Global Scientific JOURNALS

GSJ: Volume 7, Issue 12, December 2019, Online: ISSN 2320-9186
www.globalscientificjournal.com

DETERMINATION OF HEAVY METALS (Cu, Zn, Cd, Pb) IN NON-LEAFY VEGETABLES SOLD IN MAJOR MARKETS IN AKURE NIGERIA

Esho Idowu Johnson[1], Ibitoye Damilola Kingsley[2]

([1]Chemistry, Federal University of Technology, Akure, Nigeria, [2]Chemistry, University of Ibadan, Nigeria)

ABSTRACT

The present study was carried out to assess the concentration levels of seven heavy metals (Cu, Pb, Zn, Cd) in eight different non-leafy vegetables namely; Cyanne pepper (*Capsicum frutescens*), Bell pepper (*Capsicum annum*), Habanero pepper (*Capsicum annum*), Okro (*Abelmuscusesculentum*), Carrot (*Daucuscarota*), Cucumber (*Cucumissativus*), Garden-egg (*Solanummelongena*) and Sweet potato (*Ipomoea batatas*) collected from four different markets (Oja-oba, Shasha, Isikan and Odopetu) in Akure, Ondo State. Heavy metal concentration was determined using Atomic Absorption Spectrometer (AAS, VGP210). The results showed that in all the samples, the highest concentrations were observed for Cu (3.02 mg/100g) in Cyanne pepper at Oja-oba market, Pb (0.80 mg/100g) in Habanero pepper at Isikan market, Zn (7.53 mg/100g) in Okro at Oja-oba market, Cd (0.30 mg/100g) in Cyanne pepper and Bell pepper at Odopetu market, respectively. Also, the results showed that the mean concentrations of all the metals analyzed in the non-leafy vegetables were in the following order; Zn>Cu>Pb>Cd. It was observed that Pb and Cd levels exceeded the maximum permissible limits set by FAO/WHO, but the levels of Cu and Zn were within the limits. However, proper monitoring plan is necessary to evaluate the levels of metal concentration in vegetables in order to develop the proper measures for reducing excessive build-up of these metals in the food chain.

Keywords: *AAS, Heavy metals, Non-leafy Vegetables.*

INTRODUCTION

Heavy metals are ubiquitous and have been reported to be found in air, generated during mining operation, used in the manufacture of fertilizers, pesticides, produced during burning of petrol containing anti-knocking agent (tetraethyl lead), burning of tyres, irrigation with waste water, release of gases from industrial chimneys and so on (Halweil and Nierenberg, 2007). Fumes or gases produced from industrial chimneys and vehicular exhausts are deposited and get absorbed by the vegetables planted along the road side which easily increase the concentration of the metals in them (Khairiah *et al.*, 2004; Chojnacka *et al.*, 2005; Muhammad *et al*., 2008). Ladipo and Doherty (2011) studied heavy metal levels in vegetables from selected markets in Lagos, Nigeria. Intake of vegetables is a very important pathway for heavy metals to enter the human system and as result of this, it is important to assess the levels of heavy metals in edible vegetables and report possible contamination sources. Therefore, Vegetables are diets taken by large population in the world being the constituents of essential nutrients to human body and highly recommended by medical personnel. Non-leafy vegetables are used in many ways such as cooking stews, eaten as fruits and processed into canned foods. Akure is the most inhabited town in Ondo State and most of the vegetables sold in developing countries like Nigeria are exposed in markets. During cultivation, the vegetables are also exposed to contamination either from wet or dry condition, depositions from vehicular exhausts, through the application of pesticides or from run-offs. Due to large consumption of vegetables and because it is highly recommended by medical practitioners, monitoring the concentration of heavy metals is very important. The specific objective is to determine the total heavy metals (Zn, Cu, Pb, Cd) in non-leafy vegetables.

MATERIALS AND METHODS

Collection of Samples

Eight different species of non-leafy vegetables were collected at three different points from four different markets (Oja-oba, Isikan, Odopetu and Shasha markets) in duplicate within Akure metropolis in Nigeria. All the collected samples were separately packed-up in air-tight container and brought to the laboratory for sample treatment and analysis.

Sample Preparation

The samples were first washed thoroughly with running water and to eliminate dust and dirt and then washed again with deionized water, cut into pieces with a knife, air drying and later oven-dried at 60 ^oC for 3 h to remove any suspended moisture. The samples were homogenized by grinding into powder using mortar and pestle, sieved using 2 mm size and were kept at room temperature prior to analysis (Noor-ul-Amin *et al*., 2012; Miss Priyanka *et al*., 2017).

