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Study of heavy metals in some Green Leafy Vegetables in Sulaimani, Kurdistan-Iraq

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Abstract

*The paper presents the results of a study on the heavy metals in some green leafy vegetables.The leafy vegetables were sampled from different areas of Sulaimani city. They were digested using three- acid mixture (68%HNO3, 98%H2SO4 and 37%HCL). Analyzing of the heavy metals was performed using atom absorption spectrophotometry. The concentrations (mg/kg) of heavy metals in samples were ranged from 6.118 to 339.646 for Fe , 0.*140 *to 0.247 for Cr , 0.00*1 *to 0.027 for Cd, 0.196 to 0.3*60 *for Cu, 0.037 to 0.503 for Ni and 0.690 to 2.*608 *for Zn. The highest concentration of heavy metals was for Pb in leek and Fe curly cress at the Garazel. The amount of Cu in mint, leek, dill and celery in the samples collected from wuluba farms was more than those collected in Garazel farms. In contrast, the amount of Ni in mint, leek, dill and celery for the sample collected from Garazel farms were more than those of Wuluba farms. Thus, the amount of Pb in dill, celery, curly cress and Cd in mint, leek, dill for the sample collected from Wuluba farm was more than those of Garazel farms. However, the amount of Zn in mint, celery and curly cress for the sample collected from Wuluba farm were more than those of Garazel farms. Also, the amount Fe in mint, dill, celery, curly cress and Cr in celery, curly cress in the sample collected from Garazel farm was found to be higher compared to those of Wuluba farms. It can be concluded from this investigation that the amount of Pb, Fe, Cr, Cd, Cu, Ni and Zn was lower than the acceptable level recommended by WHO, FAO.*

Keywords: *Heavy metal, Leafy Vegetable, Garazel, Wuluba*

Introduction

Vegetables are an important part of human daily diets. They are naturally good and contain lots of minerals and vitamins that help in protecting the human body **(**Watson and Preely, 2011). They are an essential source of a wide range of vital micronutrients and are usually consumed in relatively small amounts as a side dish or relish with staple food (IARC, 2003). Leafy vegetable are widely used for culinary purposes. Vegetables are used to increase the quality of soups and also for dietary purposes. They made up chiefly cellulose, hemi-cellulose and pectin substance that give them texture and firmness **(**Sobukola et al. 2010). Several researchers observed that consumption of vegetables could prevent a number of chronic and non-communicable diseases and could contribute substantial to protein, minerals, vitamins, fiber and other nutrients which are usually in short supply in daily diets **(**Jimoh et al . 2012). However, these plants contain both essential and toxic elements over a wide range of concentrations(Radwan and Salama, 2006). Metals accumulation in vegetables may pose a direct threat to human health (Oluwole et al. 2013) because it has positive and negative roles in human life **(**Adriano, 1984).**G**enerally,most heavy metals are not biodegradable, have long biological half-lives and have the potential for accumulation in different body organs leading to unwanted side effects **(**Jarup, 2003).

Green leafy vegetables take up elements by absorbing them from contaminated soils and waste water used to irrigate them as well as from deposits on different parts of the plant exposed to the air from polluted environment (Shuaibu et al. 2013). It has been shown that accumulation of heavy metals in the kidney and liver of humans may occur after prolonged exposure to unsafe concentrations of heavy metals through foodstuffs. The important effects of heavy metal poisoning are neurological disorders, central nervous system destruction, and cancers of various body organs. They may cause disruption of several biochemical processes, leading to cardiovascular, nervous, kidneys and bone diseases. Also, there are some reports showing low birth weight and severe mental retardation of newborn children were during pregnancy mother exposed to toxic amounts of a heavy metal through direct or indirect consumption of vegetables (Jafarian and Alhashem, 2013)

The main aim of this research work was to determine the concentration of heavy metals in seven different

Table (1) Concentration of Pb (mg /kg) in green leafy vegetables

Sampling site						
	Wuluba			Garazel		
Sample	**Mean**	Minimum	Maximum	**Mean**	Minimum	Maximum
Mint	**0.219±0.137**	0.0746	0.3481	**0.219±0.068**	0.1492	0.286
leek	**0.174±0.118**	0.0373	0.2487	**0.287±0.042**	0.241	0.3233
dill	**0.200±0.148**	0.0294	0.2984	**0.149±0.113**	0.0249	0.2487
Celery	**0.103±0.068**	0.0249	0.1492	**0.071±0.005**	0.0657	0.0746
Curly Cress	**0.211±0.140**	0.0497	0.2984	**N.D**	N.D	N.D
FAO/WHO Safe limit	**0.300**			**0.300**		

