Plant Archives Volume 20 No. 2, 2020 pp. 7461-7464 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

DETERMINATION OF COPPER AND LEAD IN SOIL SAMPLES AND CULTIVATED PLANTS IN AL-MURADIYA AREA, IRAQ

Suaad K. Abd-Alwahab, Zeina Gany Fadeel* and Sherin Mohammed Mahmood

Department of Biology, College of Education for Pure Science, University of Diyala, Iraq.

Abstract

In this study, concentrations of heavy metals (lead and copper), which are considered as the main source of plant and soil contamination, were estimated. Six random samples of leaves were collected from each of eggplant and cucumber plants, as well as 6 samples of soils from outside and inside the plant houses and a sample of an organic fertilizer used in the present study. Samples were collected from the area of Muradiyat Al-Zahawi near Diyala University. The highest mean concentration of lead was found in eggplant leaves (3.014 ppm) compared with that in cucumber leaves which was lower by a large margin to 0.494 ppm. Concentration of copper in eggplant leaves showed a significant increase (5.356 ppm) compared to its concentration in cucumber leaves which was 4.897 ppm. As related to soil, the highest values of mean copper concentration (73.595 ppm) was observed in indoor soil samples compared to the average concentration in external soils (40.534 ppm). The concentration of the lead element in the external soils recorded un-measurable readings, whereas mean lead concentration in the outdoor soils was 24.338 ppm. Compost samples showed mean concentrations of 9.404 and 0.021 ppm for copper and lead, respectively.

Key words: plant extracts; contaminations; heavy metals

Introduction

Heavy metals are elements with high specific density that are also known as trace elements due to their scarce presence in the environment. These elements are naturally present throughout the environment at low levels which can be increased by increasing industrial, agricultural and sewage wastes. This increase leads to changes in the quality and nature of their environments. Two groups of heavy metals can be generally recognized. First, those essential for sustainability of life, such as copper, zinc, calcium, phosphorus, iron, and manganese. However, levels higher than the optimal limits lead to physiological damages and life-threatening effects. Second, heavy non-essential heavy metals that have no biological significance such as lead, cadmium, mercury and arsenic. These elements are dangerous even if they are present in low concentrations in the environment and, when increased, lead to poisoning and death (Salman *et al.*, 2017). The transmission of these elements to the living organisms occurs usually through the food chain, as they are transferred to plants grown in soils polluted with these elements. Such pollution is mainly due to the excessive use of chemical fertilizers and agricultural pesticides and often the result of irrigation with water contaminated with factory waste, sewage, as well as waste disposal (Hassan *et al.*, 2008).

Pollution with heavy metals is one of the forms of environmental pollution resulting from industrial or agricultural human activities. In recent years, scientists have been interested in studying the heavy elements in terms of their presence in the environment and their biological effects and its relation to human health (Kennish, 1992). The concentrations of heavy elements increase in crops and, especially, vegetables grown in the areas near sewage water sources and heavily-populated areas, as well as those located in the vicinity of waste dumps and their accumulations (Lone *et al.*, 2003 and Rupent *et al.*, 2004). A previous study (Zaalan *et al.*, 2006) estimated heavy elements in the samples of vegetables in the area of south Basrah. The results showed high mean concentrations of lead, copper, cadmium and zinc in five vegetable plants that are papaya, eggplant, cucumber, cowpea and pepper. The toxic hazards resulting from

