Assessment of the Level of Trace Metals in Commonly Edible Vegetables and Fruits of Baghdad City (Iraq)

J.D. Salman, I.D. Sulaiman, S.S. Abd Al-Raziq

Department of Chemistry College of Education, Ibn Al-Haitham,

University of Baghdad

Received in : 28 November 2010

Accepted in :12 April 2011

Abstract

A study was carried out to determine the concentrations of trace metals in vegetables and fruits, which are locally available in the markets of Baghdad-samples of fourteen varieties of vegetables and fruits, belonging to Beta vulgaris, Brassica rapa, Daucus carota, Allium cepa, Eurica sativa, Malva silvestris, Coriandrum Sativum, Trigonella Foenum craecum, Anethum graveolens, Barassica oleracea, Phaseolus vulgaris, citrus reticulata, Pyrus malus, and Punica granatum. Analysis for Cd,Pb, Mn, Fe, Co, Ni, Cu and Zn were determined by flame atomic absorption spectrophotometry. The results indicated that the Malva silvestris recorded the highest concentrations of Cd and Mn while Allium cepa showed the highest concentrations of Pb and Cu. But Eurica sativa, Anethum graveolens, phaseolus vulgaris and Daucus carota were observed the highest values of Fe, Co, Ni and Zn respectively. It can be noticed that the zinc has the highest values while the nickel recorded the lowest values in all studied samples.

Keywords : Trace metals, vegetables, fruits, Flame atomic absorption spectrometry

Introduction

The environment pollution with heavy metals is due mainly to the activity of humans. High quantities of these metals can be toxic for all organisms. The entry of heavy metals from the polluted environment in fruits and plants is influenced by different factors and stopped through several mechanisms. Their presence can have effects on different physiological processes. Photosynthesis, respiration, transpiration, cell membrane permeability. Using heavy metal contaminated vegetable products in alimentation can have important effects on short or long terms[1]. Absorption and accumulation of heavy metals in vegetables and fruits are influenced by many factors, including: concentration of heavy metals in soil, composition and intensity of atmospheric deposition, including precipitations, phase of plant vegetation [2]. Incidences of food contamination have become increasingly frequent in recent years raising question about their human health and economic consequences [3].

It is generally considered that heavy metals originate from two primary sources: natural inputs (e.g. parent material weathering) and anthropogenic (e.g. metalliferous industries and mining vehicle exhaust, agronomic practices, etc.) [4].

Human health may thus be directly affected by ingesting fruits and vegetables. The effect becomes pronounced due to imbalance of macro and micro-nutrients. The assessment of these nutrients in various raw foods depends on source, material and locality [5,6].

Different vegetable species accumulate different metals depending on environmental conditions, metal species, plant available and forms of heavy metals. Studies have shown that up take and accumulation of metals by different plant species depend on several factors and various researchers have studied them [7,8].

There is a growing concenrn about human intake of toxic trace elements such as cadmium, chromium and lead, which even at low doses over along period of time can lead to malfunction of organs and cause chronic toxicity [9].

Food and water are the main sources of our essential metals these are also the media through which we are exposed to various toxic metals. Heavy metals are easily accumulated in the edible parts of leafy vegetables as compared to grain or fruit crops [10].

Several studies have been carried out to estimate the trace metal contents in vegetables. The determination of metal content in vegetables is important from the view point of crop yield technology, food nutrition and health impacts. In event of their excess presence, these metals enter into the body and may disturb the normal functions of central nervous system, liver lungs, heart, kidney and brain [11].

In the present work samples of vegetables and fruits were digested and analyzed by the method of flame atomic absorption spectrophotometry to determine the concentrations of (Cd, Pb, Mn, Fe, Co, Ni, Cu and Zn).

The main aim of this study was to investigate the level of trace metals in different varieties of vegetables and fruits, which are available in local market. In this study level of Cd, Pb, Mn, Fe, Co, Ni, Cu and Zn are being reported for fourteen varieties of vegetables and fruits.

