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HEAVY METALS EVALUATION BY ATOMIC SPECTROSCOPY FOR DIFFERENT PARTS OF WATER HYACINTH (*EICHHORNIA CRASSIPES*) PLANTS : BANKS OF TIGRIS RIVER AND AL-ZUHAIRAT VILLAGE SITES

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ABSTRACT : The current paper deals with studying the ability of the water hyacinth to adsorb heavy metals from polluted water and detecting the adsorbed amount of these metals in different parts of the plant. The studied samples included the water hyacinth herb growing in two regions on the Diyala Governorate; the first region was the east bank of Tigris river at Al- Al-Rashdiya sub-district, southern west of Baqubah and the other region was the tributaries of Al-Zuhairat village in the sub-district of Abu-Sayda, northern east of Baqubah. The obtained plants were cutted very carefully and the parts of the water hyacinth herb extracted from the two regions were isolated, which are the roots, leaves, stems, stolons and the rafts. Determination of heavy metals using the Atomic Absorption Spectrophotometer (AAS) in the different parts of the water hyacinth was done by analyzing the plant parts in addition to the tendency of the river near and far from the herb to identify the ability of this herb to take toxic metals from the water. The results of the analysis showed that the water hyacinth plant has a high ability to adsorb heavy metals from water and that the specifications of the water near the herb are in conformity with Iraqi and international specifications. Thus, this herb can be one of the materials to filter the water contaminated with these polluting and toxic metals and use it in a beneficial way instead of getting rid of it because of the great damage it causes to the water eco-systems accessing to Zero Residues Level (ZRL).

Key words : Heavy metals, atomic absorption spectroscopy, eater hyacinth, Tigris' banks and ZRL.

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INTRODUCTION

Pollution is defined as any chemical or qualitative change in the biological and abiotic environmental components, if this change is outside the range of fluctuations for any of these components so that it leads to an imbalance of nature (Ali *et al*, 2020). Pollution is closely related to the various environmental problems that the environment suffers from, and pollutants are defined as any solid, liquid or gaseous substances and any microorganisms or particles that lead to an increase or decrease in the natural field of any of the environmental components (Abbas *et al*, 2013). In general, the Earth's ecosystem suffers from several problems since human existence, including global warming or greenhouse effect, which is the rise in temperatures on the surface of the Earth due to an increase in the quantities of greenhouse gases emitted to the atmosphere, including carbon dioxide which is considered the main culprit (Abbas *et al*, 2020), loss of bio-diversity, such as desertification and change in terrestrial and marine ecosystems (Fao, 2020) and transboundary Pollution which refers to the impact of polluted air on countries other than the country in which it originated (Abas *et al*, 2019). This pollution causes many environmental problems, such as pollution of water bodies, formation of acid rain, trade of hazardous waste around the world, depletion of the ozone layer that protects the globe from the harmful effects of the sun's ultraviolet rays, depletion of forests, increase in population, and soil

