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An Investigation of Contamination of Heavy Metals of Zinc and Cadmium in Soil and Plants of Squares of Meshginshahr Town

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ABSTRACT
According to limitation of resources of earth, provision of health food security of growing population of the world in a way to have the least destruction in environment is considered as of the most importance. The present study aims to determine amount of concentration of heavy metals of zinc and cadmium in main squares of Meshginshahr City. In this research, to investigate position of concentration of heavy metals of zinc and cadmium in main squares of Meshginshahr Town, first position of sampling from soil and plants in main squares of Meshginshahr City was determined and eight squares were selected. Data obtained from this research was statistically analyzed by SPSS software. Pearson Correlation Test was used to determine correlation of samples and one-sample t-test to consider meaningfulness of samples, Kolmogrorov-Smirnov Test to determine normality of data and variance analysis test to investigate average of concentration of data were used. Results indicated that amounts of concentrations of heavy metals of zinc and cadmium in measured squares were less and standard limit of FAO and so it was meaningful. Also, results of Pearson Correlation Analysis did not indicate a meaningful relationship between amounts of concentrations of heavy metals of zinc and cadmium in soil and plants. Also, results of analysis of data variance indicated that there is not a meaningful difference between metals in soil and plant.

Keyword:
heavy metals, soil, main squares, Meshginshahr City

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INTRODUCTION

Statement of the problem

Increase of industrial activities along with production of pollutants such as heavy metals is one of the recent growing problems confronting men at the present era (Torabian and Mahjuri, 1381, 31). Direct effect of air pollutants on plants, animals and soil can affect on structure and performance of ecosystem such as their self-regulation abilities. Therefore, in this regard, it can influence quality of life. Tracer elements are released in atmosphere by human activities such as burn of fossil fuels and woods, industrial activities with high temperature and cineration of rubbishes and wastes. Combustion of fossil fuels includes main source of Ba, V, Co, Ni, Sc, Sn, Sb, Hg, and especially Cr, Mn, Cu, Zn, and As. Outputs of smoke and vapor resulting from diesel may contain different amounts of Ni, Cu, Zn, Cd and Pb (Samara et al. 2003, 52). Contamination of heavy metals is one of the main environmental problems and usually results from industrial activities such as exploitation of mines, processes of gas evacuation, production of energy and fuel, utilization of fertilizer and pesticide and process of urban wastes. It is clear that this phenomenon has intensified with industrialization and modernization of communities (Erfanmanesh and Afyuni, 1379, 142). In spite of the differences in behavior of heavy elements in terms of their activity and absorbtivity, in most cases, amount of their output through leaching and or absorption is less than amount of their input to soil. This causes very slow accumulation of heavy metals in soil and their effects are identifiable for more than tens of years. Due to element accumulation process which is almost an irreversible process and in long term causes reduction of quality of soil and finally destruction of farmlands (Afyuni and Khademi, 1385, 85), contamination of heavy elements not only directly affects on physical and chemical characteristics of soil but also causes decrease of biological activity and reduction of availability to nutrition of soil and is considered as a serious danger for human health through entering into food chain and environmental security through infiltration into groundwater (Bisun et al. 1999, 29). Most of heavy metals are found at low amounts in soil and plants. These scare elements enter into environment naturally as a result of weathering of stones. They can be crushed and enter into surface water or groundwater and or absorbed by plants. They can enter into atmosphere in form of gas or connect to components of soil such as clay or organic material. Behavior of heavy metals is of high importance because they can cause contamination of groundwater and surface water and also can enter into food chain (Noruzi, 1385, 57). Heavy metals are considered as pollutants of environment. One of characteristics of these metals is their stability so that often they cannot be analyzed by organic materials and through chemical and biological processes in nature. One of important results of this stability is condensation and aggregation of these metals in food and or tissues of animals which use this nutrition (Petti, 1998, 131). Heavy elements resulting from various resources may finally reach surface soil and their next fate depends on their physical and chemical characteristics and also soil's. Main characteristics of soil involved in motivating pollutants include: pH amount, potential of oxidation and revitalization, organic material, clay mortar and carbonates and salt (Bisun et al. 1999, 35). Heavy metals have various definitions in different scientific fields. For example, in petrology, this term refers to metals which react with dithizone. But in most of common usages, this word refers to metals which their special weight is more than 4.5 gr/cm^2 and also is attributed to concepts such as toxicity and stable presence in environment (the US Environment Organization, 2007). Heavy metals as dangerous and pollutant factors of environment have received much attention and have been evaluated many times. These metals enter into nature cycle through water, soil and soil due to different natural and artificial resources and make dangerous short-term and long-term effects in them. Therefore, it is considered as a serious danger for survival of living creatures. Heavy metals cannot be analyzed in nature like organic pollutants through chemical or biological processes. One of the important results of stability of these metals is biological aggregation of the metals in food chain. As a result of this process, amount of the metals in higher members in food chain can reach to several times of those which are found in water or air and consequently, they are considered as a threat for health of plants and animals which use this food (Tavakkoli Mohammadi et al. 1390, 174). These metals have a potential to pollute soil and water and can be used by human through dispersion and aggregation in plants and animals (Wcislo et al. 2002, 46). In this research, we proceeded to evaluate amount of concentration of heavy metals of cadmium and zinc in main squares of Meshginshar.

