time and concentration of the plants ability to absorb the lead and the effect of time was clear in the absorbing indicator, as we notice the increase in the lead concentration in the plant as time of the experiment passes as shown in figure(1). The results of the statistical analysis showed significant differences at the level $p \leq 0.05$ for the concentration used in the experiment of the two plants treated by lead, also there were significant differences for each day of the experiment, it was shown from the experiment the gradual removal of the element through the days of the experiment and it was also noticed there are significant differences between time and concentration in the ability of the plants to absorb lead metal and the effect of time was obvious in the absorbing indicator; we notice the increase in the concentration of the lead in the plant with the progress in time of the experience. The highest efficiency of the plant to absorb the contaminants in the water including lead was 28 days.

The reason might be that the plant has the ability to remove the element with high efficiency on the medium and low concentrations, with the lack of this effect on the high concentrations, that may be due to the linkage of lead ions with other materials inside the cell, which transforms it in to other inactive forms or due to the motivation of the lead element to produce Metallothionein from the plant which has been mentioned by (Vymazal, 1990).

While the high concentration of lead causes the work stoppage of the enzymes and the production of the proteins when the element reaches the high concentrations (Memon, 2001), Abbas et al. (2012) proved that the increase of pollutants leads to the decrease of accumulation in the structure of the plant due to the inhibition of the enzymes.

The study shows that the higher the concentration of lead in experimental tank water, the greater its concentration is in the tissues of plants and during the duration of the experiment but within certain limits and this coincides with Al-Bayati (2008) in her study about the role of L.

Eiehhorina crassipes in treatment of sewage in a cretin environmental system, conclusions also coincides in the current study with Al-Saad (1994) and Algum (2002) about the ability of aquatic plants such as C.demersum, Typhi domingensis and Myrophyiium verticatum,as plants vary in their ability to absorb heavy metals according to the quantity of these elements in the water and to the ability of aquatic plants to concentrate these elements compared with its initial Concentration (Algum, 2002).

Also *C. demersum* showed high ability to remove lead but less efficiently than *Hydrilla* as it removed 29.2% of lead from the aqueous medium on the third day at a concentration of 20 $mg.L^{-1}$, and removed 51.1% of the metal after seven days, and it was noticed the increasing rate of removal by days, and respectively after fourteen days the rate of removal was (77.8) % and after twenty one days it was (79.8) % and after twenty eight days it was 81.9%. The remaining lead in the treated water for the third day was 70.5 %, on the seventh day the remaining was 48.4%, on the fourth day it was 29.9 %, on the twenty first day it was 22.1 % and on the twenty eighth day the remaining of lead was 18.0 %.

