RESEARCH ARTICLE

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Determination and Evaluation of Copper, Lead and Zinc in Leek Vegetable from Some Olericulture Farms of Hamedan, Iran

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A-B-S-T-R-A-C-T

Background & Aims of the Study: Heavy metals are ubiquitous in the environment, as a result of both natural and anthropogenic activities, and humans are exposed to them through various pathways, especially food chain. So, this study aimed to assess heavy metals (Cu, Pb and Zn) concentrations in different parts of the leek vegetable in Hamedan Province, Iran.

Materials & Methods: Leek samples were collected from 3 farms in Hamedan, Iran. Samples were digested, using wet digestion method (HNO_3 solution) and the concentrations of total Cu, Pb, and Zn were determined by inductively coupled plasma atomic emission spectroscopy (ICP-AE).

Results: The average concentrations of heavy metals in different parts of the root, stalk and leaf of the Leek were in order; Copper (0.34, 0.54, 0.71), Lead (0.03, 0.05, 0.16) and Zinc (1.42, 3.43, 4.5) $mgkg^{-1}$; So, all samples concentrations were lower than the permissible limits which are recommended by FAO/WHO. Also, most of the heavy metals were positively correlated with each other in concentration.

Conclusions: Pearson correlation test showed that Cu, Pb and Zn are similar naturally and related to the anthropic activities especially chemical fertilizer, implies the same interactions and/or relationships among these metals. According to the results, there is no risk to consumers via consumption of the leek vegetable. Appropriate measures should be taken to an effective control of heavy metal levels in vegetable soils and protect the human health finally.

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Background

With the rapid development of industry and the economy, more and more pollutants are being released into the environment (1). Nowadays, heavy metals are ubiquitous because of their excessive use in industrial applications. Heavy metals accumulation in agricultural soils that irrigated by wastewater may not only result in soil contamination, but also affect the food quality and safety (2). Some of them form an integral part of several enzymes. Although they are essential, they can be toxic when taken in excess (3). Heavy metals are non-biodegradable, and excessive accumulation of heavy metals in agricultural soils could pose a risk to public health (2). A number of factors affect the concentration of heavy metals on and within plants. These factors include climate, atmospheric deposition, the nature of the soil on which the plant is grown and the degree of maturity of the plant at the time of harvesting (4). Soil is not only the key nutrient-bearing environment for plant life, but also a supplier of many pollutants to plants because they can uptake toxic substances through their roots

from the soils. The accumulation of heavy metals from the soils to vegetables has been studied extensively due to the close relation of vegetables and human health (5). Vegetable is the staple food for many people of the world and plays an important role in human diets. In many regions, vegetable is heavily exposed to Cd, causing a health hazard (6). The major route by which humans are exposed to heavy metals is through the soil - crop- food way (7). Disadvantages of heavy metals for example mutagenic, teratogenic, neurotoxic and carcinogenic effects have been reported even at very low concentrations (8). In one study which has done on four heavy metals (Cu, Cd, Pb and Zn) in edible green vegetables in Tanzania by Bahemuka, the results showed that some concentrations of heavy metals in studied vegetables were above the recommended levels by FAO/WHO for human consumptions (9). Because of the expansion of heavy metals pollutions, the aggregation of them in agricultural crops, entrance of them to the food chain; also, high consumption of vegetables in the human diet, purification and control of this important material sounds to be seen necessary.

Aims of the study:

This research has focused on the survey of heavy metals concentrations in different parts of the root, stalk and leaf of the Leek, collected from some farms in Hamedan, Iran.

Materials & Methods

This paper is a case study; Samples of the leek were picked from three parts of the leek (root, stalk and leaf). They were collected from three agricultural fields in five replicate of Hamedan, Iran. So, 45 samples were collected generally.

Sample preparation

All the collected samples of the leek vegetables were washed with double distilled water to remove airborne pollutants. Three parts of the leek were weighed and air-dried for a day to reduce water content. Then all samples were oven-dried in a hot air oven at 60 ^{0}C for 24 h to remove all moisture. Dried samples were powdered, using a pestle, mortar and sieved through 2 mm mesh.

Digestion of the vegetable samples

45 powdered samples from each area (0.2 g each) were weighed and placed accurately in crucibles, five replicates for each sample. The ash was digested with 4 cc nitric acid solution. The samples were left to cool and contents were filtered through Whatman filter paper No. 42. Each sample solution was made up to the final volume of 25 ml with distilled water and analyzed by Varian 710-Es model of plasma atomic emission spectroscopy (ICP-AES) (2).