degradation and erosion (epa.gov, 2020). Among the examples of pollution that must be stopped and the necessary quick and efficient solutions to be found is pollution of water sources with various types of pollutants. Water is heavily polluted because of surface runoff from different lands to different water sources, carrying with it a large percentage of phosphorous and nitrogen as it passes through residential areas and agricultural lands (Ghulam *et al*, 2020). The surface water is also polluted due to many other human activities, such as: oil leakage, and the accumulation of plastic waste and industrial operations, mining operations and the resulting toxic water flow in some cases (Ali *et al*, 2021). In addition to the bioaccumulation of some persistent chemicals, this type of pollution results in many negative health and environmental effects, and leads to a significant deterioration of the marine environment (Alalwan *et al*, 2020). Many countries of the world are facing a problem in the lack of fresh drinking water because of many industrial and agricultural activities that represent the backbone of the economy for a person in this life, as many materials are used in some activities that contain polluting materials for the environment, including heavy metals (Maddodi *et al*, 2020). These metals are included in all agricultural, commercial, industrial, recreational and military activities and in all aspects of daily life (Abbas *et al*, 2020). Pollution in them leads to environmental and health problems as a result of their toxic effects on living organisms and various ecosystems in general and water bodies in particular (worldwildlife.org, 2020). On the other hand, water resources suffer from continuous depletion because of the plants that grow in them and multiply in a frightening way and absorb large quantities of water, which is an important source for drinking and agriculture alike, and among those plants is water hyacinth herb that has a bright look and a dangerous effect (Ali *et al*, 2020). Each flower absorbs between four to five liters of water daily and is characterized by its rapid growth, reproduction and spread, as each plant can multiply 11 times a day, which threatens the deterioration of the water environment and the increase in soil salinity and other harmful effects as a result of its ability to absorb heavy metals, as confirmed by previous studies (Tobias *et al*, 2019). From this, it is noticed that the environmental problems facing water bodies are many, varied and great and require real efforts, organized plans and sound management to reach effective solutions with the least possible losses and the lowest costs (Ezama *et al*, 2019). One of these solutions is to invest in the Nile flower plant and convert it into an adsorbent material to absorb heavy metals and pollutants from polluted water bodies and this is the main goal of this study (Mishra *et al*, 2017). The goal of the current paper is to reveal the ability of the different parts of water hyacinth herb to absorb heavy metals from the water of the tributaries of Diyala Governorate, Iraq and thus determine the possibility of using them as a natural filter for the water of rivers and water bodies as a simple method for remediation reaching to zero residues level (ZRL) concept. The samples were obtained from two locations were chosen, namely the east bank of Tigris river at Al-Rashdiya sub-district and the village of Al-Zahirat in the Abu-Sayda sub-district as cases study.

Water hyacinth herb

It is a perennial herbaceous plant, broadleaf and from a floating jungle of water floating on the surface of the water by rafts spread on the surface of the water. The stems of the plant are usually short floating but may be rooted in the mud when the depth of the water is shallow (Pellegrini *et al*, 2018). The roots may be rhizome or outstretched, and the roots are formed on the nodes. The leaves are grouped in the form of a rosette and they have very swollen spongy teeth (Gopal, 1987). The length of the herb reaches 30 cm, and the blade of the leaf is round, kidney-shaped, 4-12 cm wide and 4-16 cm long, and works as a sail in the wind (Chu *et al*, 2006). The flower is in the form of a spike, 4-15 cm long, and it is made up of several flowers 2-8 and may sometimes reach 40 flowers (Pierret *et al*, 2016). The color of the flowers is bluish-purple or white and attractive, which helps spread and reproduce as a decorative plant (Yan *et al*, 2017). The fruit is in the form of a membrane box with three chambers that open, spreading the seeds that may number up to 50 seeds per fruit (Arguelles, 2019). The water hyacinth is considered one of the water very dangerous herb and affecting water resources in many countries of the world (Worku *et al*, 2018). The original home of this plant is the Amazon river basin in Brazil - South America, from which it has spread to more than 70 countries of the world, including Iraq (nhm.uobaghdad.edu.iq, 2020). This plant was put in to Iraq in the mid-eighties from the last century as an ornamental plant and it spread in the beginning of the matter in the Army Channel, eastern of Baghdad and no serious efforts were made to get rid of it early, but until recently, it was considered one of the ornamental plants displayed in the streets and nurseries (Ayad, 2015). This plant has spread in the Diyala river and some sites in the Tigris River and also in Wasit Governorate in the Kut dam and in the Numaniya district, where residents of some areas carried out propagation operations for this plant in the swamps near residential homes because they believed that it absorbs water and

reduces the presence of mosquitoes in the water and has proven its presence in Al Gharraf And Hussainiyah, Dujaila and others, many streams, canals and the Tigris river basin on the road leading to the tourist island of Baghdad near the Muthanna Bridge and also in the Qadisiyah governorate, Karbala, Babil, Maysan and the dam of Samarra (msc.uobasrah.edu.iq, 2017). This plant reproduces in two ways, which are seed and budding, the main reproduction and growth period of this plant is the most famous high temperature (Cho *et al*, 2012). The general estimated information confirms that it spreads and multiplies very quickly, as it is one of the most productive plants on earth, as it doubles its existing numbers within a period of (5-18) days (Phiri *et al*, 2001). One of the dangers of this plant is that it affects the quality of water, reduces its oxygen content, and creates an environment unfit for other beneficial biological species and encourages the growth of other harmful organisms (Abdel Shafy *et al*, 2016). This plant consumes large amounts of water, as it is estimated that one plant consumes 4 liters of water/day. It impedes navigation and river flow by creating dense surfaces of interlocking vegetation. It causes great stress on floating bridges erected on rivers, causing them to displace and break down. Sunlight is blocked from reaching other organisms that live in the water, especially phytoplankton, which are the main base of the ecosystem and the main food for zooplankton and fish, causing an imbalance in the delicate balance of the food chain (Al.Garaawy, 2012). There are several ways to get rid of this plant, which are chemical, mechanical, manual and biological methods (Andika *et al*, 2016). On the other hand, this plant is used in the disposal of water-polluting metals, in preparing biofuels, as well as fertilizer for soil, animal feed, and in the manufacture of paper (Zhou *et al*, 2020).