Digestion of Samples for Analysis

The powdered sample (1 g) was weighed into a crucible and transferred into a muffle furnace to ash at 550 ^oC for 8 h. The ash was dissolved in 2% Nitric Acid (HNO_3) until a clear solution is formed (Crosby N.T., 1977; Sahito *et al*., 2002; Monali M. Kalaskar, 2012). The solution was filtered using Whatmann No. 42 filter paper and the filtrate was made up with distil water to 100 mL in a volumetric flask. The metallic concentrations of the samples were measured by Atomic Absorption Spectrometer (AAS, VGP210) as described by Agrawal (2003). All the readings were taken in triplicate. The mean data reported in mg/100g

RESULTS AND DISCUSSION

The concentrations of the heavy metals in all samples at different market locations was found to be in the order Zn>Cu>Pb>Cd. Heavy metal concentrations varied among different vegetables, which may be attributed to differential absorption capacity of the vegetables for different heavy metals (Zurera *et al*. 1989). Qais *et al*. (2013) in the survey of some heavy metals in Yemeni Vegetables collected from local markets in Ibb city of Yemen have found the levels of Cd (0.007 mg/100g), Cu (0.17 mg/100g), Fe (0.20 mg/100g) and Pb (0.009 mg/100g) in Cucumber, Cd (0.009 mg/100g), Cu (0.048 mg/100g), Fe (0.180 mg/100g) and Pb (0.067 mg/100g) in garden-egg, Cd (0.007 mg/100g), Cu (0.037 mg/100g), Fe (0.396 mg/100g) and Pb (0.010 mg/100g) in Carrots, Cd (0.005 mg/100g), Cu (0.058 mg/100g), Fe (0.194 mg/100g) and Pb (0.022 mg/100g) in potatoes. The order of heavy metals found was in accordance with previous studies estimating heavy metals in vegetables (Arora *et al*., 2008; Singh *et al*., 2010). The highest level of Cu (3.02 mg/100g) was found in Cayenne pepper at Oja-oba market which might be because the market is densely populated with high concentrations of dust containing heavy metals from vehicular exhausts which can easily be deposited on these vegetables. Also, application of bio-solids and pesticides to the soil on which the vegetables were planted can also be means of contamination. Elbagermi *et al*. (2012) reported values of 0.50, 0.58 and 0.53 mg/100g for the concentration of Cu in Carrot, Cucumber and Spinach.

The highest concentration of Pb (0.80 mg/100g) among all the samples was obtained in habanero pepper from Isikan market. The level of Pb uptake in this study may be due to transportation, re-suspended road dust and other anthropogenic activities of the markets, pH of the soil and burning of organic materials containing lead which can easily be deposited on the vegetables and the use of pesticides and phosphatic fertilizers during plantation. It has been reported that Pb can accumulate in vegetables through air and water and cannot be eliminated by washing the vegetables (Abbas *et al*., 2010; Zamor *et al*., 2012). The levels of Pb reported in this study are higher when compared to that reported in the leaves of lettuce (0.001 mg/100g) by Adu *et al*. (2012). The level of Pb obtained in this study was lower than the concentration (1.07 mg/100g) observed by Demirezen and Ahmet (2006) in different samples of vegetables which pose health risks to human life. In another study, Sharma *et al*. (2006) investigated that concentration of Pb (1.75-2.50 mg/100g) in vegetables grown in wastewater industrial areas and the concentrations were above the safe limit. Geetanjali Chauhan (2014) reported high concentration of Pb (0.89 mg/100g) in spinach vegetables collected from the cement factory area in India which is almost equal to that obtained in this present study. The concentration of Zinc (7.53 mg/100g) was observed to be the highest in *Albemuscus esculentus* at Oja-oba market. The primary source of Zinc in the area could be from of motor vehicle rubber tyres aggravated by poor road surface, waste combustion and lubricating oils in which additives as zinc dithiophosphateshas been added. These can easily mix with air and be deposited on the vegetables. Also, the use of pesticides, bio-solids and manures during growing period. The concentration range of Zn (0.40-7.53 mg/100g) recorded during this present study was higher than the range (0.13-0.37 mg/100g) reported by Sridhara Chary *et al*. (2008) for lady's finger grown in waste water irrigated areas of Hyderabad, Andhra Pradesh. Overall, Okro at Ojaoba was the highest accumulator of Zn while habanero pepper at Odopetu was the lowest Zn accumulator. The highest level of Cd (0.30 mg/100g) was found in bell pepper and cayenne pepper at Odopetu market while the lowest level of Cd (0.10 mg/100g) was obtained in Okro at Odopetu. The major reason for this may be due to traffic exhausts from motorcycles, cars, wear of automobile tyres and burning of oils (USEPA, 1996) in the market and probably the use of contaminated water for irrigation, phosphate fertilizers (Jones and Jarvis, 1981), sewage and compost (Basta *et al*., 2005) during growing period. There has been report that cadmium is a highly mobile metal, easily absorbed by the plants through root surface and moves to wood tissue and transfers to upper parts of plants. Itanna (2002) and Muhammad *et al.* (2008) reported that there is a direct relation between the