Data analysis

In this research, data were analyzed by SPSS 16.0statistically. Dankan test was used for comparison between the average concentration of metals (Zn, Pb and Cu) in surveying samples and T test was used for one sample to compare the average concentration of above metals with national and international standards. Pearson correlation test was used for determining correlation between metals in vegetable samples.

Results

The results show that there is a significant difference between the concentrations of heavy metals, Cu and Zn, in different parts of the root, stalk and leaf of the leek vegetable (p-value=0<α=0.0005), whereas there is no significant difference between the Lead concentrations in root and stalk of the Leek. Uncommon letters (a, b, c) in each column show that there is a significant difference between heavy metals absorption in surveying samples of the Leek on the basis of the ANOVA-Dankan test results.

Statistical results show that the average concentration of metals (Copper, Lead and Zinc) are lower than the WHO/FAO standards in all 3 parts of the root, stalk and leaf of the Leek. So the concentrations of those metals in the Leek vegetable are healthy. (p-value =0 <α=0.0005), (table1).

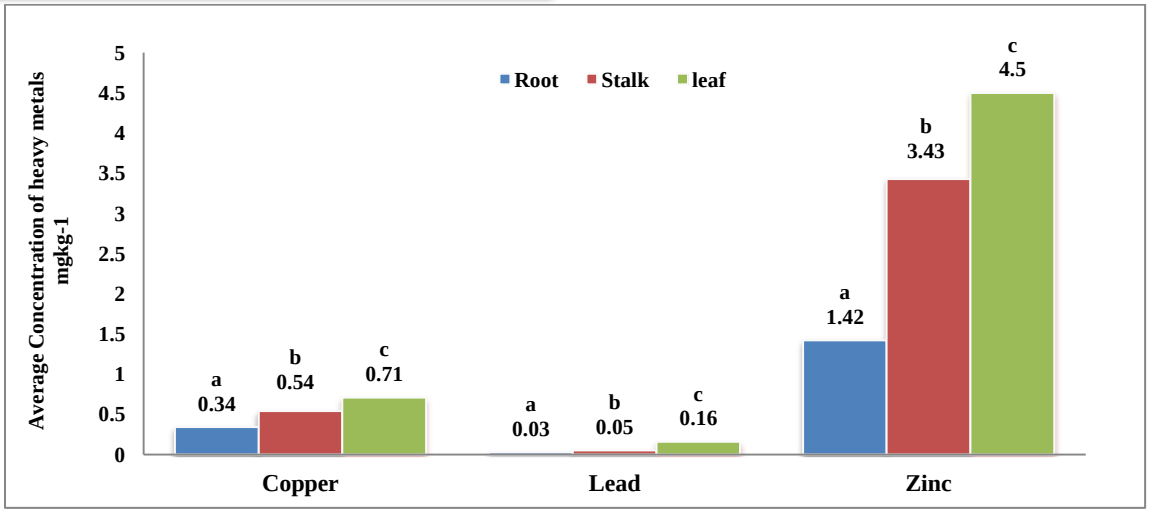

Figure 1) Average concentration of heavy metals in root, stalk and leaf in samples of Leek

Table 1) Comparison of heavy metals concentration with standard levels in Leek mg/kg

Heavy metal	Plant sample	Standard level* (WHO/FAO)	Top certitude limit	Low certitude limit	Degrees of freedom	Sig	Average
Copper	Root	20	-19.63	-19.66	14	0.000	0.34
	Stalk	20	-19.44	-19.47	14	0.000	0.54
	Leaf	20	-19.25	-19.30	14	0.000	0.71
Lead	Root	0.3	-0.11	-0.16	14	0.000	0.03
	Stalk	0.3	0.264	0.267	14	0.000	0.05
	Leaf	0.3	-0.24	-0.25	14	0.000	0.16
Zinc	Root	60	-58.52	-58.63	14	0.000	1.42
	Stalk	60	-56.96	-56.16	14	0.000	3.43
	Leaf	60	-55.46	-55.53	14	0.000	4.50

*FAO/WHO, 2001 (10).

The results of Pearson correlation test showed that there is a strong correlation between the surveying of heavy metals in the root, stalk and leaf of the Leek. There is a positive correlation between Zinc in the leaf and Copper in the stalk with 1% expectancy. There is a negative correlation between Zinc in the root and Copper in the leaf; also between Zinc in the stalk and Lead in the leaf of the Leek, conversely. Also, there is a positive correlation between Lead in the stalk and Lead in the root and also between Zinc in the leaf and Zinc in the root of the Leek with 5% expectancy (table2).