Methodology

The present study is of descriptive and cross-sectional kind and amounts of heavy metals (zinc and cadmium) were investigated in soil and plants of squares of Meshginshahr. First, dominant species in green spaces of squares were identified and then sampling was performed completely randomly in shoots of dominant species and also surface soil under crown of coverage of the mentioned species. To sample plants, shoots (branch and leaf) were sampled completely randomly for each species in form of statistical plan.

To sample soils and plants of squares of Meshginshahr, eight squares were investigated. From each square, two samples of soil and two samples of plants existing in the squares were selected to analyze chemically.

Soil samples were transferred into laboratory and then after aerating and drying, they were crushed and crossed from a 2 mm sieve. Assimilation of samples and release of element were performed by the recommended method through Esposito. Accordingly, by considering humidity of soils, 12.5 ml 4-molar Nitric Acid was added to 2 gr soil sample. Samples were kept one night in bain marie at 80^{o}C. Then, the obtained solution was crossed from filter paper and concentrations of zinc and cadmium were determined by atomic absorption device.

For plant, 0.2 gr weighing dry plant material and 4 ml 65 per cent Nitric Acid were added and it was kept for 24 hours in ambient temperature. Then, they were put for 5-6 hours in 90^{o}C mortar so that they evaporate. After cooling, samples were filtered by filter paper and it volume was increased by distilled water to 10 ml. Standard gr/mol solutions of zinc

and cadmium were prepared and their absorptions with samples were read by atomic absorption device.

Statistical population, studied sample and sampling method

In this research, to investigate state of concentrations of heavy metals of cadmium and zinc in squares of Meshginshahr, first positions of stations to sample soil and plants in squares of the city (Imam Khomeini, Azadi, Janbazan, Imam Hosein, Dadgostari, Moallem, Namaz and Sabalan squares) were determined by GRIS. Then, from every square two soil samples and two plant samples were prepared to measure zinc and cadmium elements which totally they become 32 samples.

Method of gathering data

At first, a total list of main squares of Meshginshahr was prepared and geographical positions of squares were recorded by GRIS device of GRARMIN model under metric system. Therefore, required data was gathered through sampling and field studied. To investigate background of research and information required about subject of research, information sources such as valid internet sites, articles and books of related organizations were used.

Method of analysis of data

Data obtained from the research was analyzed by SPSS software. Pearson Correlation Test was used to determine correlation of samples and one-sample t-test was used to investigate meaningfulness of samples. Kolmogrorov-Smirnov Test was used to determine normality of data and variance analysis test was used to consider average of concentration of data.

Chemical analysis

Soil samples were transferred into laboratory and then after aerating and drying, they were crushed and crossed from a 2 mm sieve. Assimilation of samples and release of element were performed by the recommended method through Esposito. Accordingly, by considering humidity of soils, 12.5 ml 4-molar Nitric Acid was added to 2 gr soil sample. Samples were kept one night in bain marie at 80^{o}C. Then, the obtained solution was crossed from filter paper and concentrations of zinc and cadmium were determined by atomic absorption device.

