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EFFICIENCY OF *VIGNA RADIATA* AND *CUCUMIS SATIVUS* FOR THE ACCUMULATION OF HEAVY ELEMENTS IN THEIR TISSUES

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Abstract

The current study included testing the efficiency of some plants to repair environmental systems through the accumulation of pollutants within their tissues and the possibility of ridding the environmental systems of those pollutants, especially heavy elements. The *Vigna radiata* and *Cucumis sativus* plants were cultivated and watered by the wastewater of Hilla textile factory for six weeks in greenhouses. Heavy metals (Lead, Copper, Cadmium and Zinc) were estimated for irrigation water and soil before the experiment and for the plant at the end of the experiment. Also, some physical and chemical properties of water and soil were measured (Electrical Conductivity, pH, Salinity, Total Dissolved Solids and Chloride) and some studied traits of plants were measured (plant length, germination ratio, leaf area, number of leaves, amount of chlorophyll and Proline). The results showed that the *Cucumis sativus* was more efficient or able to accumulate heavy elements than *Vigna radiata*, knowing that the two plants could not be used for eating after the experiment.

Keywords: Heavy metals , plants, area of leaves , proline

Introduction

The activities of human have continuously increased the pollution level in the environment and the heavy metal pollution is one of most pollutant that inter the biosphere then form rapid problems by their toxicity (Yanqun *et al.*, 2004) The pollution of water with trace elements is a serious concern now days in the world (Miretzky *et al.*, 2004).

Textile factories are one of important industries that release amount of heavy metal to aquatic environment specially when their waste water are not treated in high efficiency. Cultivated species accumulate large amount of heavy metals, which then be as a part of food chain (Osmanovic *et al.,* 2014). That grow on polluted media requires a good understanding (Brallier *et al.,* 1996; McGrath *et al.*, 2000), especially those species that are fruits or vegetables because of their nature as human food.

Bioremediation is the use of life systems, including plants, to remove or reduce pollutants from domestic and industrial effluents, which is a hygienic, safe, and low-risk method (Baban *et al*., 2004).

Plants absorb chemical elements from the soil and water, so some plants possess great ability to absorb and accumulate and withstand high concentrations of heavy elements without being affected by their toxicity and called accumulated plants (Fan *et al.*, 2011)

The aim of this work was to determine the content of heavy elements (Lead, Copper, Cadmium and Zinc) in *Vigna radiata* and *Cucumis sativus* plants to find out the most capable of absorbing and accumulating these elements in their tissues and the possibility of benefiting from it in environmental purification.

Materials and Methods

Two plants, the *Vigna radiata* and the *Cucumis sativus*, were chosen and cultivated in pots in greenhouses, and 30 seeds were planted for each plant, where every 10 seeds in one pot, the using of treated wastewater of Hilla textile factory in irrigation. The plant samples were collected six weeks after planting. Note that the soil used for cultivation is a mix soil.

Some characters of plants in this experiment were studied like plant length, germination ratio, leaf area by Digital Planimeter-kp-90n, number of leaves, amount of chlorophyll content according to methods described by (Kalra, 1998) and Proline (Bates *et al.*, 1973). Heavy metals (Lead, Copper, Cadmium and Zinc) according to methods described by (Jones, 2001)

Some physical and chemical properties of treated wastewater of Hilla textile factory was brought to lab then each of Electrical Conductivity, pH, Salinity and Total Dissolved Solids measured by Multi-meter type Hanna, Oakton-U.S.A. Chloride according to methods described by (APHA, 2005). Heavy metals (Lead, Copper, Cadmium and Zinc) according to methods described by (APHA, 2003).

Some physical and chemical properties of soil was brought to lab then each of Electrical Conductivity, pH, Salinity and Total Dissolved Solids measured (In soil extract 1:1) by Multi-meter type Hanna, Oakton-U.S.A. Chloride according (Al-Sayegh & Basshour, 2007). Heavy metals (Lead, Copper, Cadmium and Zinc) according to methods described by (Haswel, 1990).

Results and Discussion

In the table (1) shows some of the physical and chemical properties of the water used in watering and the soil used in the experiment, where it was observed that the pH value of water is 9.5 and this may be due to the addition of alum (aluminum sulfate) and chlorine in large quantities and this by its nature leads to an increase in the amount of salts Total solubility as electrical conductivity is directly proportional to the amount of total soluble salts (Wetzel, 2001). And the rise in the values of the total dissolved solids in water and soil, due to evaporation and, accordingly, to the high values of electrical conductivity (Al-Naimi, 1990).

