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Determination of three heavy and toxic metals in different parts of mint and basil vegetables and related soil

Rahmatallah Rahimi[1]*, Neda Goodarzi[2]

[1]Department of Chemistry, Iran University of Science and Technology (IUST), Tehran, (IRAN)

[2]Department of Chemistry, Islamic Azad University, Saveh Branch, Saveh, (IRAN)

E-mail: rahimiius96@yahoo.com; rahimi_rah@iust.ac.ir

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ABSTRACT

Vegetables with trace elements are necessary for human body, therefore these element are needed to be supplied continually for daily life. In this report three element of Cd, Pb and Co were isolated from stem and leaf of mint and basil vegetables, and from the soil of Saveh and Broujerd cities In Iran. The characterization was done by Atomic Absorption; by comparing the results, it shows that absorption strength for Cd, Co and Pb elements from soil in basil vegetable is lower than in mint vegetable. The air pollution has no effect in absorbing the elements Cd, Co and Pb by basil vegetable but, it has been observed that air pollution has some effect for absorption of Cd, CO and Pb by mint vegetable In Saveh Industrial city.

KEYWORDS

Heavy;
Toxic elements;
Mint vegetable;
Basil Vegetable;
Transfer factor.

INTRODUCTION

Vegetables are necessary for human diet because they have some micro or trace elements which are needed for good health if they come from an organic or plant Source, but if they originates from an inorganic or metallic source abundant with heavy metals, they become toxic[13]. If these vegetable are grown in the lands which environmentally are polluted, they have potential to uptake the toxic elements from soil. The plants with extremely high uptake ability (Hyper accumulator) can be used to extract toxic metals from soils[12,16]. The soil-to-plant transfer factor (also termed uptake factor, accumulation factor, and concentration factor) is an index for evaluating the transfer potential of a metal from soil to plant. The transfer factor is generally defined as the ratio of metal concentration in plant to the total metal concentration in soil[4,5,9]. For a given metal, the transfer factor varies greatly with plant species[1,4,5,9,10]. Reports indicate that lead, cadmium, chromium and arsenic may cause a wide variety of changes in biological systems, even at very low concentrations[3]. Some elements including arsenic, cadmium and chromium are carcinogenic. Others, such as lead and mercury have been associated with developmental abnormalities including autism in children[11]. In regard to trace elements in vegetables and fruits, some studies have been done by Pinochet *et al*.[14] on selenium and copper in vegetables and fruits grown on long-term impacted soils from the Valparaiso region of Chile.[17] have also studied on The trace elements of As, Cd, Co, Cr, Fe, Mn, Ni, Pb, Se, V, and Zn in various common vegetables and surface

soil from typical areas in North West of Greece. Some studies reported that the quantity of soil metals in vegetable depends on soil properties, soil metal specification, and plant species[6,7]. There are reports that some heavy metal contamination in vegetable crops transferred from atmospheric heavy metal into leaves of plants[2,15]. In this report we have also proved that air pollution is an important pathway of heavy metals contamination for vegetable crops.

MATERIALS AND METHODS

Sample collection

Different parts of mint vegetable such as stems and leaves and related soils were collected from regions of Saveh, and Broujerd cities in Iran.

Vegetable samples

Initially each of the vegetable samples after cleaning and separating the stems from leaves were washed several times with tap water then with distilled water and were carefully dried in oven at 150°C for 15 hr. The dried samples were grounded with pestle in mortar followed by wet digestion to the volume of 25 mL with (1:1) concentrated HNO3/HClO4 acid mixture, then solution was heated but not to the boiling point, heating was done till mixture was dried up completely. It was then cooled and the precipitate/digest mixture was extracted in 5mL 2N HCl and diluted with50mL distilled water. The samples were analyzed for metal content using AAS.

Soil samples

The soil samples were air dried and powdered in an agate mortar, Half a gram of soil samples was mixed with 20mL HNO3/HCl (1:1) acid mixture, and the content was heated near dryness. It was then cooled and precipitate/digest mixture was extracted in 5mL, 2N HCl and diluted with 50mL distilled water. The samples were analyzed for metal content using AAS.

Moisture determination of vegetables

At first, the accurate weight of fresh vegetable was measured and after complete dryness, it was measured again. As such, rate of percent moist present in each of vegetables could the calculated as follows; the calculated results are presented in TABLE 1.