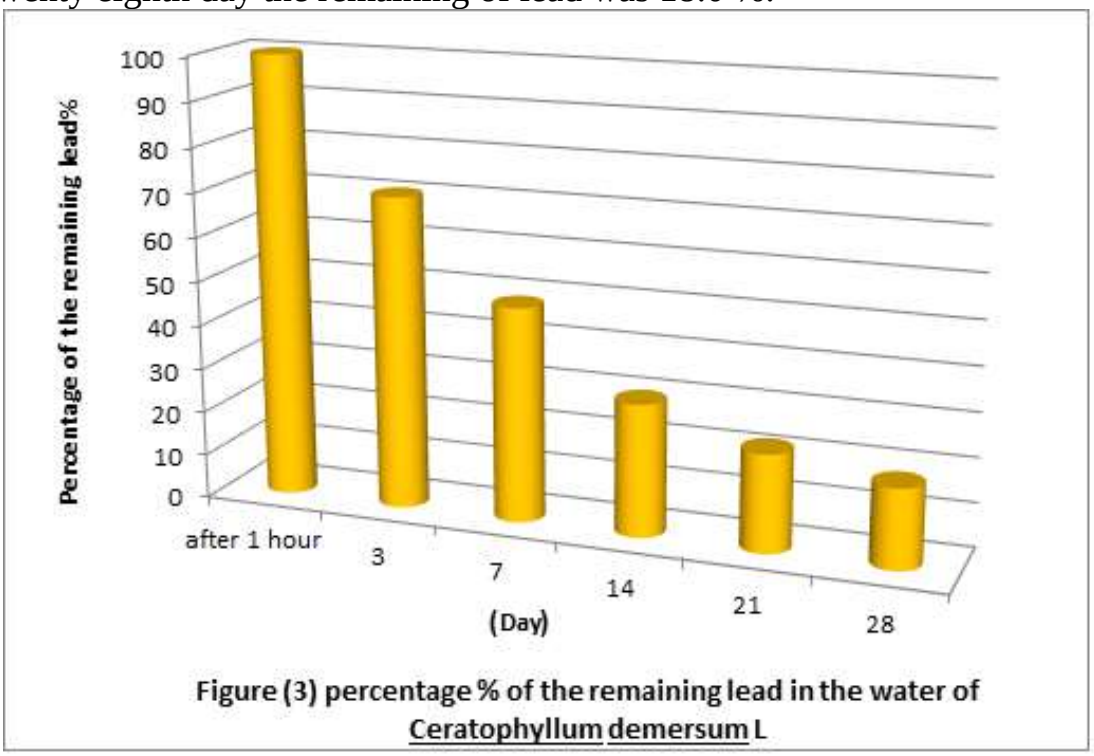

Figure (3) percentage % of the remaining lead in the water of Ceratophyllum demersum L

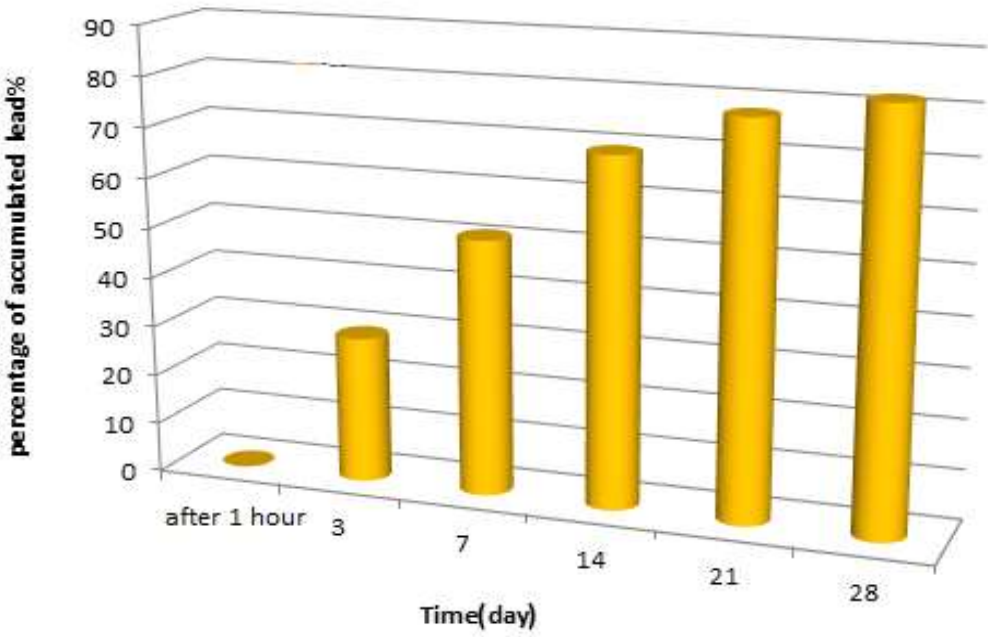

Figure (4) percentage% of the concentration of accumulated lead in Ceratophyllum demersum L

The aim of the experiment was comparison between the two plants, which are among the most common plants in Iraqi waters and also to find out the efficiency of the two plants in bioremediation.

It was founded that plant *Hydrilla* is more efficient than the plant *C. demersum* it might be due to that the *Hydrilla* leaves are characterized by a wider surface area than the plant *C. demersum* leaves also the plant *Hydrilla* has roots which are missing in *C. demersum* and thereby increased the efficiency of the plant absorbance and this coincides with (Guo-X, 2010).

