Determination of lead and cadmium in vegetables
farmed countryside Kermanshah, Iran

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Abstract

Heavy metals are considered dangerous environmental pollutants for human health and environment. Vegetables are the important components of healthy and appropriate diet and obtained evidence from various studies in recent years suggest that the consumption of healthy vegetables can prevent heart disease and some types of cancers, especially gastrointestinal tract cancers. This cross-sectional descriptive study was conducted in 2016. Five types of orally consumed vegetables (mint, fenugreek, fennel, leek and parsley) were selected. Then of each vegetable, three different examples of suburb region were prepared for analysis of lead and cadmium concentrations. In order to perform weight sampling of each taken vegetable, 1 kg and totally 5 kg of vegetables were provided from each farm. The results showed that the concentration of lead and cadmium heavy metals in all samples is lower than 5 ppb and 2 ppb. Due to the absence of heavy industry and heavy metal contamination around Vegetable farms, it was justifiable. Extensive studies have shown that consumption of vegetables contaminated with cadmium and lead has hazards to human health.

Keywords: lead; cadmium; vegetables; countryside; Kermanshah

Introduction

Heavy metals are considered dangerous environmental pollutants for human health and environment. These elements can be effective on the quality of agricultural soils and in addition of being toxic, by absorbing through plants can enter into the human diet and causing problems in the human body. Also, due to the lack of destruction and degradation, they are called sustainable environmental pollutants. So, we always try imposing limits for the amount of these toxic substances and certainly such boundary value are different for each of the plants and soil types (Mofrad et al., 2013). Vegetables are the important components of healthy and appropriate diet and obtained evidence from various studies in recent years suggest that the consumption of healthy vegetables can prevent heart disease and some types of cancers, especially gastrointestinal tract cancers.
entering Heavy metals into the food chain and reaching to a critical concentration leaves harmful metabolic and physiological effects in living organisms (Ghosh .,et al). Some heavy metals such as lead, cadmium and arsenic are harmful for plants, animals and humans Cadmium is known as a carcinogen matter to cause most cancers (Kabata-Pendias, 2011). And it seems to be an influencing factors in creating heart disease and high blood pressure (Edmunds, 1996). Lead metal also leads to metabolic disorders and birth - physical defects in children by affecting the blood and kidneys system. It was also reported when a large amounts of heavy metals such as lead enter to pregnant mother's body, premature birth and severe mental retardation babies will be greatly increased (Ferri, 2006).

All way stated that relatively high concentrations of cadmium can accumulate in the edible part of the plant without manifesting the diseases symptoms and effects in plant (Ghosh .,et al).Cadmium accumulation in plants can increase absorption potential this element in human and this is done in a manner which these plants are part of the diet ration (Kabata-Pendias, 2011). Vegetable contamination by heavy metals may be due to irrigating by wastewater, fertilizers, pesticides and factory leakage (Jahehed Khaniki, 2007). A higher intake of vegetables are useful as a source of vitamins, nutrients and fiber for overall health, while these plants contain toxic substances, and the risk higher than allowable concentration (Maleki et al., 2008). Iran is a vast country like other countries in the arid belt of land has aridity problem and major cities in order to compensate part of their needs obliged to consume a considerable amount of municipal and industrial waste. Long-term application of these wastewaters which is mainly used for vegetable cultivation leads to the accumulation of heavy metals to the soil and transferring them to plant species with concentration more than threshold. In one study which was performed on the fate of heavy metals using of Firozabad wastewater stream in agricultural lands located south of Tehran, the result showed that the mean concentration of cadmium accumulation in plants is 1.5 to 2 times higher than non-infected areas located southern regions of Tehran (Givianrad et al., 2011).

Absorbing heavy metals from contaminated land by plants, especially agricultural products is one of the most important way to enter such elements to food chain (Fu et al., 2008). Annually, about 38,000 tons of cadmium and almost a million tons of lead is added to the world soils which a large amounts are related to atmospheric dust, distribution of ash and municipal waste and their concentrations involving the use of chemical fertilizers and sewage sludge (Nriagu et al., 1998). In a study conducted by Goianrad and colleagues in Tehran results have shown that the most lead and cadmium contamination was determined 0.14 and 0.15 milligrams per kilogram of fresh vegetables respectively were higher than allowable values of Europe Union (Givianrad et al., 2011). In the study of Etminanrad et al. (2003) in Yazd results have shown that the cobalt in cabbage samples was 0.03 ppm and in spinach was 0.04 ppm (Etminanrad et al., 2004). Also in the Cheraghi and colleagues study (Cheraghi and colleagues, 2011) in terms of determining the amount of cadmium, nickel, lead and zinc in parsley vegetable harvested from some farms in Hamadan has shown that the mean concentrations of Cd, Ni, Pb and Zn in
parsley vegetable was 1.14, 2.56, 16.65, 25.23 mg per kg respectively (Chraghy et al., 2010). Since the two lead and cadmium heavy metals are known as a crucial carcinogenic element in the development of cancer, particularly gastrointestinal cancer, so the aim of this study was to investigate the levels of lead and cadmium in farmed vegetables at the suburb of Kermanshah.

