Determination of some traces heavy metals in some vegetable by using ICP Spectroscopy

Hiatham Ahmed M. Soliman

Dr- Ahmed seifeldin

Department of chemistry, University of Alzaem Alazhari, Khartoum, Sudan

المستخلص:

هدفت هذه الدراسة إلى تحديد تركيز بعض العناصر الثقيلة فى بعض الخضروات كالباميةواللوبياوالخدرة. وتم جمع العينات من منطقة الفردوس غرب مصنع سكر عسلاية ولاية النيل الأبيض (السودان) حللت لتقدير محتوياتها وتتبع تلوث بعض العناصر الثقيلة الموجودة بها مثل الرصاص ,الكادميوم, الكروم , النحاس, الزرنيخ,الزئبق ,الكروم , النيكل ,المنجنيز ثم الخارصين , وذلك بإستخدام جهاز البلازما المقترن بالحث(Inductive coupling plasma spectrophotometer ICPE9000).وأظهرت النتائج أنه تقدير تركيز الزرنيخ فى الطماطم +13 ملجم/كجم وفى الخدرة +16 ملجم/كجم وهى كمية عالية جد وأن تركيز عنصر الحديد 51 ملجم/ كجم فى الطماطم و فى الخدرة 58 ملجم/كجم . وأن تركيز عنصرالرصاص 3 ملجم/كجم فى الخدرة وأظهرت النتائج أنه لم يتم إكتشاف تراكيز لعناصر النيكل الخارصين والكروم والزئبقفى مختلف العينات عدا عنصر النحاس حيث تم تقدير تركيزه 140 ملجم/كجم فى اللوبيا وهى كمية عالية. تناولت الدراسة تحليل بعض الخضروات مثل كالباميةوالطماطم واللوبيا والخدرةوتوصى هذه الدراسة بأن تكون هنالك دراسات لاحقة لبعض الخضروات الأخرى فى هذه المنطقة نتيجة للآثار الصناعية فى هذه المنطقة وكذلك توعية المزارعين بالإستخدام الواعى للأسمدة الكيميائية.

Abstract:

The aim of this study is determination of the some heavy metal in some vegetable such as an Okra, tomatoes, Green and Bean Samples of vegetables including an Okra, tomatoes,Green and Bean were collected fromSome commonly consumed vegetables samples were collected randomly from four different areas in the AlfardoosVillage west Assalaya sugar company White Nile State. Methods:the sample were analyzed to determine their content of

the trace and contaminated heavy metals such as Pb, Cd, Cu, Cr, Ni, Hg, As, Fe, Co and Zn by using (ICPE9000) Spectroscopy. Result:in different vegetables. In the present investigation, the value of Cadmium (Cd) (0.48 mg/Kg) was recorded in reduced tomatoes, while not detected in OkraBean and Green .The Cobalt (Co) was not detected in all samples. The highest concentration of Cu was found inBean(140 mg/gr), while lowest concentration (9.8 mg/kg) was recorded in Okra. The concentration of Iron (Fe) content was highest in Green (58 mg/kg),while it was found lowest (0.3 mg/kg), in Okra . Green showed high content of Nickel (16mg/kg), while Okra and Labia was not detectedand it was found lowest concentration of (Fe) (0.3 mg/kg), inOkra. Green show high concentration of Nickel(Ni) (16mg/kg), while Okra and Bean was not detected. Lead (Pb) content was found high concentration in Green (3 mg/kg), while other sample like Okra, tomatoes andBean was not detected. the concentration of Zn was found (6 mg/kg) in Tomatoes, and was not detected in Bean ,Chromium (Cr) concentrations was not detected in Okra and Bean but was determine (0.97mg/kg) in Green and (0.85mg/kg) in tomatoes.The concentration of arsenic (As) were not detected in Okra and Bean and in tomatoes is (+13g/kg) and green is (+16mg/k)g.The concentration of Mercury (Hg) were not detected in Okra ,Bean and tomatoes but Green is 1.3mg/kg .**The recommend** of this study it is very important to conduct a subsequent study to access the levels of heavy metals for the vegetables that are grown nearAlfardoosVeletge due to industrial production.