Experimental

Sample Preparation

All the collected samples of various vegetables and fruits were separately washed with tap water and double distilled water to remove airborne pollutants. All the sample were then oven-dried in a hot air at 70-80°C for 24h, to remove all moisture. Dried samples were powdered using a pestle and mortar and sieved through muslin cloth. (0.1 gram) of each sample was weighed using sensitive balance (0.1 mg sensitive). The digestion carried out by adding (2 ml) of concentrated nitric acid (70%), heating for one hour, cooling and dilution to (25 ml) in a volumetric flask using double distilled water.

All reagents were ultra-pure or analytical reagent (A.R) grade(GBC 933). Distilled and deionized water was used for dilution and preparation of reagents and standards. The purity of the distilled water used for the preparation of all reagents and calibration standards.

Heavy metals analyses were carried out using GBC 933 plus, Flam Atomic Absorption Spectrophotometer.

Results and Discussion

The concentrations of Cd, Pb, Mn, Fe, Co, Ni, Cu and Zn analysed in fourteen varities of vegetables and fruits are given in Table 1, 2 and 3.

Cadmium is a toxic element, this metal causes adverse health effects in humans and their presence in the human environment comes from anthropogenic activities [1]. Figure (1) shows that the concentrations of cadmium was higher in all samples studied than the recommendable maximium limits for 0.05 μg/ml except Allium cepa was recorded 0.03 μg/ml. The highest values were found in Malva silvestris for 0.83 μg/ml.

Lead accumulates in the Skeleton, especially in bone narrow. It is aneurotoxin and causes behavioural abnormalities, retarding intelligence and mental development Figure (2) presents the concentrations of lead in samples studied it can be noticed that the concentrations of lead was lower than their maximum limit values 0.5 μg/ml except Allium cepa and citrus reticulate was recorded (1.83, 0.62) μg/ml respectively.

The trace metal like Mn and Fe are considered as essential element for normal life processes [12] Figure (3) clearly the concentrations of manganese in the vegetables and fruits studied it was found to be in the range between (0.02-1.60) μg/ml. A daily dietary intake (2.5-5) mg of manganese by human contributes to the well being of the cells [13], these values indicate that the concentrations of manganese were lowest that the recommendable maximum limit.

Iron is an important element in human body metabolism which acts as a catalyst and is present in greater amount than any other trace element. The Figure (4) shows the highest values of iron in Eurica sative 2.54 μg/ml while recorded Beta vulgaris the lowest values 0.16 μg/ml.

Cobalt is a poisonous non essential heavy metal when ingested in large amount it is excreted through the urinary system [14]. Figure (5) the concentrations of cobalt in the vegetables and fruits studied was range between (0.11-1.37) μg/ml. It can be noticed that the highest values of cobalt in Anethum graveolens.

Nickel recorded values range between (0.02-0.09) μg/ml, the low values were 0.02 μg/ml in Daucus carota and Allium cepa while Phaseolus vulgaris and Eurica sativa the highest values 0.09 μg/ml. It was observed in Figure (6) that the fruits studied recorded the values range between (0.04-0.05) μg/ml. The high level of these element has a low toxicity to man [15].

Copper is an essential element widely distributed and always present in food animals livers which are the major contributor to dietary exposure to copper. It is necessary for normal biological activities of amino-oxides and tyrosine enzyme-concentrations of copper shows in Figure (7) that the samples studied were recorded in the range between (0.07-3.80) μg/ml. A daily dietary intake of (2-3) mg of copper is recommended for human adults [13]. Continous ingestion of copper from food induces chronic copper poisoning in man.

Zinc is present in the body as a co-factor for enzymes such as orginase and diaminase. It takes parts in the synthesis of DNA-proteins and in sulin. It is essential for the normal functioning of the cell including protein synthesis, carbohydrate metabolism cell-growth and cell division. Figure (8) that the concentrations of zinc in these vegetables and fruits studied was found to be (0.42-21.60) μg/ml, a normal body contains (1.4-2.3) gm of zinc and it is present in all body cells. In view of this the estimated concentrations of metals in vegetables and fruit studies under investigation do not cause health hazards for consumers.