It was found through the study that the value of the pH in the soil was alkalinity or tilted to the alkalinity and this result is consistent with (Al-Khafaji and Al-Rawi, 1975), as most of the soil of the sedimentary region is of alkalinity pH or tilted to the alkalinity. Electrical conductivity is an indication of the amount of dissolved salts present in water or soil. It is an important factor in determining the soluble elements in them as the high values of electrical conductivity are directly proportional to the amount of soluble salts (Wetzel, 2001).

Table 1 : Characteristics of Hilla textile treated waste water and soil Some

soil	water	**Parameters**
5708	2245	Electrical conductivity (µs/cm)
8.2	9.5	pH
3750	1372	Salinity (mg/L)
4030	1579	Total Dissolved Solids (mg/L)
1280.2	519.6	Chloride (mg /L)

Table (2) shows some of the studied phenotypic and physiological measurements of the *Vigna radiata* and *Cucumis sativus*, where the highest germination percentage was for the *Vigna radiata* and was 63% while the *Cucumis sativus* plant was 45%. Perhaps the reason for that is due to the physiological and biological processes of the plant. His rapid growth in all stages of his life such as the seed formation stage, the seedling growth phase, the vegetative growth phase and the fruiting phase (Al-Khafaji and Al-Rawi, 1975).

The results showed that there is a difference in the length of the plant and the area of the leaves and the number of leaves of the two plants used in the study and this is related to the genetic origin of the two plants, with respect to the leaves, which represent one of the important parts of the plant because they are used in the process of photosynthesis, respiration and transpiration, as for the characteristic of the leaf area It is a measure of a plant's ability to photosynthesis (Cutier *et al*., 2007).

The results also showed Table (2) a decrease in the chlorophyll content in *Cucumis sativus* while its rise in *Vigna radiata* and the reason may be due to the high concentrations of heavy elements in *Cucumis sativus* and its decrease in *Vigna radiata*, the inverse relationship between the amount of chlorophyll and the concentration of pollutants, especially the elements heavy (Marwood *et al.,* 1999).

Table 2 : Some physical and physiological measurements of the studied plants

Cucumis sativus	***Vigna radiata***	**Parameters**
7.7	8.4	Plant Height (cm)
45	63	Germination Ration (%)
15.8	4.1	Leaf Area (cm^2)
4	5	Number of Leaves
22	28.5	Chlorophyll Content (SPAD)
18.61	12.22	Proline (mg/g.D.W)

All plants absorb chemical elements from the soil, and some plants have a great ability to absorb and accumulate and withstand high concentrations of heavy elements called accumulated plants (Fan *et al.,* 2011). One of the important solutions to tackle soil contamination with these harmful materials is the technique of purifying soils contaminated with heavy elements using plants (Mittal *et al.,* 2014).

Through the results in Figure (1), the highest concentration of heavy elements in the water was for the zinc and lead components, possibly due to plumbing processes or an oxidizing agent of sulfur dyes as a result of using heavy elements salts in dyeing. Also, this is due to their entry into the water from many sources, such as water pipes consisting of lead and zinc, soldering and plumbing materials, galvanized steel pipes, (PVC) tubes (Wetzel, 2001), or the dissolution of the zinc lining of the transporting tubes or water tanks as a result of adding chlorine (Spellman, 2008) where sodium chloride and sodium hypochlorite are added in the printing, dyeing and textile preparation units, which in turn leads to higher chlorides to increase corrosion, which affects the concentration of zinc in Water (USEPA, 2002).

As for the soil, the highest concentration of heavy elements was lead element (Figure 1), perhaps due to the lower pH of the soil compared to water as it increases the solubility of lead in the soil (ATSDR, 1999) and may also be due to the high affinity of the lead element To bind to the organic matter present in the soil (Bradl, 2005).