KEYWORDS: Heavy metals, Vegetables, health risks, Contamination, Permissible limits

INTRODUCTION:

Food safety is a major public concern worldwide. the increasing demand for food safety has stimulated research regarding the risk associated with consumption of foodstuffs contaminated by

pesticides and heavy metals [1].Heavy metals generaly collective term which applies to the group of metals and metalloids with an atomic density greater than 4 g/cm³. Although it is a loosely defined term [2], it is widely recognized and usually applies to the widespread contaminants of terrestrial and freshwater ecosystems. Vegetables constitute an important part of the human diet since they contain carbohydrates, proteins, vitamins, minerals as well as trace elements. The contamination of vegetables with heavy metals due to soil and atmospheric contamination poses a threat to its quality and safety. Dietary intake of heavy metals also poses risk to animals and human health. High concentrations of heavy metals (Cu, Cd and Pb) in vegetables were related to high prevalence of upper gastrointestinal cancer [3].Vegetables also act as buffering agents for acidic substances obtained during the digestion process. However, these plants may contain both essential and toxic elements, such as heavy metals, at wide range of concentrations [4]. Metals, such as lead, chromium, cadmium and copper are cumulative poisons. These metals cause environmental hazards and are reported to be exceptionally toxic [5].Contamination of vegetables with heavy metal may be due to irrigation with contaminated water, the addition of fertilizers and metal-based pesticides, industrial emissions, transportation, the harvesting process. It is well known that plants take up metals by absorbing them from contaminated soil as well as from deposits on parts of the plants exposed to the air from polluted environments [6, 7].Publicity regarding the high level of heavy metals in the environment has created apprehension and fear in the public as to the presence of heavy metal residues in their daily food. The potential toxicity and persistent nature of heavy metals, and the frequent consumption of vegetables, it is necessary to analyze these food items to ensure the levels of these contaminants meet agreed international requirements[8]. Lead and cadmium are particularly toxic. Excessive content of these met-

als in food is associated with a number of diseases, especially of the cardiovascular, renal, nervous and skeletal system. These heavy metals are also implicated in carcinogenesis [8]. Other metals, such as copper and zinc are essential for important biochemical and physiological functions and necessary for maintaining health throughout life. .

Many researchers have shown that some common vegetable-sarecapableof accumulating high levels of metals from the soil [9] Another study, Konzlisi and Friebele (1998) discussed that the environment is constantly being spoiled and rendered very unsafe for human habitation and other organism.

Materials and methods

Inductive coupling plasma spectrophotometer (ICPE 9000). Was used for determination of analyses. All the chemicals used were of analytical reagent grade and triple distilled water was used for experiments.

The Soil Sample:

Soil samples were taken at the four randomly replicated plots in three different quarters.Sample one taken from mager 20g of soil was weighed into acid washed platinum crucible. 20 cm^3 of concentrated HNO_3 was added and left for 20 minutes.15 cm^3 of mixture acids HNO_3 and HCl in the ratio I:3 were added and left about 10 minutes. the sample was heated at 135–180 ^oC and evaporate the content almost to dryness. 10 cm^3 of deionized water was added and boil gently to dissolve the residue. The solution was cooled and faltered and then transferred to 100 cm^3 volumetric flask and completed to the mark used deionized water. the sample was taken for analysis by using Inductive coupling plasma spectrophotometer (ICPE9000). the results were reported in table(1).

The vegetables samples:

Some commonly consumed vegetables samples were collected randomly from four different areas in the AlfardoosVillage

west Assalaya sugar company White Nile State. The samples were included tomato, green, okra, and lobia. The samples were washed and cutting in small portion, 20 grams from each sample weighed and added 15 cm^3 of mixture acid Nitric and hydrochloric acids 3:1, the mixture were stirred for few minutes, left about 24 hours, after that the mixture were heated a till clear solution produced, 10 cm^3 of distilled water was added, and solution was filtered, the solution transferred to 100 cm^3 volumetric flask and complete the volume to the mark used distilled water. This procedure was applied to prepared all samples. The samples were analyzed by using Inductive coupling plasma spectrophotometer (ICPE 9000). the results were reported in table(2).

Table-1 Show the concentration of some heavy metals in soil

Metals	Cu	As	Cd	Cr	Fe	Hg	Co	Pb	Zn	Ni
Con-(ce(mg/kg	37	23	0.62	4.5	4	0.74>	8.5	06.7+>	4.3	10
Standered	40[d]	0.2[e]	0.1[b]-0.3[c]	2.3[b]	4.25[b]	0.2[c]	0.1-0.05[f]	0.2[c]	60[e]	1.5[a]

a : WHO/FAO (Codex Alimentarius Commission. Joint FAO/WHO, 2007) and indianstandardawashthi

b: WHO (Codex Alimentarius Commission, Joint FAO/WHO, 2001 and codex alimentarius commission, 1994).

c : European Union (EU), 2006.

d : WHO/FAO (FAO/WHO,codex general standard for contamination and toxin in foods, 1996).

e : WHO (codex alimentarius commission, 1991).

f : Agency for toxic substance disease registry (ATSDR, 1994a).