And these results coincide with Mojiri (2013) when he studied the plant *Typha domingensis* and exposing the plant to six elements including lead and the removal percentage was gradual with time, the plant removed lead within 24 hours later from being exposed to 10 liters of contaminated water with lead metal from 0.76 $mg.kg^{-1}$ to 0.87 $mg.kg^{-1}$ within 48 hours later and 1.1 $mg.kg^{-1}$ within 72 hours later, he also mentioned the increasing types of plants that have the ability of purification led to the increasing speed of absorption of the heavy metals from the contaminated water. And also coincides with the study of Singh (2012). During his study of the removal of heavy metal pollution by using a number of plants and the efficiency of these plants to remove it, he founded after a week that the plant *Hydrilla sp* absorbed 98% of the lead metal, but *Lemna* sp absorbed 90% of the lead element after a week.

The removal of the element lead by the plant *C. demersum* and *Hydrilla* might be due to the presence of negatively charged ions on the cell wall of the plant which uptakes the lead positive charged ions from the tanks water and this conclusion coincides with (Abo Al-Dhahi. 1989) and (Sekabira *et al.*, 2010). He confirmed the existence of negative charges on the cell wall back to the carboxylic groups of pectic acid so negative charges attract positive charges to it and prevent it from going out again to the medium or the reason may be due to the electrical voltage difference hypothesis.

Conclusions

- The effectiveness of *Hydrilla* plant was more efficient than *Ceraophyllum* plant in the removal of the lead element.
- Ability to use plants in the biogenic treatment of the water contaminated with heavy metals in Iraq especially due to dense presence of plants in Iraqi water

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الخلاصـــــــة

أجريت هذه الدراسة مختبريا" للتعرف على قدرة نبات الشمبلان, *C. demersum* ونبات الهيدرلا*Hydrilla verticillata*على إزالة بعض العناصر الثقيلة من المياه وهوعنصرالرصاص وقد استعملت تركيز (20) ملغم لتر$^{-1}$ ، ولمدة ثمانية وعشرين يوماً لكل نبات، وقدرت كفاءة النبات في إزالة العناصر الثقيلة من المياه كنسبٍ مئوية للإزالة . بينت النتائج أن النبات يقومُ بتركيز العناصر في أنسجته بكميات كبيرة. ووجدت فروق معنوية بين تركيز العنصر لكلا النباتين عند مستوى احتمالية $P \leq 0.05$ خلال مدة التجربة، وسجلت فروق معنوية بين التراكيز في اليوم الثالث وحتى نهاية اليوم الثامن والعشرين من التجربة.وبينت التجربه ان لنبات الهيدرلا قدره حيويه اكثر مقارنه بنبات الشمبلان ومن خلال النتائج وكمية العنصر المتبقي يدل ان نبات الهيدرلا له قدرة على استيعاب كمية اكثر بانسجته من نبات الشمبلان . وبذلك يمكنُ استعمال النبات في المعالجة الإحيائية للمياه الملوثة بالعناصر ألثقيلة إذ أظهر النبات نسب إزالة مئوية مرتفعة لعنصرالرصاص وكانت بين (79.8 -31.1) % للتراكيز المدروسة خلال فترة التجربة على التوالي هذا بالنسبه لنبات الهيدرلا، بينما تراوحت نسب إزالة عنصر الرصاص بين (77.8 -29.2) %للتراكيز المدروسة على التوالي بعد مرور اليوم الثامن والعشرين من التجربة لنبات الشمبلان، وتم قياس تراكيز العناصر بعد(3 و 7 و 14 و 21 و 28) يوماً من التجربة لكل تركيز .كما تمت ملاحظة بدء أوراق النبات بالذبول عند المعاملة مع عنصر الرصاص عند التركيز20 ملغم لتر$^{-1}$ لنبات الشمبلان اسرع مقارنه بنبات الهيدرلا.