GSJ: Volume 7, Issue 12, December 2019
ISSN 2320-9186

levels of Cadmium in the root zone and its absorption by plant. In this present study, the concentration of Zinc was higher than that of Cadmium in all the vegetables. Radwan and Salama (2006) have also found highest concentration of Zn and lowest of Cd in vegetables collected from Egyptian markets. When the present concentrations of metals were compared with permissible limits of FAO/WHO (2001), it was found that the average concentration of Cu and Zn were within the limits but average concentrations of Cd and Pb were lower higher than the permissible limits; this implies that these non-leafy vegetables are good sources of Cu and Zn. In this present study, the level of Cd obtained in bell pepper and cayenne pepper at Odopetu was above the permissible limit (0.02 mg/100g) stated by FAO/WHO (2001) and thus might be a threat for the consumers.

Location	**Cu**	**Pb**	**Zn**	**Cd**	**Cr**	**Ni**	**Fe**
Sample A							
Oja oba	3.02±0.03	BDL	3.60[a]±0.04	BDL	BDL	0.10[d]±0.00	8.20[c]±0.00
Shasha	1.10[c]±0.02	0.20±0.00	2.30[b]±0.00	BDL	BDL	0.40[c]±0.00	23.53[b]±0.02
Isikan	1.30[b]±0.00	BDL	3.40[d]±0.02	BDL	BDL	0.50[b]±0.00	32.23[a]±0.03
Odopetu	1.10[c]±0.02	BDL	1.93[c]±0.05	0.30[a]±0.00	BDL	0.70[a]±0.01	8.00[d]±0.04

Sample B							
Oja-oba	1.00^{a}±0.00	BDL	2.43^{a}±0.03	BDL	0.30±0.00	0.70^{a}±0.00	8.90^{c}±0.00
Shasha	0.60^{c}±0.00	BDL	1.70^{c}±0.01	BDL	BDL	0.30^{c}±c0.00	9.53^{b}±0.02
Isikan	0.80^{b}±0.00	BDL	2.40^{a}±0.00	BDL	0.10±0.00	0.60^{b}±0.00	15.70^{a}±0.03
Odopetu	1.10^{a}±0.00	BDL	1.89^{b}±0.01	0.30^{a}±0.00	BDL	0.70^{a}±0.00	8.03^{d}±0.01
Sample C							
Oja-oba	0.80^{b}±0.00	BDL	2.20^{a}±0.00	BDL	0.10±0.00	0.60^{a}±0.00	22.87^{a}±0.03
Shasha	0.30^{c}±0.00	BDL	0.70^{c}±0.00	BDL	BDL	0.20^{c}±0.00	8.20^{c}±0.00
Isikan	1.60^{a}±0.00	0.80^{a}±0.01	1.80^{b}±0.02	BDL	0.40±0.00	0.50^{b}±0.00	10.60^{b}±0.02
Odopetu	0.30^{c}±0.00	0.50^{b}±0.00	0.40^{d}±0.00	BDL	BDL	0.60^{a}±0.00	10.20^{b}±0.00
Sample D							