Discussion

Although several adverse health effects of heavy metals have been known for a long time, exposure to heavy metals continues and even increasing in some parts of the world (11). Crops growing on contaminated sites can take up and accumulate these metals, cause to health problems when consumed by humans and animals (7). A number of studies have shown heavy metals as important contaminants of the vegetables (12). Uptake of heavy metals by plants is often influenced by plant species, growth stage, soil type, metal species and environmental factors. Heavy metal concentrations in the soil solution play a critical role in controlling of the metal availability to plants. Increasing levels of heavy metals in the soil may cause increased uptake by plants. (13). The results show that the concentrations of heavy metals in the leaf of the leek are more than them in the stalk and the root.

Table 2) Correlation between amount of heavy metals in root, stalk and leaf of Leek mgkg^{-1}

Heavy metal		Copper			Lead			Zinc		
		Root	Stalk	Leaf	Root	Stalk	Leaf	Root	Stalk	Leaf
Copper	Root		0.43	-0.48	0.20	0.29	-0.08	0.11	0.05	0.47
	sig		0.10	0.07	0.46	0.28	0.77	0.67	0.83	0.07
	Stalk			-0.028	0.14	0.18	-0.39	0.43	0.27	0.85**
	sig			0.31	0.60	0.50	0.14	0.10	0.32	0.00
	Leaf				0.35	0.26	0.20	-0.59*	0.17	-0.49
	sig				0.19	0.34	0.46	0.02	0.52	0.06
Lead	Root					0.55*	0.18	-0.20	0.50	0.01
	sig					0.03	0.50	0.45	0.05	0.96
	Stalk						0.20	-0.18	0.16	0.08
	sig						0.47	0.51	0.55	0.77
	Leaf							-0.26	-0.55*	0.36
	sig							0.33	0.03	0.18
Zinc	Root								-0.23	0.53*
	sig								0.41	0.03
	Stalk									0.08
	sig									0.76
	Leaf									
	sig									

**0.01 Significant level and *0.05 Significant level

Comparison of our results with standard levels (FAO/WHO) showed that the average concentrations of Cu, Pb and Zn in different parts of the root, stalk and the leaf of the leek are lower than recommended standards levels. So, the root, stalk and the leaf of the leek vegetable are healthy (with 95% expectancy) and doesn't cause any problem to health. In one study with the title of health risk assessment of heavy metals in soils and vegetables and potential risk for human health in China, all of heavy metals except Cd in the soil and vegetable samples are lower than recommended standard levels; so, our results are the same with this paper (14). This result agrees with the conclusions of Kibria et al and Lin et al (15,16). The results of correlation coefficient showed that there is a significant relation between Copper, Lead and Zinc in the root, stalk and the leaf of the Leek with 99% and 95% expectancy. This correlation showed that there is a common resource for entrance of metals to the Leek. Ping et al suggested that most of heavy metals in their research could be associated with each other and might originate from some common sources (1,17,18). This result agrees with the conclusions of Cai et al. and Cheraghi and Ghobadi's (1,20). Existence of heavy metals in edible parts of vegetables shows the absorption of these metals from different ways by plants. Thus, information about the intake of heavy metals through the food chain is important in assessing risk of human health.

Conclusion

Food and water are the main sources of our essential metals; these are also the media through which we are exposed to various toxic metals. Heavy metals are easily accumulated in the edible parts of the leafy vegetables, as compared to grain or fruit crops. It is known that many serious systemic health problems can develop as a result of an excessive accumulation of dietary heavy metals such as Cd, Cr and Pb in the human body .One important dietary uptake way of metals could be through crops irrigated with contaminated wastewater. This paper focused on the analysis of the heavy metal content and its accumulation in vegetables in the Hamedan province of Iran.

According to our results, long-term phosphate fertilizer use led to moderate the accumulation of Cu, Pb and Zn in the leek vegetable. Widespread use of fertilizer, pesticides and contaminated irrigation water has contributed to the elevation of heavy metal concentrations in agricultural soils significantly. Comparison of our results with the WHO/FAO standards showed that the concentrations of heavy metals (Cu, Pb and Zn) in all leek samples are at safe levels. Also, there is a positive correlation between heavy metals (Cu, Pb and Zn) in leek samples showing that these metals have the same resource.

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