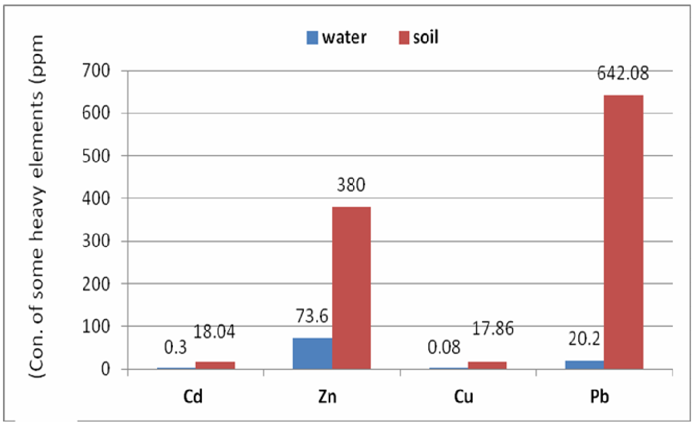

Fig. 1 : Concentrations of some heavy elements in water and soil

As for soil, the highest concentration of heavy elements in them was the lead element, Figure (1), perhaps due to the low pH in the soil and thus increasing its solubility in the soil, which facilitates its movement in the soil column and facilitates its absorption by plants (Page *et al.,* 1981).

The results showed in Figure (2) that the *Cucumis sativus* is more able to absorb and accumulate heavy elements in its tissues compared to the *Vigna radiata*, the reason may be that the leaves of the *Cucumis sativus* have a larger surface area than the leaves of the *Vigna radiata* (Guo-Xin *et al*., 2005)

The ability of plants to withstand the different concentrations of heavy elements and their continued growth is the result of a balance potential in the level of both enzymatic and molecular antioxidants such as proline (Al-Wahaibi, 2007), where we note the high proline values in *Cucumis sativus* and this because of the high concentrations of heavy elements in its tissues compared to *Vigna radiata* where the values of Proline has lower and the concentrations of heavy elements in its tissues are also lower. That is mean, the plant's ability to increase enzyme antioxidant activity when the plant is under a lot of stress(Foroozesh *et al*., 2012.; Al-Mamoori and AL-Adily, 2018).

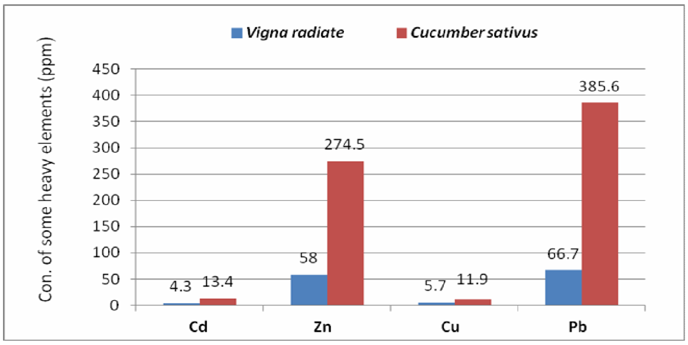

Fig. 2 : Concentrations of some heavy elements in *Vigna Radiata* and *Cucumis sativus*

References

Al-Khafaji, A. and Al-Rawi , A.H. (1975). Chemical and mineralogical proportion of some calcareous soils in the dry farming area of Talafer. Scientific Research foundation, second scientific conference, Baghdad.

Al-Mamoori, Shaymaa O.H. and AL-Adily, B.M.H. (2018). Some Effects of Treated Waste Water of Hilla Textile Factory on Four Species of Cultivated Plants, Journal of Plant Archives, 18(2): 2379-2382

Al-Naimi, S.N.A. (1990). The relationship of soil with water and plants, Dar Al-Kutub for printing and publishing, University of Mosul.

Al-Sayegh, A. and Bashoure, I. (2007). Methods of analysis for soils of arid and semi arid regions. FAO.

Al-Wahaibi, Mohammed bin Hamad (2007). The phenomenon of accumulation of heavy elements in plants. Saudi Life Sciences Magazine, 14(2): 1-28.

ATDSR (Agency for Toxic Substances And Disease Registry). (1999). Public Health Statement. In Toxicological profile for lead. Atlanta, G A: U.S. Department of Health and Human Services.

APHA (American Public Health Association), (2003). Standard method for examination of water and waste water, 20th Ed. Washington DC, USA.

APHA (American Public Health Association), (2005). Standard method for examination of water and waste water, 21th Ed. Washington DC, USA.

Baban, A.; Yediler, A.; Ciliz, N. and Kettrup, A. (2004). Biodegradability oriented treatability studies on high strength segregated waste water of woolen textile dyeing plant. J. Chemo, 57: 731-738.