Oja-oba	1.60[a]±0.00	BDL	7.53[a]±0.01	BDL	0.20±0.00	0.39[b]±0.00	15.10[b]±0.00
Shasha	1.60[a]±0.00	BDL	5.93[b]±0.01	BDL	BDL	0.60[a]±0.00	5.30[d]±0.00
Isikan	1.30[b]±0.00	BDL	6.10[b]±0.00	BDL	BDL	0.40[b]±0.00	15.20[a]±0.00
Odopetu	1.30[b]±0.00	0.20±0.00	5.10[c]±0.02	0.10±0.00	BDL	0.60[a]±0.00	6.60[c]±0.00
Location	**Cu**	**Pb**	**Zn**	**Cd**	**Cr**	**Ni**	**Fe**
Sample E							
Oja-oba	0.70[c]±0.00	BDL	2.80[bc]±0.00	BDL	BDL	0.80[b]±0.00	6.50[a]±0.00
Shasha	0.90[b]±0.00	BDL	2.70[c]±0.00	BDL	BDL	2.70[a]±0.01	11.50[b]±0.00
Isikan	0.40[d]±0.00	BDL	3.50[a]±0.01	BDL	0.10±0.00	0.50[c]±0.00	11.30[c]±0.00
Odopetu	1.10[a]±0.01	BDL	2.90[b]±0.00	BDL	0.20±0.00	0.80[c]±0.80	12.90[d]±0.00

Sample F							
Oja-oba	1.10^{b}±0.00	0.10^{a}±0.00	6.33^{a}±0.02	BDL	0.10±0.00	0.50±0.00	14.20^{a}±0.00
Shasha	1.00^{c}±0.00	BDL	3.83^{c}±0.00	BDL	0.20±0.00	1.20±0.00	11.10^{c}±0.00
Isikan	1.50^{a}±0.00	0.30^{a}±0.00	4.80^{b}±0.00	BDL	0.10±0.00	0.40±0.00	13.60^{b}±0.00
Sample G							
Oja-oba	1.20^{a}±0.00	BDL	3.50^{b}±0.00	BDL	0.20^{a}±0.00	0.70^{a}±0.00	14.00^{b}±0.00
Shasha	1.90^{a}±0.00	BDL	2.50^{c}±0.00	BDL	0.30^{b}±0.00	0.80^{b}±0.00	10.70^{a}±0.00
Sample H							
Oja-oba	1.10^{a}±0.00	0.40±0.00	1.50^{b}±0.00	BDL	0.20^{a}±0.00	0.30±0.00	7.33^{b}±0.01
Shasha	0.20^{a}±0.00	BDL	0.80^{b}±0.00	BDL	0.10^{a}±0.00	BDL	3.40^{c}±0.00

Sample A: Cayenne pepper, Sample B: Bell pepper, Sample C: Habanero pepper, Sample D: Okro, Sample E:Daucus *carota*, Sample F: Cucumis *sativus*, Sample G: Solanum *melongena*, Sample H: Ipomoea *batatas.*

BDL: Below Detection Limit (Pb<0.04, Cd<0.01, Cr<0.04)

