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HEAVY METAL CONTAMINATION OF VEGETABLES IN IRAQ: A CASE STUDY IN THE LOCAL MARKETS OF THE CITY OF HILLA

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Abstract

The heavy metal contamination of five types of local vegetables was measured and compared with the permissible limits. The studied types of vegetables are cucumbers, tomatoes, celery, potatoes and chard, while the studied heavy metals are lead (Pb), cadmium (Cd), copper (Cu), and nickel (Ni). The concentration of these heavy metals were measured using atomic absorption technology, and the test was repeated five times for each metal to ensure the reliability. The studied samples were collected, randomly, from different markets in the city of Hilla during non-rainy day. The heavy metal concentration was measured without washing the collected samples. The results of the current study revealed that the highest concentrations of lead, cadmium, and nickel were in potato, while the highest concentration of copper was found in chard. Where the measured concentrations of lead, cadmium, copper, and nickel were (0.0011- Nil – Nil - 0.0158-0.0042 $mg.kg^{-1}$), (Nil - Nil - Nil - 0.0042 - 0.0019 $mg.kg^{-1}$), (0.0125 - 0.0133 - 0.0432 - 0.0514-0.0570 $mg.kg^{-1}$), and (0.0013 – Nil -0.0035 - 0.0082 - 0.0019 $mg.kg^{-1}$) in cucumbers, tomatoes, celery, potatoes and chard, respectively.

Keywords**:** Vegetables, Heavy metal, Hilla markets, contamination.

Introduction

Heavy metal pollution is one of the most challenges environmental problems due to its direct impacts on the environment components such as air, water, soil and the fabric of the organism (Ibrahim ,2004). Although heavy metals are naturally occurred in the environment, their concentrations has dramatically increased, during the last two centuries, because of the industrial revolution and the need for more welfare (Anthony and Balwant, 2004). For example, agricultural and industrial activities, such as oil refining, power production and mining, fertilizers and pesticides usage, are significantly increase the concentration of heavy metals in water, air, and soil (Krelowska – Kulas, 1993; Chronopoulos *et al*., 1997). Previous studies indicated that the concentration of heavy metals in agricultural crops that grown near heavy water sources, areas with high population density, landfills, livestock habitats, or animal husbandry fields, is high in comparison with those grown in rural areas (Gary *et al*., 2004; Abulude, 2005). Polluted rivers are another source of contamination of vegetables by heavy metals if agricultural lands are flooded or irrigated by those rivers (Grandner, 1985).

The accumulated concentration of heavy metals in agricultural crops is transferred into human body through the food chain, which in turn could causes serious health problems such as cancer, kidney failure, anemia and inhibition of absorption of calcium (Harma *et al*., 1999). Thus, a countless number of studies have been carried out to investigate the heavy metal pollution phenomenon, its impact on both human health and environment, its resources, and its treatment methods.

In this context, the current study focuses on heavy metal contamination (with lead, cadmium, copper, and nickel) of vegetables in the city of Hilla.

Table 1: Permissible limits for heavy metals in both drinking and irrigation water (Guttormensen *et al*., 1995).

Element	The standard limit in drinking water	Maximum allowed in irrigation water	You need limitation human intake per day
Lead Pb	≤ 0.05 mg kg^{-1}	0.5 mg kg^{-1}	0.01 mg kg^{-1}
Cadmium Cd	≤ 0.005 mg kg^{-1}	0.01 mg kg^{-1}	0.1 mg kg^{-1}
Nickel Ni	≤ 0.05 mg kg^{-1}	0.2 mg kg^{-1}	0.2 – 0.3 mg kg^{-1}
Copper	≤ 0. 5 mg kg^{-1}	2 mg kg^{-1}	2 mg kg^{-1}

Materials and Methods

Chemicals and tools

The required chemicals, nitric acid concentrates (HNO_3) and Perchloric acid concentrate ($HClO_4$), were used as supplied. The following devices and tools were used to achieve the planned targets:

1. Atomic Absorption.
2. Drying Oven.
3. Accurate scale.
4. Electric Heater.

Action steps

Collection and preparation of samples

Fresh vegetable samples were collected from different markets at the city of Hilla. The studied vegetables were cucumbers, tomatoes, celery, potatoes, and chard. Each piece of vegetable was cut into small slices. Then, these pieces were dried using an oven at 65 – 70 C for three hours (Temminghoff and Houba. 2004; Motsara and Roy, 2008). The dried samples were crushed, and then stored in plastic bags to be digested later.