It can be noticed that the concentrations of metal in vegetables and fruits studied was found lower than the recommendable maximum limits except cadmium.

The elements in the samples studied altogether

$$Zn > Fe > Mn > Cu > Co > Pb > Cd > Ni$$

Consumption of fruits or vegetables contaminated with heavy metals by humans could lead to changes in health of the inhabitants of polluted areas and contribute to the emergence of various chronic diseases.

Accuracy and Precision

The accuracy and precision of the results were also evaluated by analysing each sample was found, that the range of relative standard deviation percentage and max relative error percentage for each element is shown in table (4) .

References

1- Alina, Soceanu, (2009) "Presence of heavy metals in fruits from prunus genera" Ovidius University Annals of Chemistry, 20(1): 108-110.

2- Vontsa, D.; Grimanis, A.and Samara, C. (1996)"Trace elements in vegetables grown in industrial areas in relation to soil and air particulate matter", Environmental solution,94:325-335.
3- Musaiger , A.O.; Al-Jedah J.H. and Souza, R.D. (2008) Occurrence of contaminats in foods commonly consumed in Bahrain ,"Food control " 19 :854
4- Zhang, C . (2006) Using multivariate analyses and Gls to identify pollutants and their spatial patterns in urban soils in Galway ,Ireland , Enviromental pollution 142:501-511
5- Wiersma, D.; Van Goor, B.J. and Vander Veen, N.G. (1986) "Cadmium, Lead, Mercury and Arsenic concentrations in crops and corresponding soils in the Netherlands", J. Agric. Food Chem. 34:1067-1074.
6- Takacs, S. and Tatar, A. (1997) "Trace elements in the environment and in human organs, Environ. Res. 42:312-320.
7- Mido, Y.and Satake, M. (2003) "Chemicals in the environment. In Toxic Metals" (M.S. Sethi, and S.A. lqbal, eds), pp.45-68. Discovery Publishing House, New Delhi,.
8- Bingham, T.F.; Page, A.I.; Hahler, R.J. and Ganje, T.J. Growth. (1975) "Cadmium accumulation of plants grown on soil treated with cadmium enriched sewage sludge". J. Environ. Qual. 4:207-210
9- Kumar, A.; Sharma, I.K.; Alka Sharma, Sarita varshney and Verma, P.S, (2009) "Heavy metals contamination of vegetable foodstuffs in JAIPUR EJEAFChe,Electronic Journal of Environment al ,Agricultural and food chemistry 8 (2): 96-101.
10- Mapanda, F.; Mangwayana, E.N.; Nyamangara, J.and Giller, K.E. (2005) "The effects of long-term irrigation using water on heavy metal contents of soils under vegetables. Agriculture, Ecosystem and Environment, 107:151-156.
11- Huheey, J.E.; Keiter, E.A. and Keiter, R.L. (2000) "Inorganic chemistry", 4^{th} Ed., Pearson Education Inc., USA, p.889.
12- Gulfrz, M.; Ahmed, T. and Afzal, H. (2001) "concentration level of heavy and trace metals in the fish and relevant water from Rawal and Mangla dam". Bio.sci.(5): 414, 105-109.
13- Dara, SS. (1993)"Environmental chemistry and pollution control. First edition, Published by S. Chand and Company Ltd., New Delhi, India, pp.184-205.
14- Salman,J.D. and Faisel,M.Z.(2000),Study of the concentration of Totalsuspended particulates and some heavy metals in the city of Baghdad , Ibn- Al-Haitham J.For pureand Appl.Sci.13(1):60-68
15- Salman ,J.D.(2001) determination of trace elements in some vegetables by Flame atomic absorption spectrometry , Ibn- Al-Haitham J.For pureand Appl.Sci.14(1):66-72