Experimental Procedure

Samples of the water hyacinth herb were obtained from the east bank of Tigris River at Al-Rashdiya sub-district, southern west of Baqubah and also from one of the tributaries of Al-Zahirat village in the Abu Saida sub-district, northern east of Baqubah. The obtained plants were carefully cut and their vegetative parts were extracted to analyze their ability to adsorb heavy metals. The tributaries samples of the Al-Zuhairat village and banks of Al-Rashdiya were distinguished by that they consist of roots, the stem, the stolons, leaves and rafts. The amount of heavy metals in the different parts of the plant was determined via atomic absorption spectrophotometer analysis. Therefore, the sample was prepared for examination by burning it in the oven at 400°C and then digesting the charred samples with concentrated nitric acid in a ratio of (10:1) (weight of burned water hyacinth : volume of nitric acid) for a period of 3 hours and the process was repeated twice to ensure that the samples were fully digested. After that, the samples were mixed with an excess of distilled water and heated to a boil to ensure that any excess nitric acid was removed. Thus, the samples are ready to be tested using atomic absorption spectroscopy. Also, samples of water samples near the place of plant growth were examined to find out the concentration of heavy metals present in it.

RESULTS AND DISCUSSION

Samples obtained from the east bank of Tigris River at Al-Rashdiya sub-district, southern west of Baqubah, and tributaries of Al-Zuhairat village in Abu-Sayda sub-district, northern east of Baqubah, were examined using an atomic absorption spectrometer. The ability of the water hyacinth herb plant to absorb six types of heavy metals, *i.e.* lead (Pb), manganese (Mn), cobalt (Co), chromium (Cr), iron (Fe) and zinc (Zn) which represent the most common heavy metals, used in different life activities. The results of the samples' analysis using an AAS device confirmed that the water hyacinth plant has a large capacity and high efficiency to adsorb heavy metals studied in this study with high removal efficiencies. The results obtained from the analysis of the plant parts samples from the tributaries of the village of Al-Zuhairat showed that the roots absorbed iron (Fe), zinc (Zn), manganese (Mn), and chromium (Cr) with concentrations of 20.72, 1.24, 13.2, 0.34 mg/l, respectively, while the roots of Al-Rashdiya absorbed lead (Pb), manganese (Mn), and zinc (Zn) with concentrations of (3.75, 3.08 and 1.08) mg/l, respectively which are higher than the rest of the other plant parts. The reason for this result is that the roots are in direct contact with the contaminated water more than the rest of the plant parts, and it is the one that delivers the water with its nutrients to all the other parts, in addition to its surface area being higher than the rest of the parts, because the water hyacinth plant is characterized by the length of its roots that extend deeply within water bodies. The rest parts of the Al-Zuhairat plants, the raft and the leaves were the most part adsorbed of magnesium and cobalt metals with concentrations reaching 4.3 and 0.82 mg/l, respectively, while lead concentrated in the stem at a concentration of 0.38 mg/l. However the rafts of Al-Rashdiya plants show higher absorption of iron (Fe) with concentration of 10.22 mg/l while the concentrations of cobalt (Co) and chromium (Cr) were 0.291 and 0.071 mg/l respectively and concentrated in the stem. This result can be explained by the density of these metals (magnesium and cobalt),

