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ORIGINAL ARTICLE

Effect of Chrome, Cadmium, Lead, and Zinc on Radish and Spinach Irrigated with Contaminated Water in Basin of TalkheRud River, Tabriz

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ABSTRACT
Using contaminated water to irrigate vegetables leads to uptake of contaminators including heavy metals. Due to its high consumption rate, vegetable wholesome is of high importance. Thus, measurement of heavy metals levels in vegetables may provide useful information considering food safety. The present study evaluates heavy metals level found in vegetables cultivated at downstream basin of Talk he Rud river of Tabriz. This is a descriptive-analytical study. The sampling process was done during June from three regions and three samples were randomly selected from each vegetable, i.e. 9 samples of spinach and 9 samples of radish. After incineration and acid digestion, level of chrome, cadmium, lead, and zinc was measured using Atomic Absorption Spectrometer. SPSS software was used to analyze data at the meaningful level of 0.01. Mean ±SD of chrome, cadmium, lead, and zinc (mg/kg) in dry weight of vegetables was respectively 2.22±0.26, 3.61±0.34, 10.18±0.80, and 104.93±8.90 in spinach and 1.05±0.11, 3.51±0.62, 11.84±0.65, and 45.38±3.81 in radish. As seen, level of the mentioned elements in spinach is higher than radish. In both vegetables, mean density of chrome, cadmium, and lead is higher than standard level. However, zinc is at the standard range. There was also a negative correlation between soil PH and mean density of zinc in both vegetables(P=0.01). The elements level in the understudy samples was higher than the standard level. Therefore, long-term consumption of the contaminated vegetables may endanger health of residents of the region.
Keywords: Contaminated water, Heavy elements, Vegetables, Diet, Environment

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INTRODUCTION

Vegetables are of valuable foodstuff containing kinds of vitamins and other nutrients and consumed by more people. Due to its high consumption rate, vegetable wholesome is of high importance [1]. Using contaminated water to irrigate vegetables leads to uptake of contaminators including heavy metals [12]. According to findings of several studies, wholesome vegetables consumption may prevent from heart diseases and some cancers especially digestive system cancer [2]. Since crops and vegetables uptake heavy metals through contaminated water (irrigation), contaminated soil, or atmospheric deposits (polluted air), heavy metal contamination of agricultural soil seriously and adversely affect human health [13]. Heavy metals are very harmful because of their non-biodegradable nature and long biological half-life. Also, they can accumulate in body tissues. In fact, once heavy metals enter the body, they are not excreted and deposited in tissues such as fats, muscles, bones, and joints. It results in appearance of several diseases and complications [16]. Heavy metals uptake by crops depends on soil conditions such as PH, temperature, ion concentration of solution, presence of other heavy metals, soil organic materials, cations, presence of iron, aluminium, manganese, and calcium oxides, type and level of heavy metal, type of crop, plough and water management [14]. In comparison with neutral soils, crops uptake more cadmium and lead from acidic soils. In some cases, presence or absence of some divalent metals in soil may affect heavy metals uptake by crop [11]. Zinc and manganese compete with cadmium to be absorbed

by crop. Additionally, zinc solubility in high PH soils, especially if it contains lime, is very low [3]. In fact, soil PH is an agent controlling zinc uptake by crop. Other minerals and salts required by the body are replaced by heavy metals. For example, zinc is replaced by cadmium if there is insufficient amount of it in foodstuff. Generally, neurological disorders, Parkinson, Alzheimer, depression, schizophrenia, kinds of cancers, and malnutrition are problems created by heavy metals. Vegetable farms, located at basin of TalkheRud river of Tabriz, are irrigated with streams containing kinds of contaminators including urban, industrial, and agricultural wastewater. Using contaminated water to irrigate these farms increases possibility of contaminators (e.g. heavy metals) uptake by vegetables cultivated in the basin. The presents study aims at determining level of chrome, cadmium, lead, and zinc in vegetables (spinach and radish) and comparing their accumulation in these samples as well as with the standard level.

MATERIALS AND METHODS

The present study was conducted at west Tabriz (basin of TalkheRud river of Tabriz) during spring. The region was initially identified where it was assumed that vegetables are contaminated by heavy metals. Then, three points were specified inside the limit as sampling stations to evaluate vegetables contamination. In every station, three vegetable farms irrigated with contaminated water were sampled.

Totally, there are 18 vegetable samples. The samples were randomly taken from beginning, middle, and end parts of the farms with three replications. Each sample weighted 1kg and, thus, 3kg of mixed vegetables was taken from each farm to study average state of each farm considering their contamination to heavy metals. The samples were completely cleaned and grasses and inconsumable stems were separated. Then, a sample of 20g was taken from every 1kg of vegetables of each farm. They were poured in a porcelain crucible and burnt on gaslight. Once they burnt completely, the samples were placed in a 550°C furnace for 45 minutes and the vegetables ash was prepared.

Distilled water (10 drops) was poured on the prepared ash and then, nitric acid (3-4ml) was added to the distilled water equally. The sample was heated for 15 minutes. Then, the sample solution was passed through a filter, entered a volumetric flask (vol.25ml), and desired volume (25ml) was obtained using distilled water. At this stage, the sample was ready to be injected to the atomic absorption spectrometer. To prepare the spectrometer to accept the sample, standard samples with different densities were prepared using tetrasol solutions. Calibration curve of the spectrometer was prepared and the sample was given to it. Here, density of cadmium, chrome, lead, and zinc was measured by the spectrometer [10].