TABLE 1 : The water content (%) of vegetables

English name	Sample Sites	Water content (%)
Mint	Bj	88.9
	Sv	87.61
Basil	Bj	90.2
	Sv	88.5

Sampling sites named after the first letter of corresponding Sampling sites: Bj for the city of Broujerd and Sv for saveh

Amount of moist = Initial weight – dry weight

$$\%\,\text{moist} = \frac{\text{Amount of moist}}{\text{Initial weight}}$$

RESULTS AND DISCUSSION

In this study, the concentration of Pb, Co and Cd have been measured in mint and basil vegetables and the related soils from the regions of Saveh and Broujerd cites in Iran and the results are presented in TABLE 2, the Concentration order of these elements in the mint leaf from a region of Broujerd city are: Pb (0.241ppm), Co (0.132ppm) and Cd (0.121ppm) (Pb> Co> Cd), in mint stem Pb> Cd> Co, and also in the collected soil from the same region are: Pb> Co> Cd. Based on the given data in TABLE 2, the concentration of Cd and Pb elements in mint stem is greater than in mint leaf. In overall comparison, the order of elements for three sources from Broujerd city are: soil Pb> Co> Cd, stem Pb> Cd> Co, leaf Pb> Co> Cd. The concentration, the order of these elements in mint leaf from a region of Saveh city are; Pb> Cd> Co, and in mint stem; Pb> Cd> Co, and in the releted soil; Pb> Cd> Co, as a result of a above order, the increase order of concentration is same for all three sources in Saveh city. There is a difference in concentration order for different regions of collections, the concentration of Cd and Pb elements in mint stem in Saveh and Broujerd cites are higher than mint leaf, but concentration of Cd and Pb elements in basil leaf are greater than basil stem. The concentration of Co in basil stem is greater than basil leaf, but concentration of Co in mint leaf is greater than mint stem.

The comparison of chemical analysis results for basil vegetable during different period of cultivation times (1, 1.5, 2.5 months after cultivation), shows that concen-

tration of Pb, Co and Cd during the one month cultivation is higher than after 1.5 month cultivation, that is also higher than 2.5 month cultivation (TABLE 3), so concentration of elements in leaf become lower as culti-

TABLE 2 : Element concentrations (ppm) in vegetable and corresponding soil from the Saveh and Broujerd cities

vegetable	Sample Sites	Cd			Pb			Co		
		Leaf	stem	soil	Leaf	stem	soil	Leaf	stem	Soil
Mint	Bj	0.121	0.1425	0.129	0.241	0.382	0.522	0.132	0.0059	0.132
	Sv	0.121	0.134	0.091	0.414	0.779	0.329	0.049	0.041	0.09
Basil	Bj	0.03	0.028	0.077	0.292	0.289	0.3	0.081	0.138	0.169
	Sv	0.047	0.027	0.064	0.234	0.21	0.343	0.04	0.055	0.131

Sampling sites named after the first letter of corresponding sampling sites: Bj for the city of Broujerd and Sv for saveh

TABLE 3 : The concentrations of elements in basil vegetable based on cultivation times

Timing	Elements	Leaf	Stem	soil
1 month after cultivation	Cd	0.0712	0.0578	0.064
	Pb	0.401	0.395	0.343
	Co	0.0484	0.0674	0.131
1.5 month after cultivation	Cd	0.04765	0.0278	0.064
	Pb	0.234	0.210	0.343
	Co	0.0401	0.0554	0.131
2.5 month after cultivation	Cd	0.0217	0.042	0.064
	Pb	0	0.034	0.343
	Co	0.334	0.0434	0.131

3-1 The transfer factors from soil to different part of basil vegetable

TABLE 4 : The transfer factor of heavy metals from soil to the vegetable

Timing	Elements	Leaf	Stem
1 month	Cd	1.11	0.69
	Pb	1.16	1.15
	Co	0.36	0.51
1.5 month	Cd	0.74	0.43
	Pb	0.68	0.612
	Co	0.3	0.42
2.5 month	Cd	0.33	0.65
	Pb	0	0.099
	Co	0.25	0.33

vation time has been increased. Therefore premature use of crops is not recommended.

The transfer factor (TF) was calculated to indicate the accumulations of metals transferred from soil into vegetables, and it is described as following formula:

$$TF = \frac{[M]vegetable}{[M]soil}$$

[M]vegetable: is the concentration of a metal in the tissue of vegetables (stem or leaf), in dry matter;
[M]soil: is the total concentrations of a metal in soils where this vegetable is grown, in dry matter.

The TF values of heavy metals from soil to leaf and stem during the one month cultivation is higher than after 2.5 month cultivation (TABLE 4).

By comparing the result of chemical analysis from two regions, the heavy and toxic elements concentration are more in Broujerd city soil than Saveh city soil. In Figure 1, the concentration of elements in leaves and stem of mint and related soils from Saveh and Broujerd cities are compared.