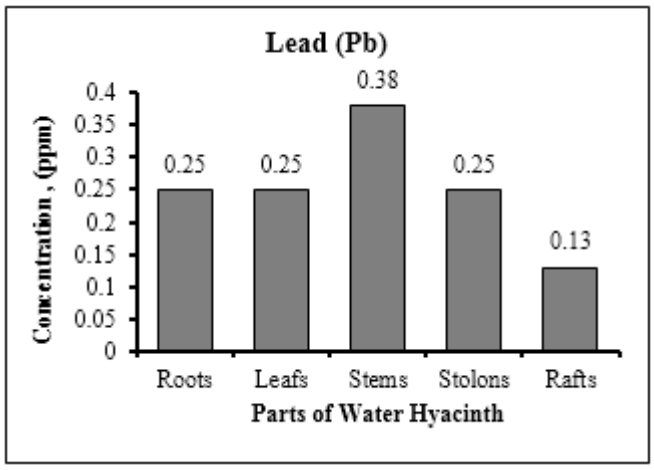

Fig. 1 : Lead Distribution on the Prats of Water Hyacinth plants (Al-Zuhairat Village).

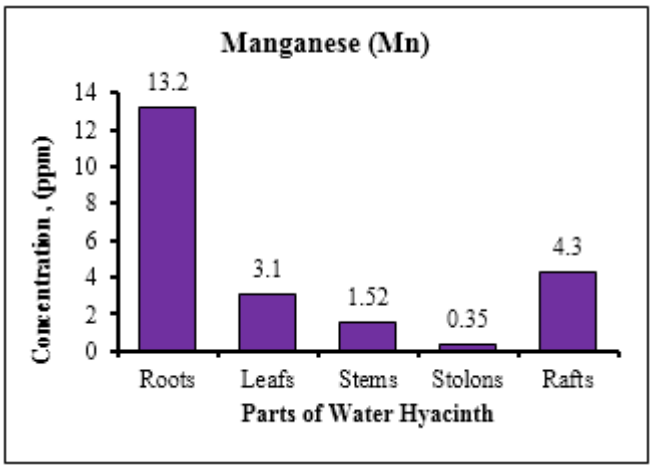

Fig. 2 : Manganese distribution on the Prats of Water Hyacinth plants (Al-Zuhairat Village).

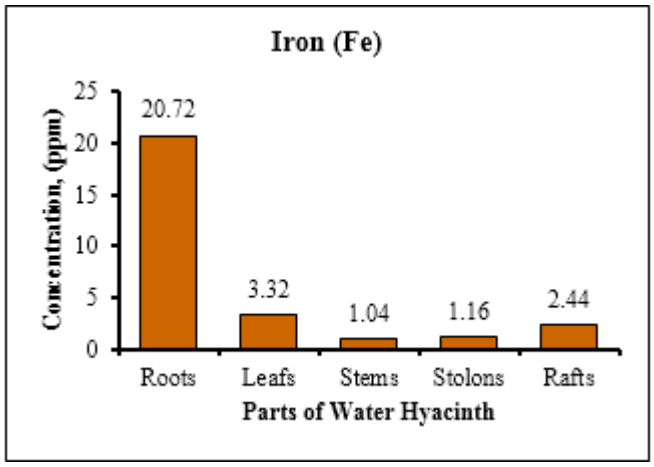

Fig. 3 : Iron distribution on the Prats of Water Hyacinth plants (Al-Zuhairat village).

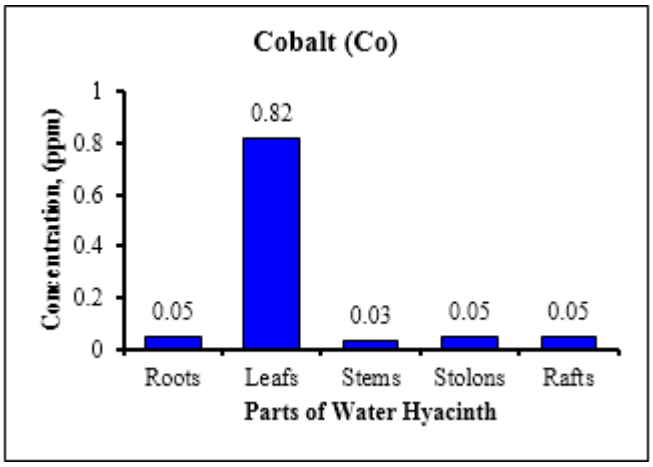

Fig. 4 : Cobalt distribution on the Prats of Water Hyacinth plants (Al-Zuhairat Village).