For plant, 0.2 gr weighing dry plant material and 4 ml 65 per cent Nitric Acid were added and it was kept for 24 hours in ambient temperature. Then, they were put for 5-6 hours in 90^{o}C mortar so that they evaporate. After cooling, samples were filtered by filter paper and it volume was increased by distilled water to 10 ml. Standard gr/mol solutions of zinc and cadmium were prepared and their absorptions with samples were read by atomic absorption device.

Data obtained from experiment of concentrations of zinc and lead in soil and plant

Table 1- Data obtained from experiment of concentrations of zinc and lead in soil and plant

Absorbable lead µgr/grr	Characteristic of sample	Number of experiments	Absorbable zinc µgr/grr	Characteristic of sample	Number of experiments
7.35	Imam Khomeini	1	458	Imam Khomeini	1
4.5	Azadi	2	422	Azadi	2
3.9	Janbazan	3	492	Janbazan	2
7.9	Imam Hosein	4	430	Imam Hosein	۴
3.25	Dadgostari	5	499	Dadgostari	5
5.54	Moallem	6	501	Moallem	6
8.69	Namaz	7	544	Namza	7
4.32	Sabalan	8	550	Sabalan	8

Table 2- Data obtained from experiment of concentrations of zinc and cadmium in soil and plant

Absorbable cadmium µgr/grr	Characteristics of sample	Number of experimen t	Absorbable zinc µgr/grr	Characteristics of sample	Number of experiment
0.21	Imam Khomeini	1	359	Imam Khomeini	1
0.79	Azadi	2	198	Azadi	2
0.56	Janbazan	3	405	Janbazan	3
0.82	Imam Hosein	4	398	Imam Hosein	4
0.21	Dadgostari	5	215	Dadgostari	5
0.46	Moallem	6	132.32	Moallem	6
0.85	Namaz	7	387.54	Namaz	7
0.46	Sabalan	8	412.5	Sabalan	8

In this section, we investigate and explain information in form of descriptive statistics such as mean, standard deviation, range of variations, maximum, minimum, etc. based on kind of data. As it is observed in Table 1, from every square, 8 soil samples and 8 plant samples were provided. Results obtained from sampling indicated that the highest amount of zinc was found in Sabalan Square with 550 µg/gr and the highest amount of zinc in plant was found in Sabalan Square with 412.5 µg/gr. Also, the highest amount of cadmium was fount in Namaz Square with 8.69 µg/gr and in plant in Namaz Square with 0.85 µg/gr.

Test of normality of data

Kolmogorov-Smirnov Test indicates normality of distribution of data. That is, it compares distribution of an adjective in a sample. If data has normal distribution, it will be possible to use parametric test and otherwise, non-parametric test should be used.

Table 3- Investigation of normality of data

Cadmium of plant	Zinc of plant	Cadmium of soil	Zinc of soil	
8	8	8	8	*Number*
0.545	313.42	5.68	488.25	*Mean*
0.2585	112.58	2.039	45.803	*Standard deviation*
0.152	0.189	0.219	0.14	*The highest positive difference*
-0.203	-0.282	-0.168	-0.158	*The highest negative difference*
0.575	0.798	0.619	0.446	*Kolmogorove-Smirnov*
0.895	0.574	0.838	0.989	*Meaningfulness level*

Based on Kolmogorov-Smirnov Test, data of zinc and cadmium in soil and plant indicate a meaningfulness level of more than 0.05. That indicates lack of meaningfulness of data. That is data is normal.

Comparison of amount of zinc in soil and plant

Table 4- Comparison of amount of zinc in soil and plant

Meaningfulness level	*F*	*Mean of squares*	*Degree of freedom*	*Sum of squares*		
0.246	2.456	2097.929	5	14685.5	*Inter-group*	
		36.792	2	110.375	*Intra-group (error)*	*Zinc*
			7	14795.529	*Sum*	

Investigation of difference of amount of zinc between soil and plant indicates that there is a meaningful difference between them. That is, zinc existing in soil and plant are different.