Table (2) Concentration of Fe (mg/kg) in green leafy vegetables

Sampling site						
	Wuluba			Garazel		
Sample	**Mean**	Minimum	Maximum	**Mean**	Minimum	Maximum
Mint	**6.118±0.600**	5.6459	6.7946	**42.682±3.212**	40.350	46.347
leek	**38.729±11.512**	25.7195	47.602	**27.965±3.215**	24.7365	31.6165
dill	**6.346±1.637**	5.2197	8.225	**26.477±4.312**	23.03	31.3132
Celery	**23.470±4.857**	18.354	24.014	**36.761±10.111**	25.483	45.016
CurlyCress	**27.092±2.557**	24.9486	29.923	**339.513±56.804**	305.50	405.09
FAO/WHO Safe limit	**425.00**			**425.00**		

Table (3) Concentration of Cr (mg/kg) in green leafy vegetables

Sampling site						
	Wuluba			Garazel		
Sample	**Mean**	Minimum	Maximum	**Mean**	Minimum	Maximum
Mint	**0.156±0.079**	0.0841	0.241	**0.143±0.062**	0.0812	0.2071
leek	**0.189±0.043**	0.1431	0.23	**0.168±0.103**	0.0812	0.2823
dill	**0.159±0.079**	0.0812	0.241	**0.173±0.032**	0.1431	0.2071
Celery	**0.192±0.075**	0.1232	0.2723	**0.247±0.025**	0.2187	0.2621
CurlyCress	**0.140±0.087**	0.0812	0.241	**0.187±0.037**	0.1620	0.23
FAO/WHO Safe limit	**2.3**			**2.3**		

Table (4) Concentration of Cd (mg/kg) in green leafy vegetables

Sampling site						
	Wuluba			Garazel		
Sample	**Mean**	Minimum	Maximum	**Mean**	Minimum	Maximum
Mint	**0.006±0.003**	0.0043	0.0098	**0.027±0.018**	0.0161	0.0488
leek	**0.001±0.001**	0.0	0.0003	**0.015±0.006**	0.0085	0.0207
dill	**0.008±0.002**	0.0073	0.0122	**0.022±0.006**	0.0146	0.0244
Celery	**0.012±0.002**	0.011	0.0159	**0.011±0.001**	0.011	0.0128
CurlyCress	**0.012±0.005**	0.0073	0.0177	**N.D**	N.D	N.D
FAO/WHO Safe limit	**0.2**			**0.2**		

Table (5) Concentration of Cu (mg/kg) in green leafy vegetables

Sampling site						
	Wuluba			Grazel		
Sample	**Mean**	Minimum	Maximum	**Mean**	Minimum	Maximum
Mint	**0.360±0.045**	0.3141	0.404	**0.251±0.036**	0.2111	0.2828
leek	**0.357±0.019**	0.3349	0.3701	**0.206±0.032**	0.1696	0.2294
dill	**0.218±0.023**	0.2007	0.245	**0.196±0.018**	0.1799	0.2163
Celery	**0.257±0.026**	0.232	0.2841	**0.199±0.003**	0.1981	0.2033
CurlyCress	**0.222±0.035**	0.1864	0.2581	**0.207±0.011**	0.1942	0.2177
FAO/WHO Safe limit	**40.0**			**40.0**		

Table (6) Concentration of Ni (mg/kg) in green leafy vegetables

Sampling site						
Wuluba				Garazel		
Sample	**Mean**	Minimum	Maximum	**Mean**	Minimum	Maximum
Mint	**0.037±0.009**	0.03	0.048	**0.083±0.003**	0.0795	0.087
leek	**0.054±0.019**	0.0315	0.0675	**0.503±0.784**	0.048	1.4096
dill	**0.051±0.009**	0.042	0.060	**0.080±0.021**	0.06	0.102
Celery	**0.042±0.018**	0.021	0.054	**0.049±0.013**	0.036	0.063
CurlyCress	**0.104±0.042**	0.06	0.1455	**0.099±0.006**	0.093	0.105
FAO/WHO Safe limit	**67**			**67**		