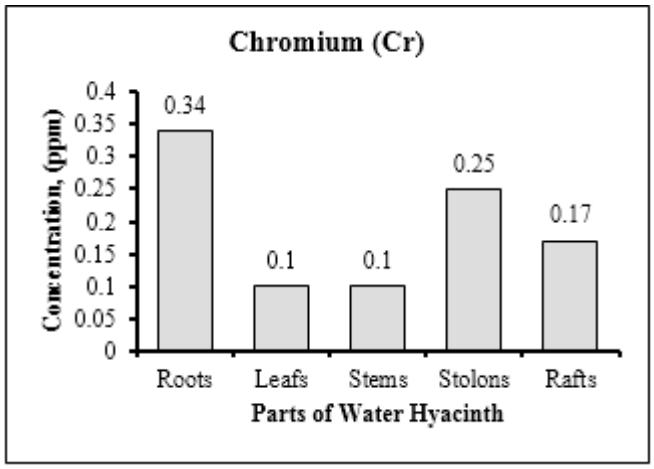

Fig. 5 : Chromium distribution on the Prats of Water Hyacinth plants (Al-Zuhairat village).

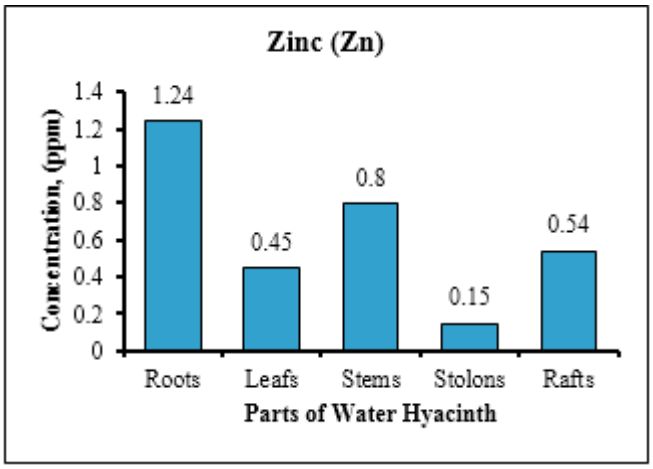

Fig. 6 : Zinc Distribution on the Prats of Water Hyacinth plants (Al-Zuhairat village).

which are less than lead, and thus it may be in direct contact with leaves that are higher than the roots. The plants originates from the tributaries of Al-Zahirat village in Abu-Sayda sub-district show high ability to adsorb metals of manganese (Mn), Cobalt (Co), chromium (Cr), Iron (Fe) and zinc (Zn) than the plants of east bank of Tigris river in Al-Rashdiya sub-district, whilst opposite results obtained with respect to lead (Pb). These results are agreement with Yan and Guo (2017). Figs. 1-6 shows the adsorbed concentrations of heavy metals by the

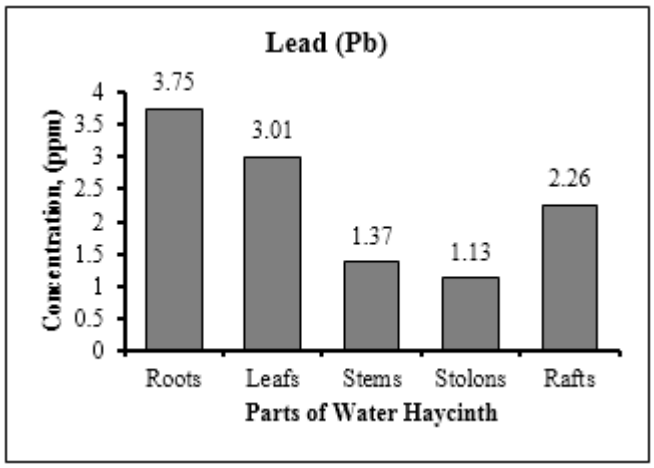

Fig. 7 : Lead distribution on the Prats of water Hyacinth plants (Al-Rashdiya sub-district).