Digestion process

The dried plant samples were digested using nitric acid (HNO_3) and Perchloric acid ($HClO_4$). Initially, 2.5 ml of nitric acid was added to 0.5 g of each crushed sample and left for 24 hours. The acidified sample was heated at 80 C° for 1.0 hour, then left at the lab to cool down to room temperature. Then, 2.5 ml of Perchloric acid was added to this sample, and the solution was heated at 180 ºC for 2 to 3 hours (until its color turns from dark brown to colorless). The solution was then cooled down and filtered at Whatman filter paper (No. 42). The filtrate was collected and tested for the content of lead, cadmium, copper and nickel using atomic absorption spectrometer (Jones, 2001).

Results and Discussion

The obtained results showed a clear variation in the concentration of heavy metals in the studied samples of vegetables, as shown in table 2 and figures 1-4. For instance, the concentration of lead varied from 0.00 mg/kg in both tomatoes and celery, to 0.0011 mg/kg in cucumber, 0.0158 mg/kg in potatoes, and to 0.0042 mg/kg in chard. The same trend has been noticed in rest of the studied heavy metals. This variation in the concentration of the study heavy metals could be attributed to one, or more, of the following reasons. Firstly, the degree of pollution of soil, water and air in the plantation areas (Giyath and Aljuba, 2002), secondly the ability of the plant to accumulate heavy metals in its tissues (Alkorta *et al*., 2004), thirdly, soil properties such as acidity, salinity and electrical conductivity (Kachenko and Singh, 2006). Additionally, the content of plants of heavy metals varies by species, variety and plant part (Stefanov *et al*., 1995).

A glance on the obtained results, table 2, revealed important facts. Firstly, the measured concentrations of the studied metals were within the recommended limits by WFO/ WHO, which are 2 mg/kg, 0.1 mg/kg, 0.04 mg/kg for lead, cadmium, and nickel, respectively (Lone *et al*., 2003). While the permissible intake of copper, according to the WFO/ WHO, is 10 mg/kg. Secondly, it has been noticed that all the studied types of vegetables contain a certain concentration of copper, which could be an indicator for high copper pollution in the city of Hilla or the plantation areas of these crops. Thirdly, the highest concentration of the studied heavy metals were found in potatoes (except copper), which could be an indication about soil pollution. Additionally, it indicates that the roots of plants are subjected to metal pollution more than other parts.

Generally, metal pollution level in the studied samples is lower than the permissible limits, which means that the consumption of these vegetables has no health effects.

Table 2: Measured concentrations of the studied heavy metals.

Sample	Measured concentration (mg/kg)			
	Lead	Cadmium	Copper	Nickel
Cucumber	0.0011	Nil	0.0125	0.0013
Tomatoes	Nil	Nil	0.0133	Nil
Celery	Nil	Nil	0.0432	0.0035
Potatoes	0.0158	0.0042	0.0514	0.0082
Chard	0.0042	0.0019	0.0570	0.0019

