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Study on the ability of Eichhornia crassipes L. plant to absorb Manganese from polluted water

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***Abstract*---**This study was conducted on the *Eichhornia crassipes* plant and tested its ability to remove the Manganese (Mn) from contaminated water through the absorption of this element and its accumulation inside the tissues, and the plant was dosed with Mn element at a concentration of 0.8 mg/l, where the results showed after digesting the plant in the laboratory the ability of the root system of *E.crassipes* to absorb the mineral Manganese and accumulate it inside its tissues until it reached the highest values in 21st day of the experiment, its concentration was 181 mg/kg in the roots, while it reached the highest concentration of leaves in 14th day of the experiment even reach to 93.1 mg/kg**.** As for the percentage of Manganese removal, the results showed a significant ability of the *E.crassipes* to absorb the element Mn throughout the days of the experiment, where it recorded 99.7% in 7th, 14th day, while noted non-significant decrease at 21st day to record about 99.6% of the total concentration in water .Thus, we can submit a scientific explanation of the possibility of using the plant under study in the bioremediation of contaminated water.

***Keywords*---**Eichhornia crassipes, Manganese, polluted water.

Introduction

Manganese (Mn) is a solid metal element, its color gray or silver white, manganese is added to the steel to increase its strength and resistance to corrosion as it enters the manufacture of fertilizers and colorants, the manufacture of dry batteries and the manufacture of alloys, its atomic number 25 and its atomic weight 55 and its qualitative weight 7.21to 7.44, while the maximum allowable drinking water is 0.1mg/l for (Larousi, 1999). Manganese is found in nature, air, seawater and water bodies, as well as in high proportions in some plants and in

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the fabric of animals and plays the role of mediator in most interactions, its poisoning affects low weight, changes in the appearance of hair and skin, neurological disorders, high blood pressure and infections in the digestive and respiratory tract (Al-Faouri, 2003). Mn is the most common ingredient and the second most widespread transitional mineral after iron in the Earth's crust.

Total Mn in soil ranges from 20 to 3000 mg/kg, in soil solutions, Mn^{+2} binary is the most available form of plants, with a concentration of between 0.1 and 800 mg depending on the conditions the soil passes through (Rengel, 2015; Medhat and Aljanaby, 2022) and the pH of soil and redox conditions affect the concentration of , Mn^{+2} (Marschner, 1995). Manganese includes the activities of more than 30 enzymes, which includes an enzyme (MnSO)(Broadley *et al.*, 2012; Hadi and Aljanaby, 2022), it also has an important role in the process of photosynthesis, which stimulates the division of the water molecule in the photosystem II (PSII) (Schmidt *et al.*, 2016). In the processes of enzymatic mediation and destruction of cellular construction, in general, heavy metals, including nutrients, are considered to be of varying toxic proportions to humans and other organisms, if found to be found to be high concentrations of (Environmental Protection Agency, 1991) only 12 species have been designated as Mn hyper accumulators i.e. plants are able to accumulate more than 10,000 mg kg^{-1} (DW) in the above-ground parts of the plant (Baker &Brooks, 1989).

Material and Methods

Collection of plants

This study conducted from December 2021 to February 2022. Where, collected aquatic plants *Eichhornia crassipes* from Al-ghazi river in Najaf city .They were brought to the laboratory in polyethylene bags and well washed with river water. Then, they were washed several times with tap water to clean from the dirt and materials that attached Then, planted for 14 days to adapt the plant to live in the tap water basins. The aquatic plants were checked using Iraq-specific references (Al-Saadi &Al-Mayah 1983).

Experimental design

The experiment was designed as 12 basins (plastic enclosures) Then, placed plants for 14 days in the adaptation basin (enclosures filled with tap water where samples are placed before planting); after acclimation, the samples transport to agriculture enclosures; it's a plastic enclosures all were equal dimensions (40cm length x 25cm width x 20cm height) filled with 10 liters of water per enclosure and water level was in each enclosure maintained at a same level (compensate the shortfall resulting from evaporation). Then, plant was exposed to chosen concentrations of the Heavy Metals (manganese=0.8mg/l**)** in (0, 7th and 14th) day**,** and the measurements were taken every 7 days in (7th, 14th and 21st) day, with constant Environmental Conditions for all basins (Figure 1).

Figure 1. Prepare *E. crassipes* samples for drying

Water samples

prepare the samples for digestion: It took 50 ml of the water sample and placed in the filtering device (to filter the sample with the filtration papers 0.45 µ) and kept in plastic containers until the sample was ready for heavy metal measurement and then placed in the atomic absorption spectrophotometer to estimate the heavy elements different wavelength and using a specific wavelength for each element and then added drops of concentrated nitric acid to prevent molecules from crystallizing and sticking after filtering.

Digestion the plant samples

According to the method (Cresser & Parsons, 1979) three grams of dried plant powder were weighed and placed in glass tubes and added a solution mixture of nitric acid and perochloric acid by 2:1, after which the samples were placed on the digestive system at a temperature of 200 ^{0}c for two hours until the solution became suspended

Results

Manganese (Mn) concentration in water

The results of the study didn't record any reading of manganese metal in the water throughout the experiment period in all basins (Table 1).