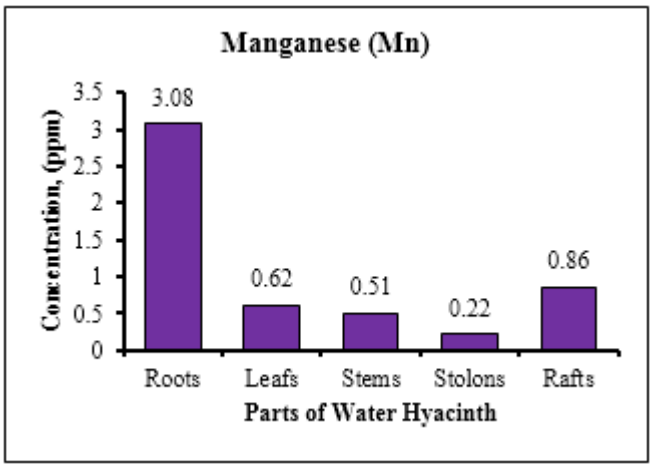

Fig. 8 : Manganese distribution on the Prats of water Hyacinth plants (Al-Rashdiya sub-district).

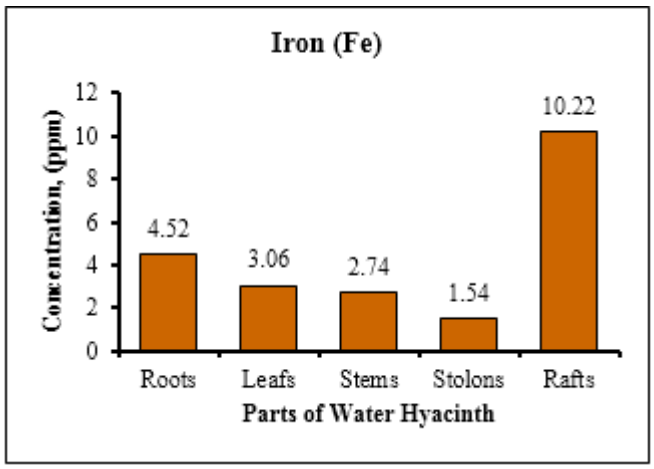

Fig. 9 : Iron distribution on the Prats of water Hyacinth plants (Al-Rashdiya sub-district)

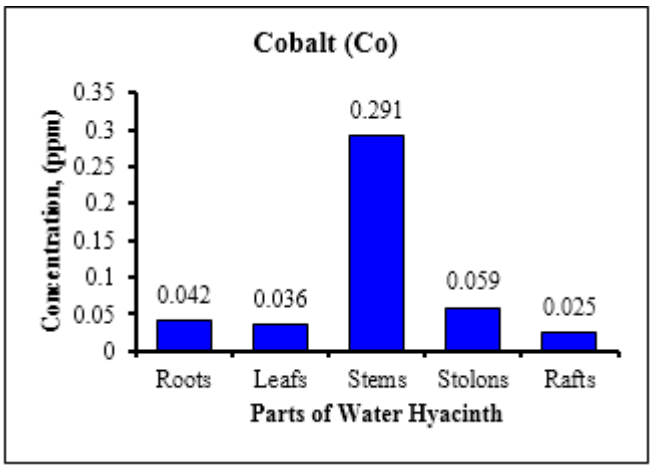

Fig. 10 : Cobalt distribution on the Prats of Water Hyacinth plants (Al-Rashdiya sub-district).

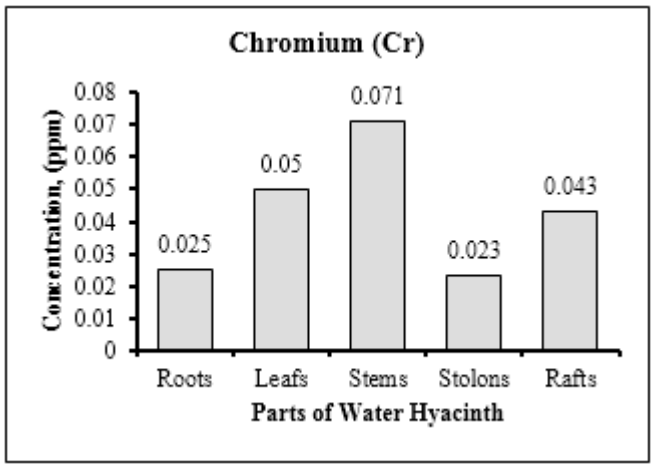

Fig. 11 : Chromium distribution on the Prats of water Hyacinth plants (Al-Rashdiya sub-district).