Materials and Methods

This cross-sectional descriptive study was conducted in 2016. 5 types of orally consumed vegetables (mint, fenugreek, fennel, leek and parsley) were selected. Then of each vegetable, three different examples of suburb region were prepared for analysis of lead and cadmium concentrations. In order to perform weight sampling of each taken vegetable, 1 kg and totally 5 kg of vegetables were provided from each farm. Of each farm, samples were randomly sampled from the beginning, middle and end of the farm to determine the average state of each farm in terms of contamination to heavy metals. Sampling was conducted during the summer season and overall 15 vegetables samples were taken from the suburbs of Kermanshah. Sampled vegetables rinse with distilled water and then placed in the oven for 8 hours and after complete drying of vegetables, the next operation was carried out as follows. After determining exact weight, 2 g of sample was poured into the Chinese plant; samples were placed for 5 hrs in electric furnace at temperatures of 550°C, to prepare vegetable ash. On the produced ash at the first, 5 ml of concentrated nitric acid was poured and was heated on the electric heater for evaporation of all the added acid. Then 10 ml of 10% nitric acid was added to the sample and solution passed from the 42 Wattman filter paper and entered to volumetric flask with volume of 50 ml and was diluted with nitric acid and brought to volume. In order to measure heavy metals in vegetables, the ICP-AES device was used.

Results

Examined vegetables from three areas of Kermanshah (Miandarband, Elahie and Droodframan) were analyzed. According to the taken survey, examined vegetables in Miandarband region in the beginning of spring planted and harvested in mid-summer, the second stage of planting begins in mid-summer. Irrigation method in this area for three days a week was flooding. Vegetables in Elahie area using well water for irrigation by flooding method in one day a week. Third area consists harvested vegetable including Drood-Framan range. Irrigation was by the use of ghanat water and twice spraying was done till harvesting. Device analysis results showed that the concentration of lead and cadmium heavy metals in all samples were below the device detection limit (Lead was 5 ppb and cadmium was 2 ppb) (Table 1).

Table 1. The results of a quantitative laboratory measurement for lead and cadmium

<table>
<thead>
<tr>
<th>Sample number</th>
<th>Lead (pb)</th>
<th>Cadmium (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leek 1</td>
<td>≤5</td>
<td>&lt;2</td>
</tr>
<tr>
<td>Mint 1</td>
<td>≤5</td>
<td>&lt;2</td>
</tr>
<tr>
<td>Fenugreek 1</td>
<td>≤5</td>
<td>&lt;2</td>
</tr>
<tr>
<td>Parsley 1</td>
<td>≤5</td>
<td>&lt;2</td>
</tr>
<tr>
<td>Dill 1</td>
<td>≤5</td>
<td>&lt;2</td>
</tr>
<tr>
<td>Leek 2</td>
<td>≤5</td>
<td>&lt;2</td>
</tr>
<tr>
<td>Mint 2</td>
<td>≤5</td>
<td>&lt;2</td>
</tr>
<tr>
<td>Fenugreek 2</td>
<td>≤5</td>
<td>&lt;2</td>
</tr>
<tr>
<td>Parsley 2</td>
<td>≤5</td>
<td>&lt;2</td>
</tr>
<tr>
<td>Dill 2</td>
<td>≤5</td>
<td>&lt;2</td>
</tr>
<tr>
<td>Leek 3</td>
<td>≤5</td>
<td>&lt;2</td>
</tr>
<tr>
<td>Mint 3</td>
<td>≤5</td>
<td>&lt;2</td>
</tr>
<tr>
<td>Fenugreek 3</td>
<td>≤5</td>
<td>&lt;2</td>
</tr>
<tr>
<td>Parsley 3</td>
<td>≤5</td>
<td>&lt;2</td>
</tr>
<tr>
<td>Dill 3</td>
<td>≤5</td>
<td>&lt;2</td>
</tr>
</tbody>
</table>
Discussion