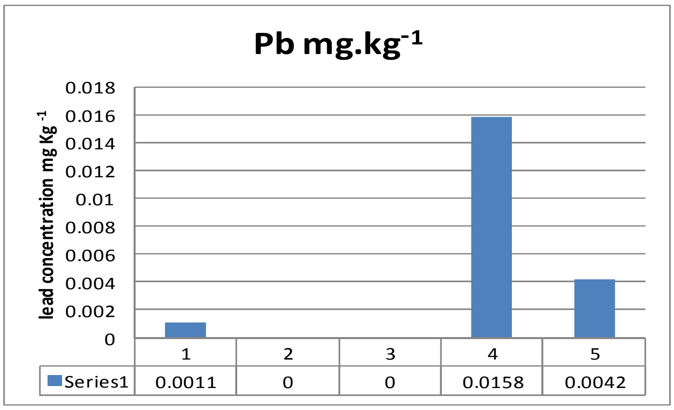

Fig. 1: Lead concentration in the studied samples

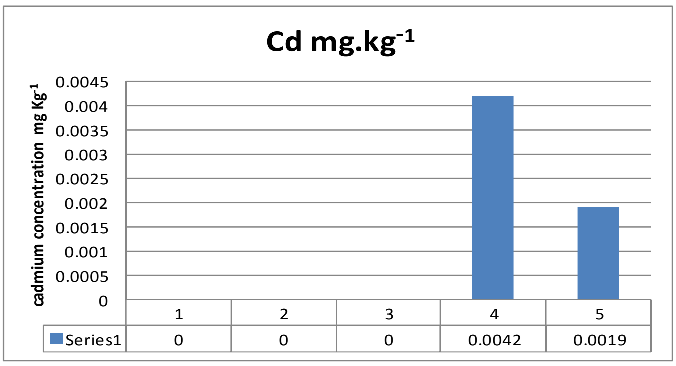

Fig. 2: Cadmium concentration in the studied samples.

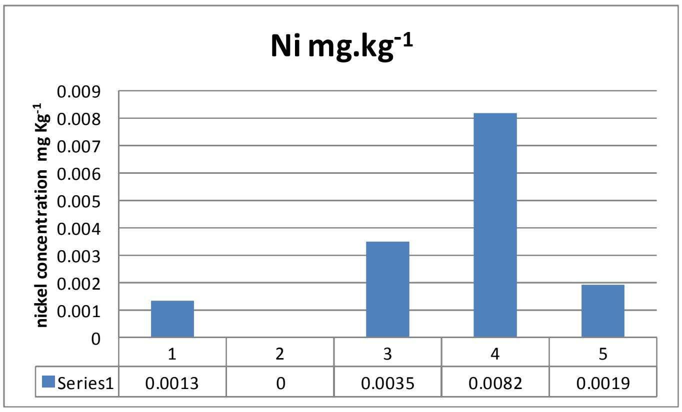

Fig. 3: Nickel concentration in the studied samples.

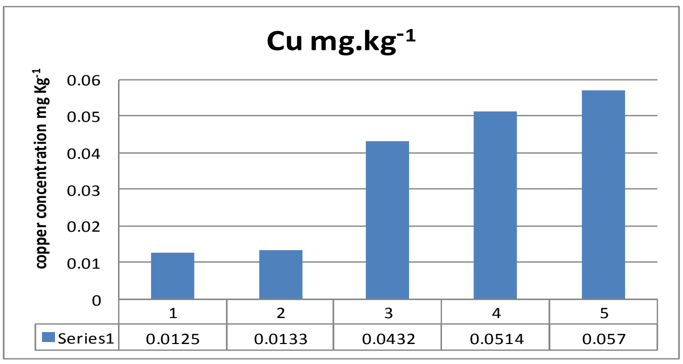

Fig. 4: Copper concentration in the studied samples.

Conclusion

The results showed different values of concentrations of heavy elements, the potatoes recorded the highest content of the elements of lead, Cadmium and nickel, while the tomatoes recorded the lowest content of all elements, and generally all the values were less than the global limit. Pollution of vegetables comes from the agricultural and marketing environment and display products in the places of sale of vegetables, plants are polluted when they grow in soil contaminated with this element, even if with few concentrations, because of the high susceptibility of plants to the absorption of this element. Copper recorded highest values for Concentrations of heavy metals in all vegetables under study. Heavy metals are transported to plants from often contaminated soil or as a result of the use of agricultural pesticides and chemical fertilizers .

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