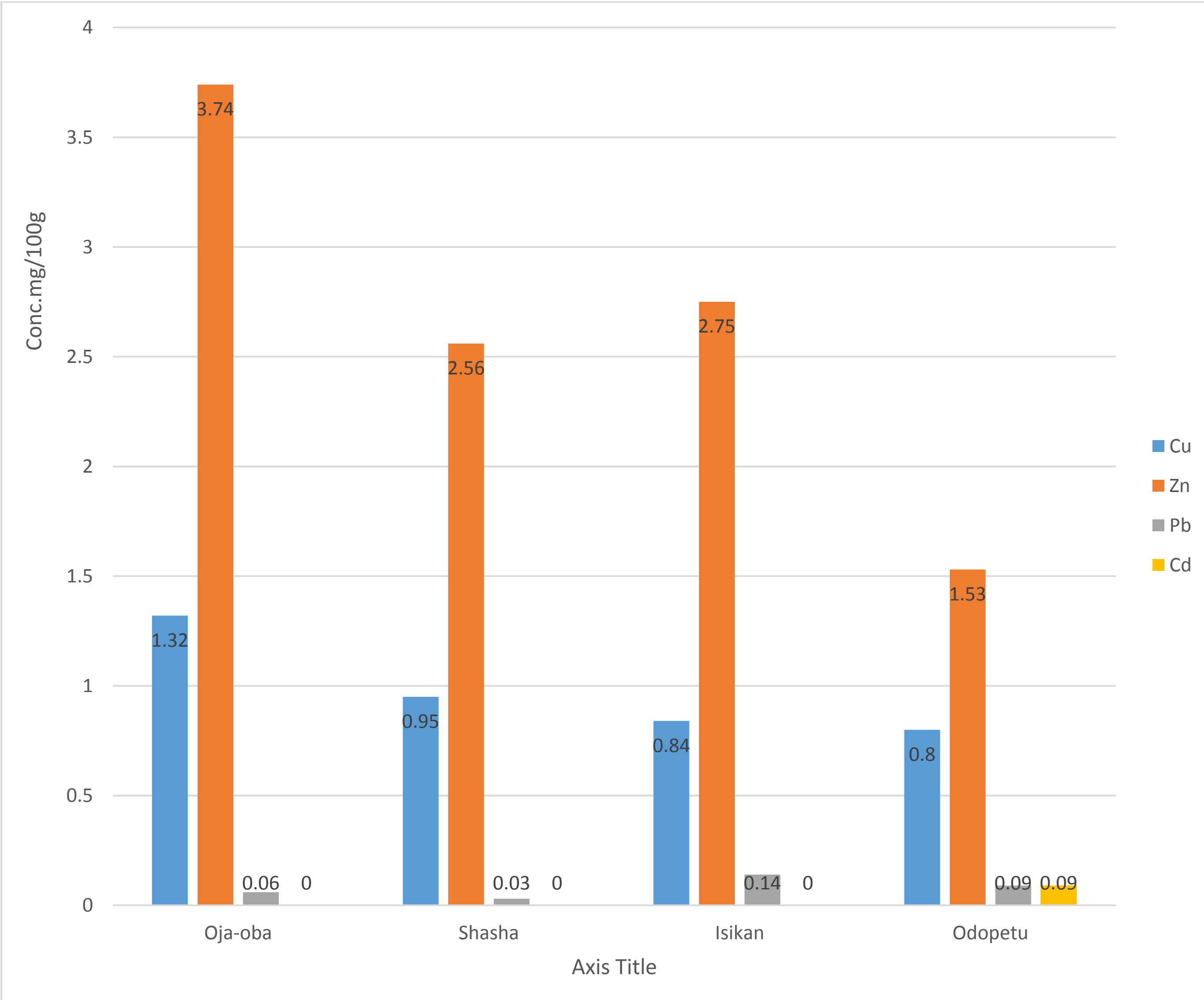

Figure1: Relative mean concentration of the metals across the markets

CONCLUSION

The present study has shown the concentrations of heavy metals in the non-leafy vegetables collected from four different markets of Akure, Ondo State. It can be concluded that Cd (0.30 mg/100g) and Pb (0.80 mg/100g) concentrations in all the vegetables were above the permissible limits set by FAO/WHO for human consumption. The levels of Zn (7.53 mg/100g), Cu (3.02 mg/100g) however fall within the maximum permissible limit. The highest concentrations of Pb was found in habanero pepper from Isikan market while the highest level of Cd was obtained in cayenne and bell peppers from Odopetu. From this analysis, it could be said that vegetables from Odopetu market may contain high level of Cd above the safe limit while those from Isikan market may have high concentrations of Cd and Pd.

AKNOWLEDGEMENT

I thank my creator for His mercy all the way, may His name be praised. My thanks goes to my mother Mrs Olanrewaju Esho and my uncle, Dr. Adeniyi, Oluwafemi Emmanuel for their immeasurable encouragement and prayers when the going was too tough, may you live to eat the fruits of your labour.

I acknowledge my generous supervisors, in person of Prof. A.V. Popoola and Dr. V.O.E. Akpambang for their understanding. I appreciate you.

My gratitude also goes to Mr. Teniola, Bode Olaniyi for his help throughout the program in FUTA. I thank my colleague in person of Olabintan Oluwapelumi for his help during my ordeal. God bless you. I will never forget the Aladenika's family and also my wonderful friend, Aladenika Michael Aderotimi, I thank God that I have you as my brother. May God grant all your good wishes in Jesus name. Amen. I acknowledge the scholars whose works I have cited in this theses.

Reference

Adu, A. A., Aderinola, O. J. and Kusemiju, V. (2012). Heavy metals concentration in Garden lettuce (*Lactuca Sativa L.*) grown along Badagry expressway, Lagos. *Transnational Journal of Science and Technology*, 2(7):115-130.

Agrawal, M. (2003). Enhancing food chain integrity: Quality Assurance Mechanism for Air Pollution Impacts on Fruits and Vegetable System. *Final Technical Report for Department of International*, UK, p.7530.

Bahemuka, T. E. and Mubofu, E. B. (1999). Heavy Metals in Edible Green Vegetables Grown *Chemistry*, 66:63-66.