****Author for correspondence :*** E-mail : zzn41@yahoo.com

the accumulation of these substances do not have a clear effect on the plant except in a few cases, but the greatest effect is evident on humans feeding on these plants. Another study (Ibrahim, 2015) determined levels of cadmium, zinc, lead, copper, nickel and manganese with their effects on the growth celery, clover, tomato and cold pepper within the district of Baiji. The results showed a significant increase in lead concentration which was above the permitted level in most samples. Therefore, increased consumption of these polluted plants might cause future health problems to humans. concentrations of heavy lead, zinc, cadmium and nickel elements in eggplant samples were also reported to be higher than the permitted World Health Organization (WHO) limits (Dospatlive *et al.*, 2012). Estimation of the levels of lead, cadmium, zinc and arsenic in samples of different soils within the city of Baghdad reported a significant increase compared to the normal values from global soils, The highest values were recorded for lead (119.5 ppm) which is very dangerously high level compared to the global limit of 50 ppm (Ali, 2010). In a study of heavy metals, zinc, lead, nickel, iron, chromium, cobalt and cadmium in 20 soil samples from different areas of Baquba city, there was an increase in the mean levels of chromium, nickel, lead and zinc beyond the normal global limits (Kareem *et al.*, 2011). Another report recorded increased levels of lead, zinc, manganese, copper, and iron in the leaves of the wheat plant and the cultivated soil in the city of Babel, near the brick factories. The concentration of these elements was very high above the permissible limit which were 0.49, 0.44, 0.63, 0.56 and 0.56 0.30 ppm, respectively, whereas results from soil samples were 0.5, 0.915, 9.38, 0.68 and 9.33 ppm, respectively (Taha *et al.*, 2013). Estimation of heavy elements cobalt, nickel, cadmium, and lead in leguminous plants showed that levels cobalt and nickel were within the limits allowed by the WHO. In contrast, the results of cadmium and lead elements reached the limits of toxicity, exceeding the permissible values (Ali and Anwar, 2008). Estimation of zinc, iron, nickel, chromium, cadmium, and lead in different plants (celery, radish, roasted, green onion, salted, baker) planted near the Diyala River, demonstrated that the concentrations of iron, nickel and zinc elements were within the WHO limits. Concentrations of lead, cadmium and chromium where higher than the permissible limits, where that of lead recorded a significant increase in all plant species (Mohammed *et al.*, 2018).

Materials and Methods

Plant samples were randomly collected from the green houses in Al- Muradiya area, behind the University of Diyala, at the rate of six samples for determination of concentrations of copper of lead. Soil samples were collected from the same place, six samples from inside the green houses and six samples from outside. In addition, one fertilizer sample was collected. Plant samples were prepared by washing, drying and then digesting. Soil and fertilizer samples were also digested in the digestion methods described below.

Digestion of plant samples

The samples were digested according to previously described method (Baker and AOAS, 1971). Briefly, 2g of dry ground plant was placed in a glass baker, 40 ml of concentrated HNO_3 was added and left for 24 hours. The baker was placed on the heater at 105°C and left until the appearance of fumes. The samples were then cooled and 3 ml of concentrated $HCLO_4$ was added. The baker was next placed on the heater without cover and heated carefully until dryness. Samples were then left to cool and 2 ml of HCL with 3 mL distilled water were added. The baker was placed again on the heater at 75°C, the samples were left to cool, and then filtered in a 25 ml volumetric bottle. The volume was completed the volume by adding distilled water.

Digestion of soil

A weight of 0.5 g of dry soil sample was taken and 8 mL HNO_3 with 2 mL $HCLO_4$ were added. The mixture was heated at 150°C for 2 hours and then the temperature was raised to 185°C until no fumes were observed. When the samples were close to drought, they were cooled, 4 mL HCL was added, and heated at 60°C for half an hour. Following another cooling step, 16 mL distilled water was added to complete the volume to 25 ml. Samples were left for 4 hours for the insoluble residues to settle down in the bottom. The solution was then filtered and measured in the machine (Roberts *et al.*, 1976).

Digestion of fertilizer

A weight of 5 g of the sample was placed in a 500 ml flask and 400 ml of distilled water was added. The samples were placed in the shaking incubator and slowly stirred at 30-40 rpm for half an hour. After that, the volume was brought up to 500 ml by adding distilled water and the samples were filtered using filter paper. The filtrate was then used for measurement (Everson, 1975).

Quantification of copper and lead using atomic absorption

Quantification of copper and lead in the samples was performed using the flame atomic absorption device and the use of ethylene gas. This technique is characterized by high precision in the measurement of heavy metals.

Results and Discussion

Soil samples

Table 1 shows the laboratory test results of concentrations of heavy metals in the soil samples outside and inside the green houses. The highest value of copper (73.595 mg / kg) was recorded in the indoor soil, with the highest value of lead (24.338 mg / kg) was also recorded in the indoor soils. Although both values were within the limits allowed by the WHO, we observed that the value of copper was very close to the environmental regulations defined by a level of 80 mg.kg^{-}. This implies that any slight increase in the concentration of copper, either within the type of fertilizer, water irrigation, or pesticides containing copper would lead to exceed the permissible limits. In contrast, we observed a decline in copper and lead levels in greenhouse-outdoor soils, which may be attributed to the type of fertilizers, pesticides or other factors.