Table (7) Concentration of Zn (mg/kg) in green leafy vegetables

Sampling site						
Wuluba				Garazel		
Sample	**Mean**	Minimum	Maximum	**Mean**	Minimum	Maximum
Mint	**1.448±0.192**	1.3093	1.6683	**1.294±0.251**	1.0948	1.5773
leek	**1.565±0.387**	1.1456	1.9082	**1.705±0.991**	1.0745	2.848
dill	**1.144±0.149**	0.9798	1.2701	**1.693±0.138**	1.5343	1.7864
Celery	**1.094±0.154**	0.9443	1.1253	**0.690±0.099**	0.587	0.7859
CurlyCress	**2.608±0.943**	2.5855	3.4455	**0.957±0.089**	0.8681	1.0475
FAO/WHO Safe limit	**99.40**			**99.40**		

green leafy vegetables collected from two different locations of wuluba (It is a place with a very small population in the state/region of Sulaimani - Iraq which is located in the continent/region of Asia) and Grazeel (it is a small Village in Township of Qaradax of the south Sulaimani) To confirm safety level of heavy metals in those vegetables they compared to what was recommended by the international organization.

Materials and Methods

Samples Collection

Chemical of analytical grade purity and distilled deionized water, HNO_3 concentration, HCL concentration, and H2SO4 concentration (Germany) were used. All glass wares and plastic containers used were washed with distilled water. Standard solutions of the metal salts and other reagents were prepared. In the present study has analyzed green leafy vegetable of Mint, Leek, Dill, Celeryand Curly cress were used. The samplewere collected from Sulaimani, Kurdistan-Iraq. Two locations were selected to collect the samples. They were Wuluba and Garazel. A total of 30 green vegetable samples were collected from different outlets farm in each location.

Sample preparation

After collection, the sample was all washed thoroughly with distilled water to remove surface pollutants, debris, sand and dust particles.The samples were then chopped into small pieces using a knife and kept in air-dried conduction for approximately 70 hours. Dried samples of the vegetables were crushed in a mortar and the resulting powders then stored in polyethylene bags, until used for acid digestion.

Acid Digestion

Heavy metals in green leafy vegetable samples were extracted following acid digestion procedure as follow: Approximately 1.0 gram of the samples were weighted and digested in a mixture of 5 ml of HCL, 2 ml of H2SO4 and 20 ml of HNO3 in a conical flask under a fume hood .The samples were mixed and heated for 30 min on an electric hot plate at 80-90 ^{o}C at which they were brought to a boil, and a clear solution was obtained. After cooling down, the solution was filtered through whatman filter paper no. 4. The solution was then preserved in a universal bottle for further analysis.

Analysis of Heavy Metal

The concentration of heavy metals in the acidic solution was estimated using Atomic Absorption Spectrophotometer (Shimatsu model No. AA-7000).

Data analysis

Data obtained were analyzed using Microsoft Excel, and results were expressed as mean ± standard deviation.

Results

The concentration of heavy metals was presented separately for each mineral. The means of heavy metals concentrations investigated were for commonly consumed as green leafy vegetables (Mint, leek, dill,

celery and curly cress) in Sulaimani city. The heavy metal levels determined were based on the plant dry weight. The observed concentrations of Pb, Fe, Cd, Cr, Cu, Zn, and Ni in the vegetables were compared with the recommended limit as established by the FAO/WHO in 2001 to assess the levels of food contamination.

Table 1 showed that the lowest lead (Pb) level (0.071mg/kg) was found in celery, and the highest concentration (0.287 mg/kg)was found in leek (Village of Garazel). While no any detectable amount of Lead (pb) had been found for Curly cress sample. The concentration of lead in dill, celery, Curly cress detected was higher in the sample collected from Wuluba than those of Garazel Village. The amount of heavy metals (Fe, Cr, Cd, Cu, Ni and Zn) found in the green leafy vegetables samples are presented in Table 2 and 7, respectively. The concentrations (mg/kg) of heavy metals in the samples were ranged from 6.118 to 339.646 for Fe , 0.032 to 0.247 for Cr , 0.0003 to 0.022 for Cd, 0.196 to 0.357 for Cu, 0.037 to 0.503 for Ni and 0.690 to 2.941 for Zn.