Table (1): Concentrations of trace metals in root vegetables (µg/ml) by FAAS

No	Sample	Metal							
		Cd	Pb	Mn	Fe	Co	Ni	Cu	Zn
1	Beta vulgaris	0.19	0.08	0.59	0.16	0.18	0.05	0.37	0.95
2	Brassica rapa	0.13	0.15	0.02	0.36	0.14	0.05	0.25	1.10
3	Daucus carota	0.55	0.16	0.40	0.24	0.11	0.02	0.41	21.60
4	Allium cepa	0.03	1.84	0.75	0.98	0.70	0.02	3.80	2.90

Table (2): Concentrations of trace metals in leave vegetables (µg/ml) by FAAS

No	Sample	Metal							
		Cd	Pb	Mn	Fe	Co	Ni	Cu	Zn
5	Eurica sativa	0.45	0.40	1.30	2.54	0.20	0.09	0.50	0.80
6	Malva silvestris	0.83	0.37	1.60	1.50	0.49	0.05	0.81	2.45
7	Coriandrum sativum	0.35	0.10	0.77	1.80	0.24	0.06	0.44	3.10
8	Trigonella Foenum craecum	0.61	0.30	1.31	1.73	0.37	0.07	0.42	0.50
9	Anethum graveolens	0.24	0.17	0.41	1.07	1.37	0.05	0.07	0.66
10	Barassica oleracea	0.23	0.12	0.48	0.49	0.18	0.03	0.17	0.42
11	Phaseolus vulgaris	0.33	0.05	0.86	0.28	0.34	0.09	0.67	10.80

Table (3): Concentrations of trace metals in fruit (µg/ml) by FAAS

No	Sample	Metal							
		Cd	Pb	Mn	Fe	Co	Ni	Cu	Zn
12	Citrus reticulate	0.06	0.62	0.13	0.24	0.32	0.05	0.12	0.80
13	Pyrus malus	0.31	0.41	0.15	0.64	0.20	0.04	0.34	1.49
14	Punica granatum	0.49	0.26	0.12	0.43	0.35	0.04	0.24	0.73

Table (4): The range of relative standard deviation and max relative error for each metal in all samples

Metal	% RSD	% Max RE
Cd	2.15 – 19.37	0.048
Pb	3.14 – 15.39	0.243
Mn	0.62 – 12.40	0.037
Fe	1.85 – 10.65	---
Co	6.75 – 15.02	---
Ni	1.78 – 19.04	0.284
Cu	0.78 – 8.82	---
Zn	1.80 – 5.27	0.041