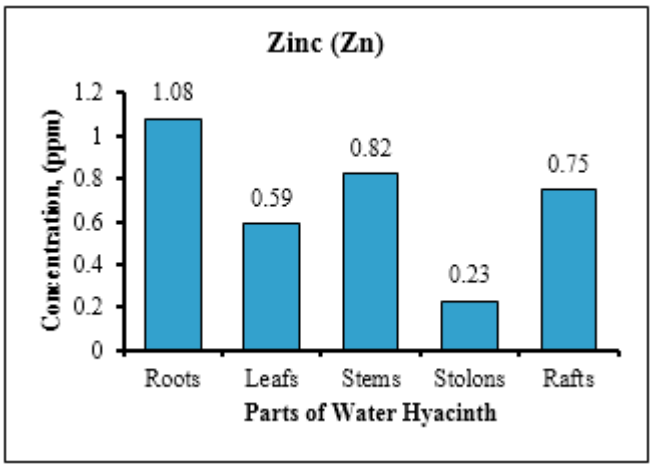

Fig. 12 : Zinc distribution on the Prats of water Hyacinth plants (Al-Rashdiya sub-district).

different parts of the water hyacinth herb in the sample of Al-Zuhairat village, Abu-Sayda sub-district. While, Figs. 7-12 shows the adsorbed concentrations of heavy metals by the different parts of the water hyacinth herb in the sample of east bank of Tigris river in Al-Rashdiya sub-district. The distribution of heavy metals on the different parts of water hyacinth samples from Al-Zuhairat village at Abu-Sayda sub-district and east bank of Tigris river in Al-Rashdiya sub-district are shown in Figs. 13-17.

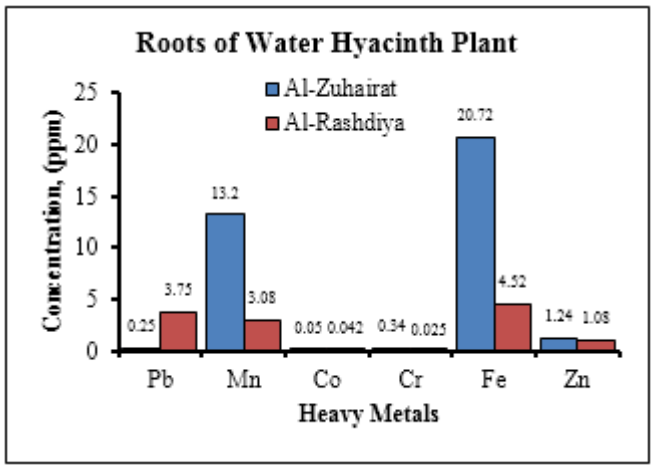

Fig. 13 : Distribution of Heavy metals on the roots of water Hyacinth plants (Al-Zuhairat and Al-Rashdiya sub-district).

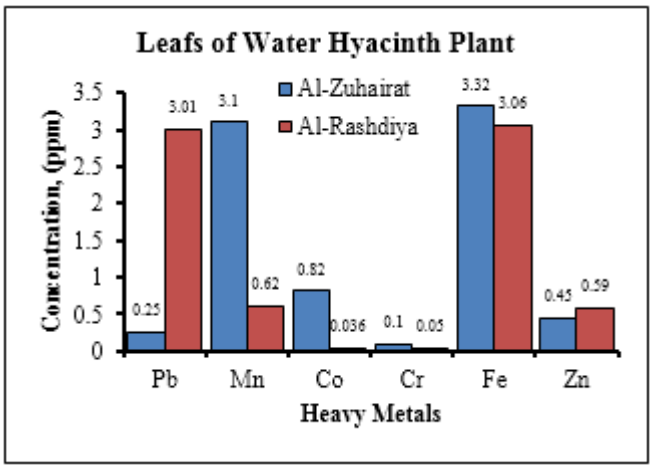

Fig. 14 : Distribution of Heavy metals on the leafs of water Hyacinth plants (Al-Zuhairat and Al-Rashdiya sub-district).