The results showed that the concentration of lead and cadmium heavy metals in all samples is lower than 5 and 2 ppb. Due to the absence of heavy industry and heavy metal contamination around Vegetable farms, it was justifiable. Extensive studies have shown that consumption of vegetables contaminated with cadmium and lead has hazards to human health (Banerjee et al., 2010). Cadmium causes kidney damages, hypertension, mutagenic and carcinogenic diseases and lead damages to the hematopoietic, nervous and kidney system (Nazemi et al., 2010). The maximum allowable concentration of cadmium and lead in plants for human consumption should not be greater than 0.1 and 5 mg per kg (Dadban et al., 2008). According to FAO, the allowable amount of cadmium intake to the body on a weekly basis was 0.4-0.6 mg for each person (Samarghandi et al., 2000). The World Health Organization has declared the allowable amount of cadmium in the diet of humans was equivalent to 7 mg per kg of body weight and the maximum allowable in human food was equivalent to 0.1 ppm (Yarghali et al., 2009).

In a study conducted by Nazemi and colleagues, the average concentration of lead and cadmium was more than the standard range provided by FAO and WHO for the plant. They assessed urban and industrial wastewater as the main reason of vegetables contamination (Nazemi et al., 2010). In another study was conducted by Shabankhani and colleagues, the amount of lead and cadmium was higher than the standard level, and raised water and wind factors as the main cause in lead transfer to plants (Shabankhani et al., 1991). In another study conducted by Rajesh Kumar Sharma and colleagues showed that the average concentration of cadmium in cabbage had exceeded from PFA standard. Cadmium tested vegetable spaces in manufacturing and markets places was more than the standard of Europe Union. But lead in manufacturing and markets places was lower the range of PFA and higher than EU standards and WHO (Sharma et al., 2009). According to a study by Alidadi et al (2014), the absorption and accumulation of lead and cadmium in vegetables (leafy vegetables) is more than radish (glandular vegetable) (Alidadi et al., 2014).

Banerjee et al. (2010) reported that the concentrations of lead in washed samples of cauliflower, pumpkin and spinach were exceeded than standard level but cadmium was in standard range and also reported that precipitation of heavy metals is associated with a wide range of sources like small industries, vehicles emission, suspended road dust, coal combustion (Banerjee et al., 2010). By comparing to another study by Gupta and colleagues (2010) showed that the amount of volatile metal such as mercury, arsenic found more in the stem. Plants absorb cadmium through their roots which due to the small amount of cadmium in analyzed soil can be the cause of small amounts of cadmium in the stem ginger samples (Gupta et al., 2010). Bo Sang and colleagues (2009) examined all metals (cadmium, lead, chromium, and nickel, arsenic, copper) except lead of produced vegetables in the local area or other outdoor or greenhouse vegetables (Bo et al., 2009). Rajesh Kumar Sharma and colleagues (2009) showed that the transport and marketing system play an important role in raising levels of heavy metals and a danger to the quality of vegetables and consequences in consumer health that...
reflects the important role of place and time (Sharma et al., 2009).

Hong and colleagues (2007) concluded in their study that transmission of heavy metals factors from soil to vegetables reduced as cadmium > Zn > Cu > Pb > Hg. Transmission factors of heavy metals in leaves is more than any other tissues (Zheng et al., 2007). Also in the study by Nabulo greese and colleagues (2006) showed that high concentrations of lead and cadmium were found especially in leafy vegetables and is in accordance with study, and the concentration of lead in the soil beside the road and leaf vegetables is a function of traffic density. It also suggested that for agricultural activities in cities, a distance of 30 meters from the side of the road, especially along busy highways is an assurance distance and by washing the vegetables, it reduces the amount of lead and cadmium in vegetables (Nabulo et al., 2006).

Conclusion

According to this study, the low lead and cadmium concentration in investigated vegetables could be due to the small number of polluting industries around vegetable farms in Kermanshah city. However, due to the presence of waste around the Elahie region and a lesser amount in Droodfaraman region, the possibility of exposure to the elements or other disruptive materials is high. Human activities in the surrounding area, irrigation with effluent or entering sewage accompanied by runoff to arable land and excessive use of fertilizers because the need for regular checking of heavy metals in various foods is essential to assess the health risks posed by heavy metals and ensure the food safety. As well as agricultural land than highways and roads, factories and power plants must meet the minimum standard distance and educating the people and use the alternative vegetable with lower emissions of lead and cadmium.

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