Comparison of amount of cadmium in soil and plant

Table 5 - Comparison of amount of cadmium in soil and plant

Meaningfulness level	*F*	*Mean of squares*	*Degree of freedom*	*Sum of squares*		
0.871	0.315	7823.179	5	39115.897	*Inter-group*	
		24809.2	2	49.618.4	*Intra-group (error)*	*lead*
			7	88734.3	*Sum*	

Investigation of difference of amount of cadmium between soil and plant indicates that there is not a meaningful difference between them. That is, cadmium existing in soil and plant are not different.

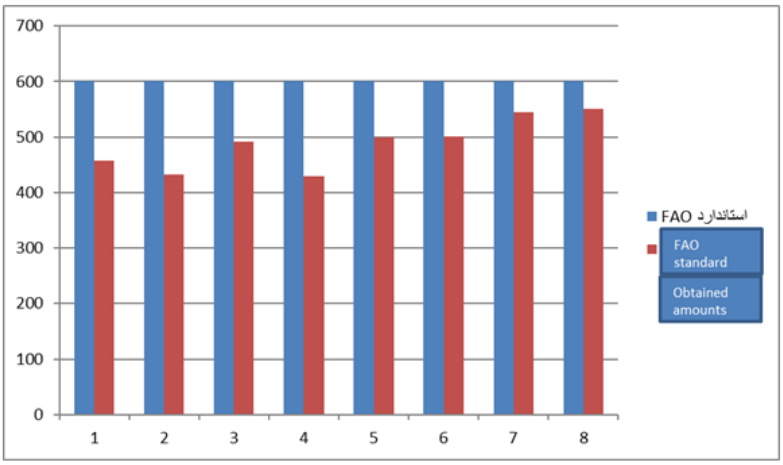
Results of statistical comparison with FAO

Investigation of zinc in soil

Table 6- Result of one-sample t-test to compare zinc existing in soil with FAO standard

Relative value: 600						
Degree of confidence 95%		Mean difference	Meaningfulness level	Degree of freedom	t-test	
The highest	The lowest					
-73.475	-150.042	-111.75	0.000	7	-6.901	Zinc

Results of one-sample t-test indicated that there is a meaningful difference between mean of zinc in soil in probability level 1%, i.e. with 99% confidence level so that mean of zinc existing in soil is less than the related

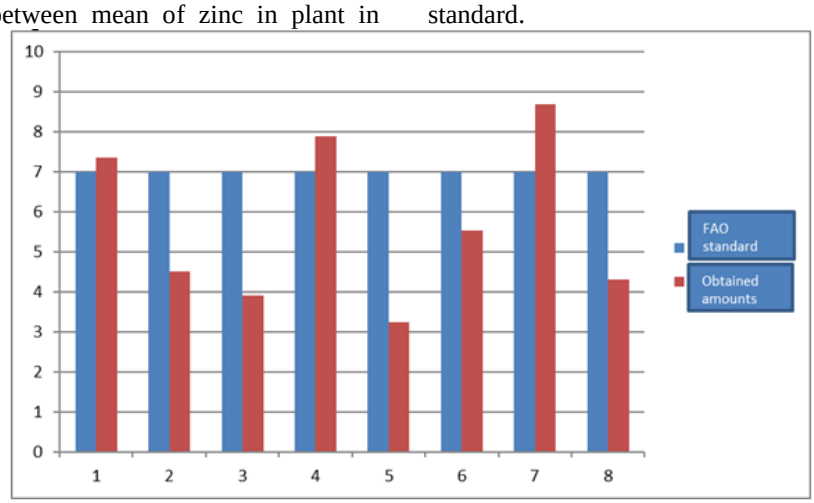


Investigation of zinc in plant

Table 7- One-sample t-test to compare zinc existing in plant with FAO standard

Relative value: 400						
Degree of confidence 95%		Mean difference	Meaningfulness level	Degree of freedom	t-test	
The highest	The lowest					
7.5469	-180.706	-86.58	0.046	7	-2.175	Zinc

Results of one-sample t-test indicated that there is a meaningful difference between mean of zinc in plant in probability level 1%, i.e. with 99% confidence level so that mean of zinc existing in plant is less than the related standard.