Organic fertilizer sample

The results in table 2 show that the concentrations of copper and lead in the organic fertilizer used in the current study were 0.404 and 0.021 mg/kg, respectively. Although these values fall within the permissible limits, an expected risk can occur during the use of this fertilizer is increased, and consequently its transfer to the soil and thereby to the plant. This would probably lead to inevitable environmental damage (Saffar, 2016). The increasing use of fertilizer, some of which containing high concentrations of heavy metals, can lead to Increase in environmental pollution due to accumulation in the soil over time (Duran and Gonalez, 2009).

Plant samples

Table 3 shows the levels of heavy metals in two types of leaves of vegetative plants. It was found that the highest concentration of copper was recorded in leaves of eggplant plant (5.356 mg / kg^{-}), while it was 4.987 mg / kg in the leaves of cucumber. Lead concentrations in cucumber and eggplant leaves was higher than the WHO limit of 3.011 mg / kg^{-} for eggplant leaves and 0.494 mg / kg for cucumber leaves. This increase in concentration of lead is due to the growth of plants in soils contaminated with this element. These results, along with the observation that lead concentration in the soil did not exceed the limits, indicates the high capacity of the plants to absorb this element, although with very low concentrations. This indicates the danger of growing plants in polluted soils (Delibacak *et al.*, 2002), as lead is a dangerous element that can be transmitted from the plant to the body of human and animal consumers through the food chain. The danger of this element lies in its cumulative nature, causing physiological damages such as mental retardation and lack of vital functions (Mohsen and Mohsen, 2008 and FAO/WHO, 2001). Lead exerts health impacts on human life, including experiencing pain in the digestive system and liver as well as kidney damage. Lead poisoning is one of the main causes of mental retardation in children. Lead is found in most factory and automotive wastes (oils and benzene) that are often randomly buried in agricultural lands (Irwan, 1997 and Chainean, 2003). The increase in the plant content of this element may be due to the atmospheric deposition of this element resulting from crowded traffic (Wiersma *et al.*, 1986). The study area is considered as a public road for the passage of various vehicles and thus is subject to many car waste containing lead element. It was previously demonstrated (Braun and Fluckiger, 1988) that pollution with lead can be disseminated to hundreds of meters from the main roads. Lead concentration in plant leaves and soil surface originates from fuel or automobile exhausts and lead-cell batteries (Najm, 2000). It was indicated that the concentration of lead may be attributed to the recent increase in the number of cars and the use of fuel as well as the burning of plastic materials and the dumping of waste, among other factors that lead to increased pollution(Ali, 2010).

Table 1: Concentration of heavy metals lead and copper in samples of soils from outside and inside the plant houses mg.L^{-1}.

Samples	Concentration mg.L^{-1}	
	Lead(Pb)	Copper(Cu)
soils from outside	0.000	40.534
soils from inside	24.338	73.595
Limited	84-10	80-6

Table 2: Concentration of heavy metals lead and copper in samples of organic fertilizer mg.L^{-1}.

Samples	Concentration mg.L^{-1}	
	Lead(Pb)	Copper(Cu)
organic fertilizer	0,021	9.404
Limited	27	30

Conclusions

The ability of cucumber and eggplant plants to absorb

Table 2: Concentration of heavy metals lead and copper in samples of leaves of cucumber and eggplant plants mg.L^{-1}.

Samples	Concentration mg.L^{-1}	
	Lead(Pb)	Copper(Cu)
leaves cucumber	0.494	4.987
leaves eggplant	3.011	5.356
Limited	0.3	73

and accumulate heavy elements and exceed the permissible limits, despite the concentration of copper and lead elements in the soil and fertilizers were within the natural limits.

References

A.D. Baker, J. AOAC 54, 951 (1971). Determination of Copper in Alfalfa.

A.H.C. Roberts, M.A. Turner and J.K. Syers, Analyst 101, 574 (1976). Simultaneous Extraction of Cadmium and Zinc from Soil Extracts.

Al-Naimi, Saadallah Najm (2000). Principles of Plant Nutrition. Directorate of Books House for Printing and Publishing, Mosul University, Iraq.

Ali, Faeza Aziz Mahmoud and Anwar Fakhri Hamde (2008). Determination of quantities of some heavy metals in some legume plants grown in contaminated soils. *Journal of Education and Science,* **21(3):**.

Ali, Maysoon Omar (2010). Study of pollution of heavy metals in some areas of Baghdad. *Baghdad Journal of Science,* **7(2):**.

B. Mohsen and S. Mohsen (2008). Investigation of metals accumulation in Some vegetables irrigated with waste water in share Ray- Iran and toxicological application . American-Eurasian. *J. Agric. Environ. Sci.,* **4(1):** 86-92.

