

## Accumulation of Cadmium and Lead in Soils and Vegetables of Lenjanat Region in Isfahan Province, Iran

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**Abstract.** Various heavy metals have been reported as dangerous agents to the human health and wildlife when they occur in the environment at high concentrations. Cadmium and lead compounds are classified as human carcinogens by several regulatory agencies. Vegetables grown at environmentally contaminated sites could take up and accumulate metals at concentrations that are probably toxic to human health. In this study, concentrations of cadmium and lead in some of vegetables and soil samples were investigated in different areas of a developed industrial city in Isfahan province, Central Iran. One hundred and thirty topsoil samples and fifty samples of vegetables were collected from agricultural lands and analyzed for heavy metals. The concentration of Pb and Cd was more than 5 and 0.5 mg kg<sup>-1</sup>, respectively. The total of Cd concentration in most of the soil samples exceeded the suggested Swiss thresholds (0.8 mg kg<sup>-1</sup>). The results showed that 48% and 75% of the vegetables samples had concentrations of Cd and Pb exceeded the FAO-WHO limits, respectively. Results from the present study demonstrate that the most of the plants grown on the soils of this region, contaminated with heavy metals, and pose a major health concern.

**Key words:** Heavy metals, Soil contamination, Vegetables, Isfahan

### Introduction

Heavy metals (HMs) such as cadmium and lead present a risk for human health because they are no degradable pollutants, having a large spectrum of effects (e.g., nervous or digestive system disturbances and carcinogenic effects), especially for young children who are more sensitive than adults (Li et al., 2004). Excessive exposure to HMs has been shown to cause various diseases (Jarup, 2003). For most people, the main route of exposure to toxic elements is through dietary intake (Calderon et al., 2003; Roychowdhury et al., 2003). Vegetables constitute an important part of the human diet since they contain carbohydrates, proteins, as well as vitamins, minerals and trace elements (Abdola, and Chmelnicka, 1990). Metal accumulation in vegetables may pose a direct threat to human health (Damek-Poprawa et al, 2003).

It is believed that vegetables can become contaminated with HMs if they grow on soils

contaminated by mining, vehicular exhaust, industrial activities and other agriculture activities (Cui et al., 2004). The levels of HMs in vegetables and soils and their risk to people are of great public concern (Wang et al., 2008, Xie et al., 2006). Vegetables take up metals by absorbing them from contaminated soils, as well as from deposits on different parts of the vegetables exposed to the air from polluted environments (Zurera and Moreno, 1984). Generally Cd accumulation in various plant parts in vegetable crops was increased with the increasing cadmium concentrations in the growth medium. The purpose of this study was to analyze the lead and cadmium concentration of soils and some vegetables grown in Lenjanat region, Isfahan, Iran.

### Materials and Methods

The studied site was located in the Lenjanat region in Isfahan province and the total experiment area of this site was 75 km<sup>2</sup>. Isfahan is an industrial city in central Iran in

which intensive agricultural lands surrounded by different industries like steel and cement-making factories and lead mining. The soils of this region are Aridisols. The average annual rainfall and temperature of the region are 100 mm and 15.5°C, respectively.

One hundred and thirty topsoil samples and fifty samples of vegetables from different soil map units were randomly collected and transported to the laboratory. Basic soil characteristics were determined using common methods. Total concentration of Cd and Pb were extracted from the soil samples using concentrated HNO<sub>3</sub> (Allen et al., 1986).

Cadmium and lead of plant samples were prepared according to the procedure of Dry-ashing. Heavy metals were extracted by 3 N HCl. The metal contents of soil and vegetables were determined by flame atomic absorption spectrometry (FAAS).

Descriptive statistics variables including mean, variance, maximum, minimum, coefficient of variation (CV), and skewness were calculated using STATISTICA 6.0 software.

## Results and Discussion

In Table 1, descriptive statistics for heavy metal (Cd and Pb) concentrations in soils and plants was presented. In the soil samples, the concentration of Cd showed a nearly normal distribution whereas concentration of Pb had a positive skewed distribution. Among parameters, coefficient of variability (CV) is the most discriminating factors for describing variability (Zhang et al., 2007). The CV of Cd in this study indicating moderate variability. In comparison, the CVs of plant Cd and Pb were 111.76%, and 73.88%, respectively; indicating plant had high variability of Cd in the study area.