Table-2 Show the concentration of some hevey metals in some vegetables.

Element/ conce (mg\kg)	Okra	Tomatose	Green	Bean	Standerd
Cu	9.8	37	30	140	40[d]
As	0 >	13+	16+	68 >	0.2[e]
Cd	0 >	0.48	0.37 >	6.8 >	0.1[b] 0.3[c]
Cr	0 >	0.85	0.97	19 >	2.3[b]
Fe	0.3	51	58	27 >	425[b]
Hg	0 >	7.8 >	1.3	5.6 >	1[f]
Co	0 >	1.1>	0.87 >	23 >	0.1[b]
Pb	0 >	2.8+ >	3	46 >	0.2[a] 0.3[b]
Zn	0.39	6	3.6	2.2 >	6.0[e]
Ni	0 >	8.5	16	34 >	15[a]

A : WHO/FAO (Codex Alimentarius Commission. Joint FAO/WHO, 2007)

b : WHO (Codex Alimentarius Commission, Joint FAO/WHO, 2001 and codex alimentarius commission, 1994).

C : European Union (EU), 2006; dWHO/FAO (FAO/WHO,codex general standard for contamination and toxin in foods, 1996).

d : WHO/FAO (FAO/WHO,codex general standard for contamination and toxin in foods, 1996).

e : WHO (codex alimentarius commission, 1991); fAgency for toxic substance disease registry (ATSDR, 1994a).

RESULTS

The results of heavy metals concentration in the soil samples are presented in (Table 1). It was found that the Hg and Pb in the sampling station was below the detection limit (<0.74 and < 6.7mg/kg) and the concentration of Cu,Fe, ,Zn, were below

the permissible limits recommended by WHO (Codex Alimentarius Commission, Joint FAO/WHO, 2001 and codex alimentarius commission, 1994). which were shown in the Table1.While the concentration of (As) in the collected soil samples is (23mg/kg) . The WHO permissible limit for arsenic in agricultural soils is 0.2 mg/kg. The soils of the study areas contain large amount of arsenic, which indicates that soils are polluted by arsenic. Therefore it is assumed that the vegetables that are grown in these soils will absorb more arsenic from the soil and there by polluted by arsenic. Plant arsenic concentrations tend to increase with increasing soil arsenic and then stabilize at some maximal value at higher concentrations in soil, which is alarming to the people of that area.

The content of (Co. Cd, Cr and Ni) was above the ranged from the maximum allowable limit of them recommended by WHO (World Health Organization). The concentration of this elements was too much high in the study areas compare with the maximum allowable limit of WHO.The sources of iron, zinc and arsenic in the study area are mainly due to burning of fossil fuel and anthropogenic activities such as fertilizers, waste water irrigation, solid waste disposal and sludge applications. So from the above results, it is concluded that the soil of the study area was highly polluted by(As , Cd, Co, Cr and Ni). There for the plants in these areas usually uptake more amount of heavy metals, thereby these plants will certainly affect the human and other animals when these plants will intake by them.

The content of (Cu. Fe and Zn) was under the ranged from the maximum allowable limit of them recommended by WHO (World Health Organization).

Table: 2 shows the concentration spectra of various heavy metals such as Cadmium (Cd), Cobalt (Co), Copper (Cu), Iron (Fe), Nickel (Ni), Lead (Pb) and Zinc (Zn) ,Mercury(Hg),Arsine(As) and Chromium(Cr).

In different vegetables. In the present investigation, the value of Cadmium (Cd) ranges from < 0 to 0.48 mg/kg in various

The Cobalt (Co) content varies from < .0 to <23 it was not detected in all samples.

The exceeds safe level concentration of Cu it causes hypertension, sporadic fever, uremia's, coma etc. Present investigation reveals that Cu varies from 9.8to 140 mg/kg, which falls above the safe limits for human health and hygiene. The highest concentration of Cu was found in Bean (140 mg/gr), while lowest concentration 9.8 mg/kg was recorded in Okra. Lobia falls above safety limits.