Braun, S. and Fluckiger (1988). Air Pollution and Ecosystems. D Reidel, Dordrecht P. 665-670.

C.H., Chaineau, Yepremian, C.J. Vidalie, F. Ducreux and D. Ballerini (2003). Bioremediation of a crude oil-polluted soil: Biodegradation, leaching and toxicity assessments. *Water, air and soil pollution an international journal of environmental pollution,* **144(1-4):** pp: 419-440.

Dospatlive, L., K. Kostadinov, G. Mihaylova and N. Katrandzhiev (2012). Determination of heavy metals (pb, zn, cd, ni) in Eggplant. *Trakia Journal of sciences,* **10(2):** 31-35.

Durán, A.C. And A. González (2009). Determination of lead, naphthalene, phenanthrene, anthracene and pyrene in street dust. *Int. J. Environ. Sci. Tech.,* **6(4):** 663-670.

FAO/WHO Codex Alimentarins Commission (2001). Food Additives and Contaminants. Joint FAO/WHO Food Standards Program, ALLNORM 01/12A. 1-289.

Hassan, Wissal Fakhri and Badr Naama Akash Badran and Mustafa Ali Faraj (2008). Geochemical distribution of trace elements in Shatt al-Arab sediments. *Marina mesopotamic,* **23(2):** 419-436.

Ibrahim, Maryam Adnan (2015). Assess the pollution in the soil and some vegetative plants by heavy fire located on the water table corridor resulting from Safi Beige. *Journal of Kirkuk University - International Studies,* **10(4):** 160-176.

Irwan, R.J. (1997). Environmental contaminants encyclopedia Zinc entry. National Park service with assistance from Colorado State University. Water resources divisions. (1sted.), 88P.

Kareem Khwedim H., A. Hussein Salah and J.A. Al- Adely (2011). Heavy Metals in some soils of Baquba city: determination Distribution and Controlling Factors. *Diyala Journal for pure sciences,* **7(2):**.

Kennish, M.J. (1992). Ecology of Estuaries. Anthropogenic effects. CRC. Press, Inc., Boca Raton, F1.

Lone, M.I., S. Saleem, T. Mahmood, K. Salfullah and Hussain (2003). Heavy metals contents of vegetables irrigated by sewage/Tubewed water. *Int. J. Agri. Biol.,* **5(4):**.

Mohammed, Sarah Abdullah, Saadia Ahmed Zahir and Amar Mawla Hamoud (2018). Estimation of contamination by heavy elements of water and plants cultivated near the Diyala River and effects on human health. *Anbar University Journal for Pure Sciences,* **12:**.

R.J. Everson, J. AOAC 58, 158 (1975). A Modification in the Official Methods for the Determination of Metals in Feeds and Fertilizers by Atomic Absorption Spectrophotometry.

Rupent, L., B. Neil, D. Scott and M.J. Neil (2004). Assessing potential risk of heavy metals exposure from consumption of home-produced vegetables by urban population environ. *Health perspective,* **115:** No. 2.

S. Delibacak, O.L. Elmaci, M. Secer and A. Bodur (2002). Trace element and heavy metals concentration in fruit and vegetables of the Gediz River region. *International Journal of water,* **2(2/3):** 196- 211.

Saffar, Nebras Mohammed (2016). Determination of some heavy elements (pb, cd, ni, co) in chemical and organic fertilizers and their effect on environmental and consumer safety. *Journal of the Faculty of Basic Education,* **22(95):**.

Salman, Jassim Mohammed and Fikret Majid Hassan and Maysam Alaa Al - Rubaie (2017). Practical Methods in Environmental and Pollution Laboratories, Center for Environmental Research and Studies, University of Babylon.

Taha, Dakhel Nasser and Saleh Hadi Kazem and Yehia Fahim Obaid and Alaa Khudair (2013). Determination of Some Heavy Metals in Wheat Plant and Soil Cultivated for Al-Kour Brick Factories Area (Babylon). *Babylon University Journal,* 8(21).

Wiersma, D., B.J. Van Goor and Vanderveen N.G.J. Agric (1986). *Food Chem.,* **34:** 1067-1074.

Zaalan, Laila Saleh, Sherine Fadel Abbas and Anfal Alwan Abdulnabi (2006). Estimation of the Contamination Rates of Some Heavy Metals in Vegetable Models in South Basra Region. *Basrah Agricultural Journal,* **19(2):**.