There is no universally accepted safe level for assessing the state of Cd pollution in soils. Therefore, different levels are used in different countries (Kabata-Pendias and Pendias, 2001). In this study, the environmental standards based on Swiss Federal Office of Environmental, Forest and Landscape were used for the threshold values of heavy metal pollution in the soils (VBBo). In Table 1, the mean value of Cd concentration in soils was higher than the threshold of 0.8 mg kg<sup>-1</sup> set by VBBo (FOEFL, 1998) and also the maximum allowable limit (1 mg kg<sup>-1</sup>) set by United Kingdom (Kabata-Pendias and Pendias, 2001), but the mean value of Pb concentration in soil was less than the threshold of 50 mg kg<sup>-1</sup> set by VBBo (FOEFL, 1998). A total concentration of Cd in 75% of soil samples is more than 0.8 mg kg<sup>-1</sup> and more than 1 mg kg<sup>-1</sup> in 67% of the samples. About 7% of the data points have more than 2 mg kg<sup>-1</sup> Cd and more than 1% have the Cd concentration higher than 3 mg kg<sup>-1</sup>. Total soil Pb content ranged between 1.8 and 115.75 mg kg<sup>-1</sup>, with a mean value of 14.23 mg kg<sup>-1</sup>. About 5% of the samples have Pb concentration more than the threshold of 50 mg kg<sup>-1</sup>.

Concentration of Cd and Pb elements found in vegetables were also summarized in Table 1. According

to the FAO-WHO, the maximum permissible limits of Cd and Pb for vegetables and fruits are 0.1 and 0.3 mg kg<sup>-1</sup>, respectively, on a dry weight basis. The results showed that the levels of Pb in all vegetable samples were between 0.04 to 8.15 mg kg<sup>-1</sup>. Cd contents in vegetables varied from no detectable limit by flame atomic absorption spectrometry to 0.9 mg kg<sup>-1</sup>. In 48% and 75% of the vegetables samples, concentrations of Cd and Pb exceeded the FAO-WHO limits, respectively. The high contamination found in fruits and vegetables might be closely related to the pollutants in irrigation water, farm soil (Qiu et al., 2000), fertilizers, dusts and also the pollution from the highways traffic. Some of the agrichemicals such as fertilizers contain Cd and Pb, which are 0.0005–0.5, 0.0008–0.93 mg kg<sup>-1</sup>, respectively (Wang and Ma, 2004). Heavy metal concentrations in our study were lower than the corresponding to metal concentrations detected in the plants grown in contaminated soils of Van region in Eastern Turkey (Turkdogan et al., 2002). Preparing the maps of heavy metals from the soil and dust of the region is recommended for future investigations.

## Conclusion

High heavy metal concentration in the area is associated with a wide range of sources. One of the main sources of Cd emissions into the environment can be attributed to the active different industries like steel and cement-making factories and Pb mining in the study area. The accumulation of Cd and Pb in fields may also partly be due to the application of agrochemicals. The long-term application of agrichemicals may result in the accumulation of heavy metals in plants so that heavy metal concentrations in some of the vegetables exceeded the threshold values. Results from the present study demonstrate that the most of the plants grown on the soils of this region, contaminated with heavy metals, and pose a major health concern. However, vegetables may be contaminated easily during growing. So, it is important to have a good quality control for these plants in order to protect consumers from contamination. Further investigations on this subject like analyzing of heavy metals content in water and dust of the region could provide us a better insight to know about the pollution of this region and also to solve the problem.

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Table 1. Descriptive statistics of heavy metal concentration in soil and plants of the region.

Element	Sample number	Mean	Minimum	Maximum	Variance	CV%	Skewness	Threshold
Cd in soils (mgkg <sup>-1</sup> )	130	1.34	0.30	3.12	0.27	38.81	0.85	<b>0.8<sup>a</sup></b>
Pb in soils (mgkg <sup>-1</sup> )	130	14.23	1.8	115.75	226.33	110.75	4.76	<b>50<sup>a</sup></b>
Pb in vegetables (mgkg <sup>-1</sup> )	50	2.91	0.04	8.15	4.65	73.88	0.34	<b>0.3<sup>b</sup></b>
Cd in vegetables (mgkg <sup>-1</sup> )	50	0.17	N.D <sup>c</sup>	0.9	0.036	111.76	1.95	<b>0.1<sup>b</sup></b>

<sup>a</sup> Environmental standards in the ordinance of Swiss Federal Office of Environmental, Forest and Landscape (mgkg<sup>-1</sup>).

<sup>b</sup> Guidelines for maximum limit (ML) of metals in vegetables was adopted from FAO-WHO (mgkg<sup>-1</sup> dry weight).

<sup>c</sup> N.D: Not detectable.