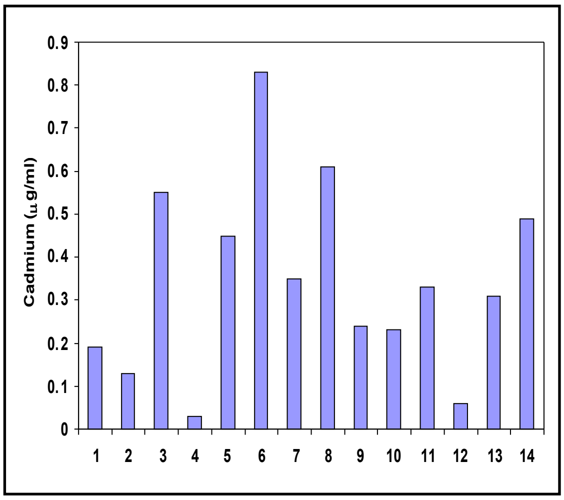

Fig. (1): Concentration of Cadmium in samples studied

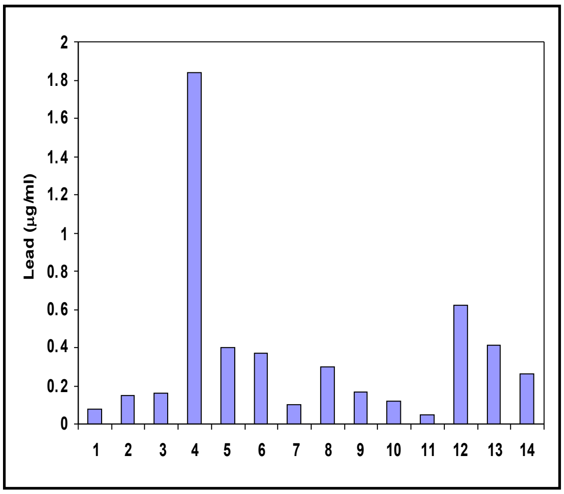

Fig. (2): Concentration of lead in samples studied

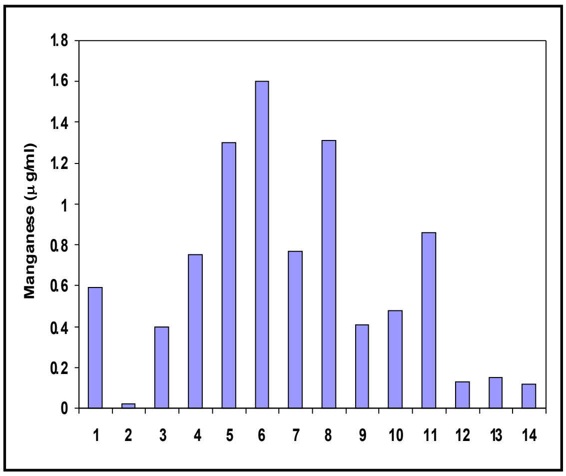

Fig. (3): Concentration of manganese in samples studied

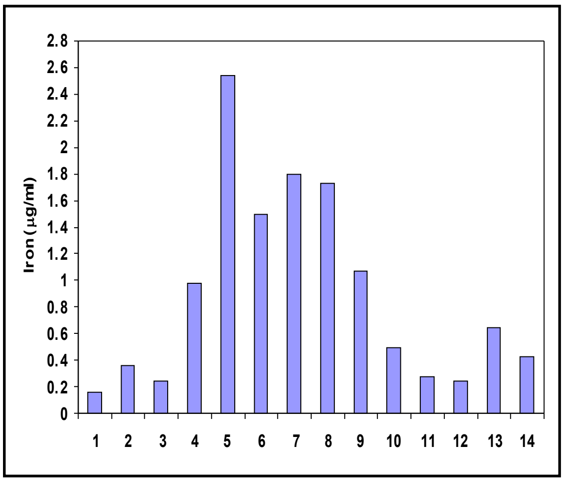

Fig. (4): Concentration of iron in samples studied

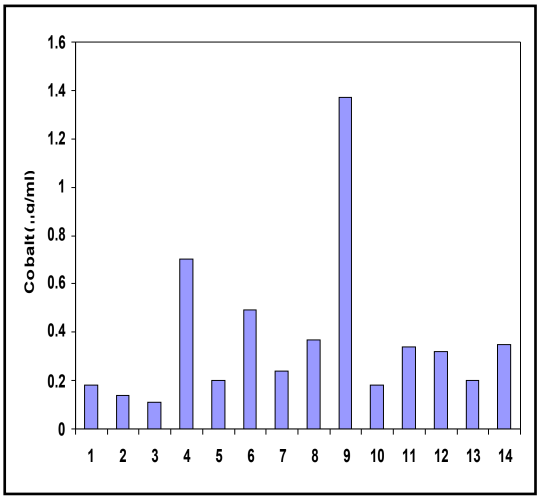

Fig. (5): Concentration of cobalt in samples studied

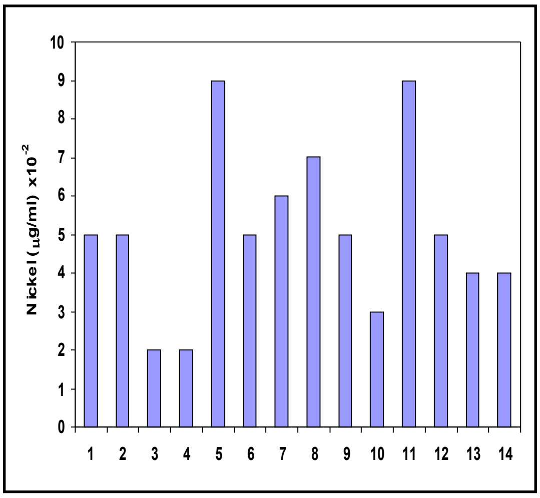

Fig. (6): Concentration of nickel in samples studied

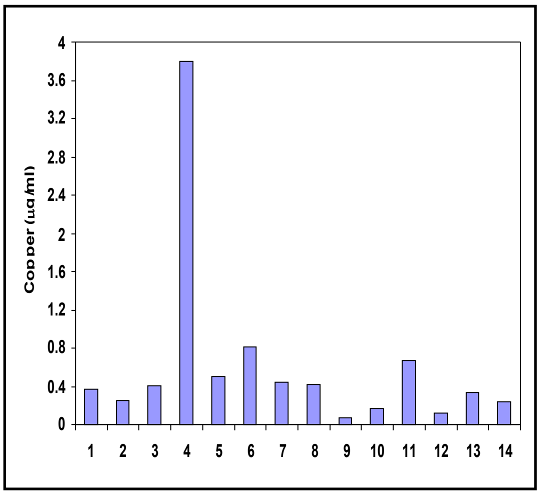

Fig.(7): Concentration of copper in samples studied

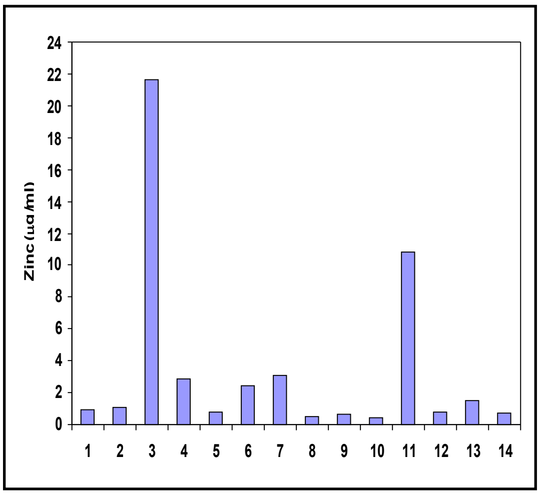

Fig. (8): Concentration of zinc in samples studied

تقييم مستوى العناصر النزرة في الخضروات والفواكه في مدينة بغداد (العراق)

جاسم داود سلمان، انتظار داود سليمان، ساهرة صادق عبد الرزاق

قسم الكيمياء ، كلية التربية ابن الهيثم ، جامعة بغداد