The amount of Fe in mint, dill, celery, curly cress and Cr in celery, dill and curly cress was higher in the samples collected from Wuluba farms compared to those of Garazel village. Also, the amount of Cu in mint, leek, dill and celery, and Zn in mint, celery and curly cress was significantly higher in the samples collected from Wuluba farms than those of Garazel village. However, the amount of Cd and Ni in mint, leek and dill was significantly higher in samples collected from Village of Garazel farms than those of Wuluba.

Discussion

The mean concentrations and minimum and a maximum of heavy metals found in green leafy vegetables sampled from the Village of Garazel and Wuluba in Sulaimani city, Kurdistan Region of Iraq, are summarized in Tables 1-7. The results showed that the levels of Lead (Pb) in all commodities were ranged between 0.00 mg/kg in Curly cress and 0.287 mg/kg in leek from Village of Garazel. While the samples collected from Wuluba indicated the ranges of 0.103 mg/kg in celery and 0.219 mg/kg in mint for Pb. The level of Lead (Pb) reported in this study is low when compared to that reported in the Leek (14.88mg/kg) by Maleki and Zarasvand (2008). Also, Lead (pb) content of the plants of this study is lower when compared to the standard safe limit (0.3mg/kg) reported by FAO/WHO (2001). The study revealed that Lead (bp) contents are within the permissible limit. Thus, the lead level in the green leafy vegetable examined seems not to be hazardous except in a case of excessive consumption.

Fe and Cr contents in the current study were observed in samples collected from Wuluba between 6.11 to 38.72mg/kg and 0.140 mg/kg to 0.192 mg/kg), respectively. Their range in Garazel Village were between 26.477mg/kg to 339.64 and 0.143mg/kg to 0.247mg/kg, respectively. The highest concentration was found in leek, curly cress and celery, while the lowest concentration was detected in mint and celery in Wuluba. These ranges are below the rate of heavy metals recorded in WHO/FAO and there is no potential hazard to the consumers health.

Cadmium (Cd) is a non-essential element in foods and natural waters **(**Divrikli et al. 2006**)**. It is known to be accumulated in the human kidney for a relatively long time, from 20 to 30 years. The high doses of Cadmium produce health effects on the respiratory system and bone disease. It enters the human body either by inhalation or consuming (Reeves et al. 1997). Different values have been previously reported in leafy vegetables (0.0017mg/kg, 0.0025mg/kg) for Leek and dill by Jafarian and Alehashem (2013)**.** In this study, Cadmium was detected at high concentration of 0.015mg/kg in Leek collected from Village of Garazel , however the amount of Cd in mint, leek and dill was higher in samples collected from Village of Garazel farms than those of Wuluba. This is below the FAO/WHO safe limit of 0.2.

Cu is an essential metal for plant growth and activation of many enzymes, however most plants contain the amount of copper which is inadequate for normal growth that is usually ensured through artificial or organic fertilizer (Akinyele and Osibanjo, 1982). Among all heavy metal, Cu is the most abundant element, which recorded highest concentration of 0.350mg/kg in Mint and 0.360mg/kg in Leek from Wuluba. The least concentration of 0.19mg/kg was recorded in the Dill and Celery from Village of Garazel. The contents of Cu recorded in this study are lower than the permissible level by FAO/WHO in the leafy vegetable.

Nickel also plays some role in body functions including enzyme functions. It occurs naturally more in plants than in the animal flesh.It activates some enzyme systems in trace amount, but its toxicity at higher levels is more prominent (Divirkli *et al* . 2006).The results indicate that the Nickel content was detected at a high concentration of 0.5mg/kg in Leek obtained from Village of Garazel and lower concentration was detected in mint (0.03mg/kg) from Wuluba. Also the amount of Ni in mint, leek and dill was higher in samples collected from Village of Garazel farms than those of Wuluba farms.

Zn is the least toxic and an essential element in human diet as it is required to maintain the functioning of the immune system. Zn deficiency in the diet may be highly detrimental to human health than too much Zn in the diet (ATSDR, 1994), but high concentration of Zn in vegetable may causes vomitingand renal damage. The higher concentration of Zn in this researcher observed in Curly cress 2.608mg/kg from Wuluba and the lowest concentration was detected in celery (o.69mg/kg) from township of Village of Garazel. Generally, Ni and Zn contents of these leafy vegetables are lower than the FA0/WHO (2001) safe limit of 67 and 99.40 mg/kg. .