Table 1
Concentration of (Mn) mg/L in water of control and treatment basin

Duration	Control	Treatment	LSD	P- value
	Mean ±SD	Mean ±SD		
0 day	0.0002±0.0001	0.0002±0.00001	0.000158	0.994
7 days	0.0002±0.0001	0.00017±0.00012		
14 days	0.0003±0.0002	0.0003±0.0001		
21 days	0.0003±0.0001	0.0003±0.0002		

Manganese (Mn) element in roots

As for the metal at the roots, the presence of the element in the roots of the plants in the basins of control was gradually reduced during the days of experimentation, where the highest reading was recorded in the 0 and 7th day while and the lowest reading was in 21st day with 13,2712mg/kg while the treatment basins recorded the lowest reading in the 14th day, with a rate of 88.6305mg/kg, while the highest value was in the 21st day with 181,576mg/kg. Statistical analysis indicates that there are significant differences between the averages of the basins of treatment and control in relation to the concentration of manganese in the roots , where the effect of the water of the treated plants in terms of the concentration of manganese on the basins of control and the concentration of manganese in relation to the control basins remained low where the linear curve in return recorded the basins of treatment absorbing the element from the first day to the seventh day and then this concentration declines to move to the leaves and re-absorb this element again, observed (table2).

Table 2
Concentration of (Mn) mg/kg in Root of control and treatment basins

Duration	Control	Treatment	LSD	P- value
	Mean ±SD	Mean ±SD		
0 day	18.15±0.001	18.14±0.002	0.00118	0.0001*
7 days	18.14±0.001	160.59±0.001		
14 days	16.36±0.001	88.63±0.001		
21 days	13.27±0.001	181.58±0.001		

Manganese (Mn) element of leaves

In the control basins recorded a continuous decline in manganese values where the highest value in the 0 day was 50.4044mg/kg, and continued to decline until recorded the lowest value in the 21st day with a value of 4.6863mg/kg. But in the treatment basins successive increase and decrease were observed it fell to its lowest level in 7th day with 19.21mg/kg then returned to record its highest level in 14th day with 92.9969 mg/kg, and continued to decline gradually until 21st day (table 3).

Table 3
Concentration of (Mn) mg/kg in Leaf

Duration	Control	Treatment	LSD	P- value
	Mean ±SD	Mean ±SD		
0 day	50.41±0.001	50.40±0.001	0.000608	0.0001*
7 days	50.40±0.001	19.21±0.001		
14 days	9.15±0.001	92.9969±0.001		
21 days	4.69±0.001	20.360±0.001		

Discussion

Manganese (Mn) concentration in water

The lack of any reading of manganese is due to the amount of manganese added to basins that did not enough the plant's need and were consumed by the plant (table 2), the plant needs about of 20-40 mg/L manganese of dry weight for different functions. (Epstein & Bloom, 2005).

Manganese (Mn) content in root

The presence of a quantity of manganese metal in the roots of the plant present in the control basins, although this element is not added to these basins ,but may be accumulated earlier in the plant before, it is brought to the laboratory where the plant can accumulate more than its need at its roots (figure and table 4.2), Cu and Zn presence in control plants was normal, as these elements are found in healthy plants as micronutrients (Victor *et al* .,2007),besides, Most plants contain 30-500 mg of manganese per 1 kg of dry weight, the highest Mn needed by the plant (Millaleo *et al.*, 2010). The reason for this decrease in control basins plant during experiment days is a natural decrease due to the lack of a source to supply manganese. As for the reason for the gradual rise of these values in all the treatment basins may be that the root transported the metal to the stem and then to the leaves through the different transport mechanisms in plant. in the 14^{th} day the leaves were saturated and the transfer stopped as a result of the accumulation of the metal in the root so as to continue adding this heavy metal of water in the basins of treatment and not to move this metal to other parts of the plant.

Manganese (Mn) content in leaves

As for the leaves the gradual decrease in the value of the element in the leaves of the plant located in the control basins as a result of the consumption of this element in metabolic processes and its decrease because of the lack of a source. As for the plant in the treatment basins, the decrease of the element in7^{th} day due to the beginning of absorption the root consumed the metal for itself, after the root of the saturation in the 14^{th} day began move to the leaves and this led to the increase value of manganese in the leaves, but its decline in the last week may be consumed by the plant this element in metabolic processes, especially photosynthesis, where manganese has an important role to play in this processes , the Mn element of the plant has several tasks, including photosynthesis and building chlorophyll, respiration and hormone activates (Mardalena *et al.*, 2018). Also, photo organisms use Mn in the process of photosynthesis at the reaction center of PSII of water splitting reaction (Nickelsen & Rengstl, 2013).

Conclusions

- The ability of the water hyacinth plant to phytoremediation plants by absorbing heavy elements in contaminated water and accumulating them within their tissues .

- Observed that the peak absorption of heavy elements by root was in 21ts day.
- *Eichhornia crassipes* plant was distinguished by its superior ability to remove the elements of manganese from contaminated water.

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