Iron is an essential element in production of Red Blood Cells (RBCs). The concentration of Iron (Fe) content was highest in Green (58 mg/kg), while it was found lowest (0.3 mg/kg) in Okra. The (Fe) content ranges from 0.3 to 58 mg/kg. Low intake of (Fe) may cause anemia, tiredness and pallid physique, while high intake may results into hepatic megaly, cardiac infraction and nephric malfunction.

Nickel is found in Green, Tomatoes, and was not detected in Okra and Bean vegetables. Green showed high content of Nickel (16mg/kg), while Okra and Bean was not detected. The presence of Ni ranges from 16 to < 0 mg/kg in various vegetables. Deficiency of Nickel have been linked with hyperglycemia, depression, sinus congestion, fatigue, reproductive failures and growth problems in humans, while excess intake leads to hypoglycemia, asthma, nausea, headache, and epidemiological symptoms like cancer of nasal cavity and lungs.

During the present study, Lead (Pb) content was found high concentration in Green (3 mg/kg), while other sample like Okra, tomatoes and labia was not detected. emphasized that most of the accumulated Lead is sequestered in the bones and teeth. This causes brittle bones and weakness in the wrists and fingers. Lead that is stored in bones can reenter the blood stream during periods of increased bone mineral recycling (i.e., pregnancy, lactation, menopause, advancing age, etc.).Among all metals, Zinc (Zn) is the least toxic and an essential element in the human diet as it is

required to maintain the proper functions of the immune system. It is also important for normal brain activity and is fundamental in the growth and development of the foetus. Zinc deficiency in the diet may be more detrimental to human health than too much Zinc in the diet. On the contrary, the high concentration of Zinc in vegetables may cause vomiting, renal damage, cramps etc. During present study, the concentration of Zn was found high in (6 mg/kg) in Tomatoes, while low concentration of Zn was not detected in Lobia (ATSDR1994a).Chromium (Cr) concentrations was not detected in Okra and Lobia and (0.97mg/kg) in Green and (0.85mg/kg) the samples were found within the permissible limit. Exposure to too much chromium may cause lung and respiratory tract cancer as well as kidney diseases. In addition, overexposure to chromium may also cause gastrointestinal symptoms, such as diarrhea and vomiting, often with blood. Symptoms may lead to severe water-electrolyte disorders, increased mild acidity of blood and body tissues (acidosis), and/or inadequate blood flow to its tissues resulting in shock. Lesions on the kidneys, liver, and muscular layer of the heart (myocardium) may also develop.

The concentration of arsenic (As) in the collected vegetable samples were not detected in Okra and Lobia and m in tomatose is (+13g/kg) and

green is (+16mg/k)g. The highest concentration of arsenic (+16 mg/kg) was found in Green and the lowest concentration. The WHO permissible limit for arsenic in vegetable is 0.2 mg/kg. which were analyzed.The concentration of Marcury (Hg) in the collected vegetable samples were not detected in Okra ,Lobia and tomatose but Green is 1.3mg/kg .

Dissection

The vegetable samples (Okra, Tomato,Green and Bean) selected for the study from Some commonly consumed vegetables samples were collected from AlfardoosVillage west Assalaya sugar company White Nile State . The vegetable samples were analysed using (ICPE9000) for heavy metals such as Pb, Cd, Zn Mn, Ni, Cr, As ,Co, Fe and Cu. Among them, the heavy metals in Okra The concentration of Cu, Fe, Zn is (9,8 ,0.3 and 0.39mg/kg) respectivly.While the concentration of other metals was not detected and they compared this metal according to the International organization like WHO (World Health Organization) and FAO, the Safe limit for the heavy metal like Cu is (40,42.5 ,and 6.0 mg/kg) respectivly (WHO and FAO mg/kgCodexAlimentarius Commission 1991).

The heavy metals in Tomatoselik (Hg ,Co, Pb) was not detected but The concentration of Cu, As, Cd, Cr, Fe, Zn and Ni is (37, 13+, 0.48, 0.85, 51, 6 and 8.5mg/kg) respectivly.and they compared this metal according to the International organization like WHO (World Health Organization)and FAO, the Safe limit for the heavy metal of them respectivly is (40, 0.2, 0.1, 0.2, 42.5, 6.0 ,and 15 mg/kg) (WHO and FAO mg/kgCodexAlimentarius Commission 1991).As, Cd, Cr and Fe was found to be more than the maximum permissible limit (WHO and FAO mg/kgCodexAlimentarius Commission 1991.