Bradl, H.B. (2005). Heavy Metals in The Environment. Interface Science and Technology. University of Applied Sciences Trier Neubrucke, Germany.

Bates, L.S.; Waldren, R. and Teare, I.D. (1973). Rapid determination of free proline for water-stress studies. Plant and Soil, 39: 205-207.

Brallier, S.; Harrison, R.B.; Henry, C.L.; Dongsen, X. (1996). Liming effects on availability of Cd, Cu, Ni, and Zn in a soil amended with sewage sludge. Water Air Soil Poll., 86: 195–206.

Cutler, D.F.; Botha, C.E.J. and Stevenson, D.W. (2007). Plant Anatomy: An applied approach. Blackwell Publishing LTD.

Fan, K.C.; HSI, H.C.; Chen, C.W.; Lee, H.L.; Hseu, Z.Y. (2011). Cadmium accumulation and tolerance of mahogany (*Swietenia macrophylla*) seedlings for phytoextraction applications. Journal of Environmental Management Taiwan, 92: 2818-2822.

Foroozesh, P.; Bahmani, R.; Pazouki, A.; asgharzadeh, A.; Rahimdabbagh, S. and Ahmadvand, S. (2012). Effect of cadmium stress on antioxidant enzymes activity in different bean genotypes. ARPN Journal of Agricultural and Biological Science. 7(5): MAY 2012

Guo-Xin S.H.I.; Kai-He, D.U.; Kai-Bin, X.I.E.; Xiuo-Yu, D. and Guo-Xiang, C. (2005). Ultrastructural study of leaf cells damaged from Hg^{+2} and Cd^{+2} *Hydrilla verticillata*. J. Integrative Plant Biol. (JIPB).

Haswel, S.J. (1990) Atomic Absorption Spectrometry Theory, Design and Application. 5th ed., University of HUG, W.K.

Jones, J.B. (2001). Laboratory guide for conducting soil tests and plant analysis. CRC Press LLC.

Kalra, Y.P. (1998). Handbook of References Methods for Plant Analysis. Soil and Plant Analysis Council. Inc. CRC Press. Taylor and Francis Group.

Marwood, C.A.; Smith, E.H.; Solomon, K.R. Charlton, M.N. and Greenberg, B.M. (1999). Intact and photo modified polycyclic aromatic hydrocarbons inhibit photosynthesis in natural assemblages of lake Erie phytoplankton exposed to solar radiation, 44: 322-327.

McGrath, S.P.; Zhao, F.J.; Dunham, S.L.; Crosland, A.R.; Coleman, K. (2000). Long-term changes in the extractability and bioavailability of Zinc and Cadmium after sludge application. J. Environ. Qual., 29: 875–883.

Miretzky, P.; Saralegui, A. and Cirelli, A.F. (2004). Aquatic macrophytes potential for the simultaneous removal of heavy metals (Buenos Aires, Argentina). Chemosphere. 57: 997-1005.

Mittal, N.; Srivastava, A.K.; Bhupendra, K. (2014). Accumulation of heavy metals (cadmium and hexavalent chromium) in accessions of *Hordeum Vulgare*, IOSR Journal of Environmental Science, Toxicology and Food Technology, India, 8(5): 79-82.

Osmanovic, S.; Huseinovice, S.; Goletic, S.; Sabanovic, M. and Zavadlav, S. (2014). Accumulation of heavy metals in the fruit and leaves of plum (*Prunus domestica* L.) in the Tuzla area, 3(1): 44-48.

Page, A.L.; Bingham, F.T. and Shang, A.C. Cadmium. In: Lepp, N. W., ed. Effect of heavy metal pollution on plant, Barking, Essex, Applied Science Publishers, 1: 77-109.

Spellman, F.R. (2008). The science of water, CRC press *Boca Raton*, London, New York.

USEPA (2002). (United State-Environmental Protection Agency). Current Drinking Water Standards: National Primary Drinking Water Regulation, 816- F-02- 013.

Yanqun, Z.; Yuan, L.; Schvartz, C.H.; Langlade, L. and Fan L. (2004). Accumulation of Pb, Cd, Cu and Zn in plants and hyperaccumulator choice in Lanping lead-zinc mine area. China Environ. Int., 30(4): 567.

Wetzel, R.G. (2001). Limnology lake and river ecology, 3rd ed. Academic press. An Elsevier science imprint.