Conclusion

The results obtained in this investigation for the concentration of heavy metals of some selected common leafy vegetable consumed in Sulaimani city were below the safe limits of 0.3, 425, 2.3, 0.2, 40, 67 and 99.40 mg/kg for Lead (Pb), Iron (Fe), Cadmium(Cd), Chromium (Cr), Copper (Cu), Nickel (Ni) and Zinc (Zn), respectively, as set by the WHO/FAO. This is an important resulted as human health in directly affected by metal in leafy vegetable that is the primary source of food for our indigenous people. It is essential that the farmers be educated and encouraged to reduce such contamination by controlling the use of pesticides, avoiding the use of waste water and cultivating in fields far away from the highway and industrial areas. This study thus showed that leafy vegetable consumed in Sulaimani city are safe for consumption.

References

[1]. AdrianoDC(1984). Trace metals in the Terrstrial Environment. New York :Verlag Spiegler

[2]. Agency for Toxic Substances and Disease Registry ATSDR (1994).Toxicological Profile for Zinc and Cobalt .US Department of Health and Human Services, Public Health Service .205-88-0608.

[3]. Akinleye,I.O.andOsibanjo,O.(1982).Levels of trace elements in hospital diet. Food Chem. 8: 247-251.

[4]. Divrikli,U.;Horzum,N.;Soylak,MandElci,L(2006).Trace heavy metal contents of some spices and herbal plants from western Anatolia, Turkey .Int.J.FoodSci.Technol.41:712-716.

[5]. FAO/WHO,Codex Alimentarius Commission (2001).Food Additives and Contaminations.Joint FAO/WHO Food Standards programme, ALINORM 01/12A:1-289.

[6]. IARC (2003).Fruit and Vegetables .International Agency for Researcher on Cancer, Lyon .PP. 22-23.

[7]. Jafarian,A.andAlehashem,M.(2013).Heavy metal contamination of vegetables in Isfahan, Iran .Rese.pharm.Scie.8(1):51-58.\

[8]. Jarup L. (2003). Hazards of heavy metal contamination. Br. Med. Bull. 68(1): 167-182.

[9]. Jimoh,T.O; Ndamitso,M. M; Abdullahi, S. H and Bankole, M. T (2012). Determination of copper, iron and lead levels in selected vegetables obtained from the three main markets ,in Minna, North Central Nigeria . Afr. J. Food Sci. 6(23): 554-559.

[10]. Maleki,A.andZarasvand,M.A.(2008).Heavy metals in selected edible vegetables and estimation of their daily intake in Sanadaj, Iran. Southeast Asian. J. Trop Med Public health. 39(2): 335-340.

[11]. Oluwole,S.O; Olubunmi,M. Sc; Yusuf, K. A; Fajana,O. O and Odumosu,A.O(2013).Determination of heavy metal contaminations in leafy vegetables cultivated by the road side. Inter. J. Engineering Res. 7(1):01-05.

[12]. Reeves,P.G.,andVanderpool,R.A., (1997). "Cadmium burden of men and women WHO report regular consumption of confectionery sunflower kernels containing a natural abundance of cadmium." Environ. Health Perspect. 105: 1098-1104.

[13]. Shuaibu, I. K.;yahaya, M. and Abdullahi, U. K (2013). Heavy metal levels in selected green leafy vegetables obtained from Katsina central market, Katsina, North-Western Nigeria. Afri. J. Pure and Applied .Chem. 7(5):179-183.

[14]. SobukolaO. P, Adeniran O. M, Odedairo A. A and Kajihausa O.E (2010). Heavy metal levels of some fruits and leafy vegetables from selected markets in Lagos, Nigeria .Afr. J. Food Sci.4 (2): 389-393.

[15]. Waston R.; Gerald.J, and Preedy V(2011). Nutrients, Dietary supplements, and Nutriceuticals. Humana Press, c/o Springer Science +Business Media, LLC,233Spring Street, New York, NY 10013 , USA), Page 273-274.

[16]. Radwan MA, Salama AK (2006). Market basket survey for some heavy metals in Egyptian fruits and vegetables. Food Chem. Toxicol. 44:1273-1278.