RESULTS AND DISCUSSION

Comparing mean density of elements in vegetables with standard levels

According to table 1, mean density of chrome, cadmium, lead, and zinc was respectively 2.22±0.26, 3.61±0.34, 10.18±0.80, and 104.93±8.90 in spinach and 1.05±0.11, 3.51±0.62, 11.84±0.65, and 45.38±3.81 in radish. In all three stations, mean density of the elements (except to zinc) is higher than the international standard level in the vegetables (0.2-1, 0.2-0.8, 0.1-10, & 100-400). It may be attributed to use of urban wastewaters, industrial sullage, and sewage sludge. According to Torabian and Mahjouri [15] heavy metals level in crops irrigated with wastewater is higher than the international standard level. The findings correspond with results of this study. In the study conducted by Nazemi *et al* [5], mean density of lead and cadmium was reported higher than the standard level of WHO and FAO for crops. They introduced urban and industrial sullage as the main source of vegetables contamination. Their findings correspond with results of the present study.

Comparing the stations

According to the results obtained from stations, MeidanChay has the highest level of contamination to chrome and zinc with the highest mean density of these elements (1.93±0.46 & 87.88±20.19 mg/kg, respectively). It is due to adjacency of this station to industrial sullage resources and use of these sullage and wastewater to irrigate the vegetables by the farmers. The highest level of lead and cadmium was reported from Hokmabad and Gharamalek stations because of using wastewater sludge, sullage, and wastewater, much use of phosphate fertilizers, adjacency of these stations to Petrochemical complex, Tabriz power plant, refinery, and machine manufacturing, and tractor manufacturing factories which use high amounts of fossil fuels per day and are regarded as the most important source of water and air pollution of the region. Lead with the highest level of atmospheric sedimentation among the elements plays a significant role in contaminating vegetables and soil of the region. In the study conducted by Nazemi *et al* [5], mean density of lead, cadmium, and arsenic was reported higher than the standard level of WHO and FAO for crops. They introduced urban and industrial sullage as well as phosphate fertilizers as the main source of vegetables contamination. The findings correspond with results of the present study.

Comparing elements in radish and spinach

According to mean density of elements in these crops, spinach is more contaminated by chrome, cadmium, and zinc than radish. In comparison with spinach, however, radish is more contaminated by lead. Also, radish gland uptakes and accumulates the lead more than spinach. Alidadi *et al* [6] studied uptake and accumulation of cadmium, lead and chrome in vegetables irrigated with contaminated water and concluded that uptake and accumulation of cadmium and chrome in foliage vegetables are more than gland ones. The results correspond with findings of this study. There is a negative correlation between soil PH and mean density of zinc accumulated in spinach tissue, i.e. the higher the soil PH, the lower the mean density of zinc accumulated in the crop tissue and vice versa. Also, there is a positive correlation between cadmium and lead level in the crop tissue (P=0.01).It demonstrates that the higher the level of one of these elements, the higher the level of another element. It corresponds with results of the study conducted by Nadafi *et al* [9] and Lee *et al* [11].

Table 1: Mean density and standard error (mg/kg) of elements in spinach and radish considering stations and vegetables

Variation resource	Chrome	Cadmium	Lead	Zinc
Station	1.93±0.46	2.66±0.19	9.92±0.92	78.88±20.19
	1.41±0.29	3.72±0.30	11.65±1.08	58.99±9.55
	1.56±0.27	4.30±0.90	11.46±0.80	78.6±13.06
Vegetable	2.22±0.26	3.61±0.34	10.18±0.80	104.93±8.90
	1.05±0.11	3.51±0.62	11.84±0.65	45.38±3.81
Standard	0.2-1	0.1-0.8	0.1-10	100-400

According to the results, there is a negative correlation between soil PH and mean density of zinc accumulated in radish tissue, i.e. the higher the soil PH, the lower the mean density of zinc accumulated in the crop tissue and vice versa. Also, there is a positive correlation between level of zinc and cadmium and lead in radish tissue (P=0.01).It indicates that increase or decrease of zinc leads to increase or decrease of these two elements, too. Lee *et al* [11] studied effect of using water containing cadmium and chrome with density of more than 100mg/l to irrigate soils with different pH and suggested that there is a reverse relation between water PH and heavy metals uptake by crops and their excretion through drainage. However, there is a direct relation between heavy metals uptake and soil PH. Also, there is a reverse relation between soil pH and heavy metals uptake through soil. The results correspond with findings of this study.

CONCLUSION

According to this study, repetitive use of wastewater and sullage at the Basin of TalkheRud River (due to permanent shortage of agricultural water) leads to contamination of farms and crops and accumulation of heavy metals in soil and crops. Water runs in TalkheRud River only during limited times of year. Thus, it seems necessary to establish filtration plants in all units producing sullage in the river basin as well as control and supervise over application of sullage and wastewater in the region.

In comparison with other contaminators, heavy elements are very resistant and stable in soil such that the soil is contaminated forever. Soil contamination with heavy metals has now become a critical environmental concern since it may leave harmful ecological effects. Also, vegetables cultivated in these farms transfer the elements to our food chain through their uptake and accumulation in their edible parts. According to this study, the vegetables cultivated in this basin contain high levels of heavy elements which may be harmful in long term.

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