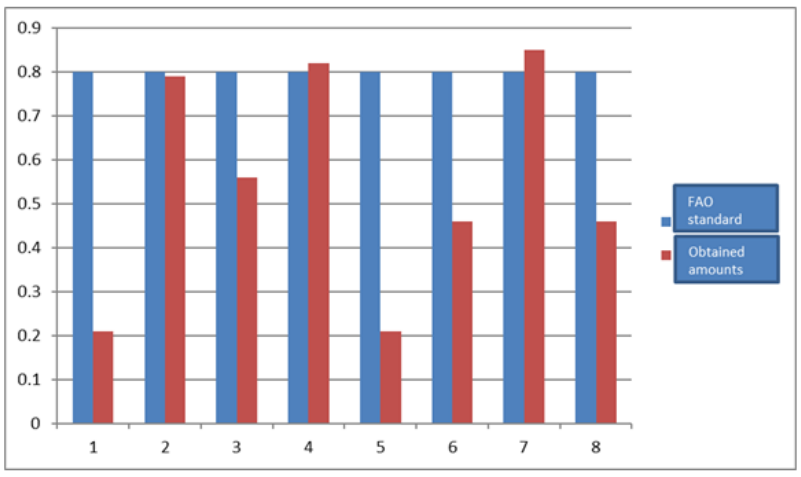


Investigation of cadmium in soil

Table 8- Result of one-sample t-test to compare cadmium existing in soil with FAO standard

Relative value: 7						
Degree of confidence 95%		Mean difference	Meaningfulness level	Degree of freedom	t-test	
The highest	The lowest					
0.386	-3.023	-1.318	0.001	7	-1.829	Cadmium

Results of one-sample t-test indicated that there is a meaningful difference between mean of cadmium in soil in probability level 1%, i.e. with 99% confidence level so that mean of cadmium existing in soil is less than the related standard.



Investigation of cadmium in plant

Table 9- Result of one-sample t-test to compare cadmium existing in plant with FAO standard

Relative value: 300						
Degree of confidence 95%		Mean difference	Meaningfulness level	Degree of freedom	t-test	
The highest	The lowest					
-0.038	-0.471	-0.255	0.027	7	-2.79	Cadmium

Results of one-sample t-test indicated that there is a meaningful difference between mean of cadmium in plant in probability level 1%, i.e. with 99% confidence level so that mean of cadmium existing in plant is less than the related standard.

Results of Pearson Correlation Test

Table 10- Investigation of correlation between zinc and lead in soil and plants

Lead in plant	*Zinc in plant*	*Lead in soil*	*Zinc in soil*		
			1	*Pearson score*	
				Meaningfulness level	*Lead in plant*
			8	*number*	
		1	*-0.098*	*Pearson score*	
			0.817	*Meaningfulness level*	*Lead in soil*
		8	*8*	*number*	
	1	*0.367*	*0.205*	*Pearson score*	
		0.371	*0.626*	*Meaningfulness level*	*Zinc in plant*
	8	*8*	*8*	*number*	
1	*0.214*	*0.432*	*-0.151*	*Pearson score*	
	0.611	*0.85*	*0.721*	*Meaningfulness level*	*Lead in plant*
8	*8*	*8*	*8*	*Number*	

According to Table 10, meaningfulness level of test in done correlations is higher than 0.05 which indicates that there is not a meaningful correlation between data of zinc and lead in soil and plant statistically.

Conclusion

The present study aims to determine amount of concentration of heavy metals of zinc and cadmium in main squares of Meshginshahr Town. According to the obtained results in the research and data obtained from laboratory, amount of heavy metals of zinc and cadmium in soil and plants of squares of Meshginshahr Town is in favored limit and less than FAO standard. It is because Meshginshahr Town has less population compared to big cities and so less vehicles used by citizens and less fuel consumption and less production of heavy metals such as zinc and cadmium by vehicles. Results of statistical analysis and comparison with FAO standards indicate that amount of concentration of heavy metals is less than FAO's standard limit and so is meaningful. Also, results of Pearson correlation analysis indicated a meaningful relationship between amounts of concentrations of heavy metals of zinc and lead in soil and plant. Also, results of data variance analysis did not indicate a meaningful relationship. That is, there is not a meaningful difference between soil and plant.

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