The heavy metals in Green lik (Hg ,Co, Pb) was not detected but The concentration of Cu, As, Cd, Cr, Fe, Zn and Ni is (37, 13+, 0.48, 0.85, 51, 6 and 8.5mg/kg) respectivly.and they compared this metal according to the International organization like WHO (World Health Organization)and FAO, the Safe limit for the heavy metal of them respectivly is (40, 0.2, 0.1, 0.2, 42.5, 6.0 ,and 15 mg/kg) (WHO and FAO mg/kgCodexAlimentarius Commission 1991).As, Cd, Cr and Fe was found to be more than the maximum permissible limit (WHO and FAO mg/kgCodexAlimentarius Commission 1991.

The heavy metals in Bean like (Hg ,Co, Pb, As, Cd, Cr, Fe,Zn and Ni) was not detected but The concentration of Cu is (140 mg/kg). and they compared this metal according to the International organization like WHO (World Health Organization) and FAO, the Safe limit for the heavy metal of Cu is (40 mg/kg) (WHO and FAO mg/kgCodexAlimentarius Commission 1991). was found to be more than the maximum permissible limit (WHO and FAO mg/kgCodex Alimentarius Commission 1991.The high values of, As, Pb, Cd and Hg might be due to the uses fertilizers, fossil fuels, car battery wash waste waters and plastic materials production processing at upper course of the river .

According to the research work, there exists contamination of vegetables with heavy metals especially As due to which people are resulted being suffering through various diseases. The responsible authorities should give an impetus to the concentration of heavy metals in vegetable cultivation (onion, cucumber and tomato) and should also take care that the consumption of the vegetables do not results causing any harm to the health of the consumer after consuming it.

REFERENCES:

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

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

(3) Agency for Toxic Substances and Disease Registry (ATSDR). 1999a. Toxicological Profile for Cadmium and Nickel.

(4) Agency for Toxic Substances and Disease Registry, US Department of Health and Human Services, Public Health Service.205-93-0606. Agency for Toxic Substances and Disease Registry (ATSDR).1999b. Toxicological Profile for Lead.

(5) Agency for Toxic Substances and Disease Registry, US Department of Health and Human Services, Public Health Service.205-93-0606.

(6) Agency for Toxic Substances and Disease Registry (ATSDR). 2000. Toxicological Profile for Arsenic. Agency for Toxic Substances and Disease Registry, US Department of Health and Human Services, Public Health Service.205-1999-00024.

(7) 1. Heidarieh M, Maragheh MG, Shamami MA, Behgar M, Zi-

aei F, et al. (2013) Evaluate of heavy metal concentration in shrimp (Penaeussemisulcatus) and crab (Portunuspelagicus) with INAA method. Springerplus 2: 72.

(8) 2. Kachenko AG, Singh B (2006) Heavy metals contamination in vegetables grown in urban and metal smelter contaminated sites in Australia. Water Air Soil Pollut 169: 101-123.

(9) 3. Gupta UC, Subhas C, Gupta MD (2008) Selenium in soils and crops, its deficiencies in livestock and humans: Implications for management. Commun Soil Sci Plant Anal 29: 1791-1807.

(10) 4. WHO (1995) Inorganic lead. Geneva, World Health Organization, International Programme on Chemical Safety. Environmental Health Criteria 165.

(11) 5. Chailapakul O, Korsrisakul S, Siangproh W, Grudpan K (2007) Fast and simultaneous detection of heavy metals using a simple and reliable microchip-electrochemistry route: An alternative approach to food analysis. Talanta 74: 683-689.

(12) 6. Wilson B, Pyatt FB (2007) Heavy metal dispersion, persistance, and bioccumulation around an ancient copper mine situated in Anglesey, UK. Ecotoxicol Environ Saf 66: 224-231.

(13) 7. Jofferies DJ (1984) Chemical analysis some coarse fish from a sufflok River carried out part of the preperation for the first release of captive-bred otters. J Otter Trust 1: 17-22.

(14) 8. Garcia, W.J., Blessin, C.W., Inglett, G.E. and Kwolek,

W.F. 1981. Metal Accumulation and Crop Yield for a Variety of Edible Crops Grown in Diverse Soil Media Amended with Sewage Sludge. Environmental Science and Technology. 15 (7): 793-804.

(15) 9-CheraghiM(2009), Effect of Waste Water on Heavy Metal Accumulation in Hamedan Province Vegetables,interJof botany.5:190 –193