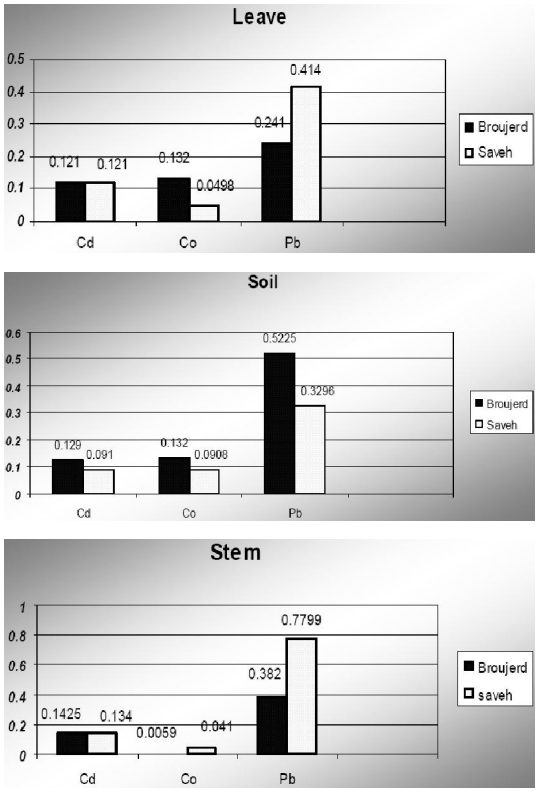

Figure 1 : Concentration of elements in leaves and stem of mint and soil from Saveh and Broujerd cities

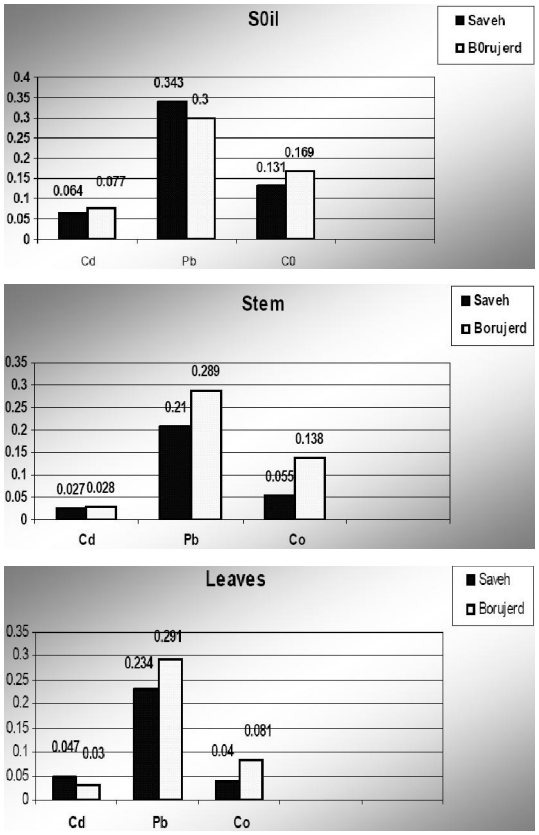

Figure 2 : Concentration of elements in leaves and stem of basil and soil from Saveh and Broujerd cities

The concentration of element Pb in basil vegetable soil from Saveh city is higher than concentration of element Pb in Broujerd city and concentration elements Pb and Cd in Saveh city soil is lower than concentration of elements Pb and Cd in Broujerd city soil (figure 2). The concentration of elements Pb, Cd and Co in basil stem vegetable from Saveh city is lower than basil stem vegetable from Broujerd city.

The concentration of elements Pb and Co in basil vegetable leaf from Saveh city is lower than concentration of elements Pb and Co in basil vegetable leaf from Broujerd city but concentration element Cd in basil vegetable leaf from saveh city is higer than concentration of element Cd in basil vegetable leaf from Broujerd city.

CONCLUSION

It is possible to conclude that in basil vegetable adsorption rate for elements of Co, Cd and Pb is less than mint vegetable. By comparing the effect of different cultivation times, in basil vegetable, when it is not reached to its complete maturation, the concentration of elements Co, Cd and Pb is very higher than the time when it has been reached to it is complete maturation.

In this reaserch, it has been found that the Broujerd soil, has toxic element like Cd and Pb in higher concentration than Saveh city, this may be caused by chemical fertilizer or well water. Since the concentration of elements Cd and Pb is very low in soil of Saveh city, comparing with Broujerd, it was expected that the concentration of these elements to be very low in mint vegetabl in Saveh city, but unfortunately it was observed that, this is not the case, as such that, the concentration of these element in vegetables of Saveh city is also high, this may be the cause of very heavy air pollution originated from Kaveh Industrial city of Saveh. it is possible that The leaves of vegetable could adsorb heavy metals from atmosphere and atmospheric deposit on the leaves surfaces such results also was reported by Wang et al.,[18]. In overall conclusion, by comparing the air pollution and soil pollution effects on intake and adsorption of toxic elements by vegetable, data shows that air pollution has more effect than soil pollution.

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