استلم البحث في : 28 تشرين الثاني 2010

قبل البحث في : 12 نيسان 2011

الخلاصة

تتضمن الدراسة تقدير تراكيز بعض العناصر النزرة في الخضروات والفواكه جمعت من الاسواق المحلية لمدينة بغداد تضمنت اربعة عشر انموذجاً متنوعا من الخضروات والفواكه (الشونذر، والشلغم ،والجزر ،والبصل الاخضر ،والكركير، والخيار ،والكزبرة ،والحلبة ،والشبنت ،واللهانة ،والفاصوليا الخضراء ،واللالنكي ،والتفاح ،والرمان .حللت عناصر الكادميوم والرصاص والمنغنيز والحديد والكوبلت والنيكل والنحاس والزنك باستعمال مطيافية الامتصاص الذري اللهبي.

تشير النتائج الى ان الخيار قد سجل اعلى التراكيز لعنصري الكادميوم والمنغنيز بينما اظهر البصل الاخضر اعلى التراكيز لعنصري الرصاص والنحاس. اما الكركير والشبنت والفاصوليا الخضراء والجزر فقد لوحظ اعلى التراكيز لعناصر الحديد والكوبلت والنيكل والزنك على التوالي. وجد من خلال هذه الدراسة ان عنصر الزنك قد سجل اعلى التراكيز في حين سجل النيكل اوطأ التراكيز في النماذج المدروسة.

الكلمات المفتاحية :العناصر النزرة ،الفواكه ،الخضر ،جهاز طيف الأمتصاص الذري اللهبي