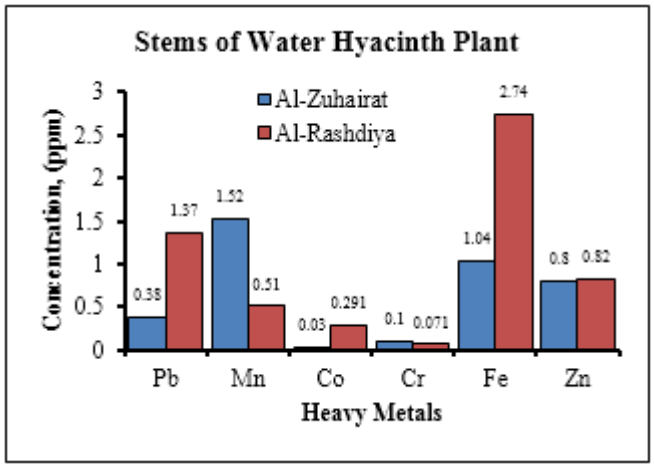

Fig. 15 : Distribution of Heavy metals on the stems of water Hyacinth plants (Al-Zuhairat and Al-Rashdiya sub-district).

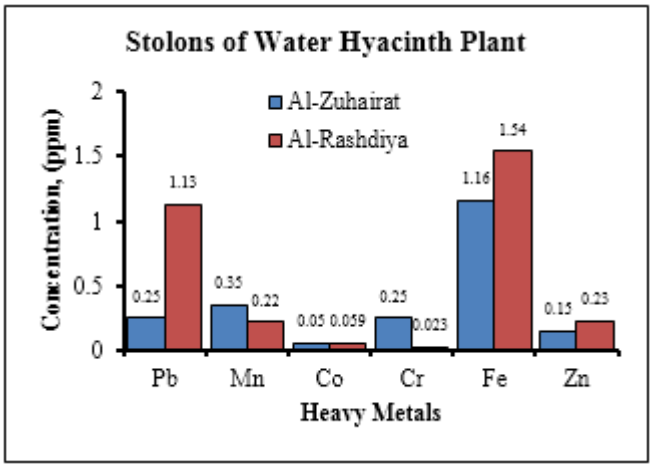

Fig. 16 : Distribution of Heavy metals on the stolons of water Hyacinth plants (Al-Zuhairat and Al-Rashdiya sub-district).

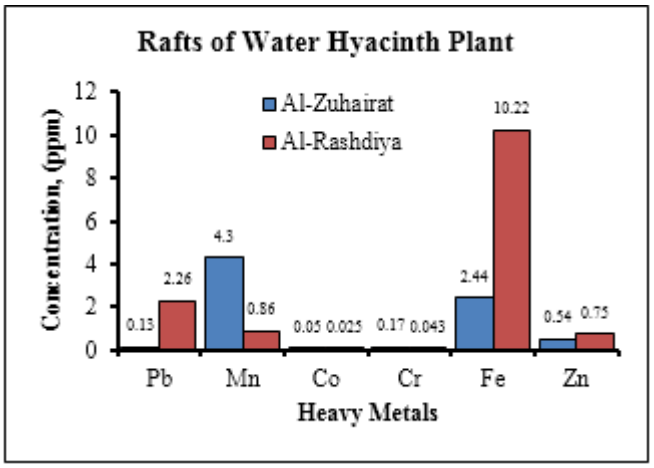

Fig. 17 : Distribution of Heavy metals on the Rafts of water Hyacinth plants (Al-Zuhairat and Al-Rashdiya sub-district).

CONCLUSION

It is noticed from the results obtained that the water hyacinth plant, despite all the negatives that accompany its rapid growth and great absorption of water from water sources, which is an important source for agriculture and drinking, it represents a high-capacity adsorbent, and its large quantities can be used to prepare natural filters with considerable efficiency and cost to purify water. By this way, it is possible to benefit from this harmful plant to the environment in treating the most important elements of the environment from pollution without needed for costly advance preparations. This type of natural treatment is actually a part of the Zero Residues Level (ZRL) concept.

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