Chien, L. C., Hung, T. C., Choang, K. Y., Yeh, C. Y., Meng, P. J., Shieh, M. J. and Han, B. C. (2002). Daily Intake of TBT, Cu, Zn, Cd and As for Fishermen in Taiwan. *Science Total Environment*, 285:177-185.

Chojnacka, K., Chojnacki, A., Gorecka, H. and Gorecki, H. (2005). Bioavailability of Heavy Metals from Polluted Soils to Plants. *Science of the Total Environment*. Vol. 337:175-82.

Crosby N.T. 1977. *The analyst*. 102, 223-268.

Der Pharma Chemica, (2012). *Quantitative analysis of heavy metals from vegetable* of Amba Nalain Amravati District Monali M. Kalaskar Department of Chemistry, Govt. Vidarbha Institute of Science and Humanities, Amravati, (M.S.) India-444604. 4(6):2373-2377.

Elbagermi, M. A., Edwards, H. G. M. and Alajtal, A. I. (2012). Monitoring of heavy metal content in fruits and vegetables collected from population and market sites in the Misurata area of Libya. *International Scholarly Research Network*, 10:1-5.

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

FAO/WHO. (1999). CODEX Alimentarious Recommended International Code of Practice General Principles of Food Hygiene. *CAC/RCP*, 1-1969, Revised 3-1997.

Guerra, K., Konz, J., Lisi, K. and Neebrem C. (2010). *Exposure Factors Handbook*. USEPA, Washington DC.

Halweil B. and Nierenberg D. (2007). *Farming the Cities State of the World,* 3:48-206.

Hayes A.W., (1984). Principals and Methods in Toxicology. New York: Raven Press.

Huang, M. L., Zhou, S. L., Sun, B. and Zhao, Q. C. (2008). Heavy Metals in Vegetables: Assessment of Potential Health Risk for Inhabitants in Khunshan, China. *Science of the Total Environment*, 405:54-61.

Khairiah, J., Zalifah, M. K., Yin, Y. H. and Aminha, A. (2004). The Uptake of Heavy Metals by Fruit type Vegetable grown in Selected Agricultural Areas. *Pakistan Journal of Biological Science,* Vol.7:1438-1442.

Ladipo, M. K. and Doherty, V. F. (2011). Heavy Metals Levels in Vegetables from Selected Markets in Lagos, Nigeria. *African Journal of Food Science and Technology*, 2(1):018-021.

Muhammad, F., Farooq, A. and Umer, R. (2008). Appraisal of Heavy Metal Contents in different Vegetables grown in the Vicinity of an Industrial Area. *Pakistan Journal Botany*, 40(5):2099-2106

Noor-ul-Amin, Anwar H., Sidra, A. and Shumaila, B. (2012). Accumulation of Heavy Metals in Edible parts of Vegetables irrigated with Waste water and their Daily Intake to Adults and Children, District Mardan, Pakistan. *Food Chemistry Journal*, 136:1515-1523.

Premarathna, H. M. P. L., Indraratne, S. P. and Hettiarachchi, G. (2010). Heavy Metal Concentration in Crops and Soils collected from Intensively Cultivated Areas of Sri Lanka. *19th World Congress of Soil Science.*

Radwan, M. A. and Salama, A. K. (2006). Market Based Survey for Some Heavy Metals in Egyptian Fruits and Vegetables. *Food and Chemical Toxicology,* 44:1273-1278.

Sahito, A., Kazi, T. G., Jakhrani, M. A., Kazi, G. H., Shar, G. Q. and Memon, M. A. (2002). Elemental Investigation of *Momordica charantia Linn*. and *Syziginm jambolana Linn*., using Atomic Absorption Spectrophotometer. *The Nucleus*, 39:49-54.

Singh, A., Sharma, R. K., Agrawal, M. and Marshall, F. M. (2010). Risk Assessment of Heavy Metal Toxicity through Contaminated Vegetables from Waste water Irrigated Area of Vanasi, India. *Tropical Ecology,* Vol. 51:375-387.

US EPA (2013) and FAO/WHO: Reference dose (RfD): Description and use in Health Risk Assessments, Background Document 1A, Integrated risk information system (IRIS); *United States Environmental Protection Agency*: Washington, DC, New York.

US EPA (2013) and FAO/WHO: Reference dose (RfD): Description and use in Health Risk Assessments, Background Document 1A, Integrated risk information system (IRIS); *United States Environmental Protection Agency*: Washington, DC, New York.

Wang, X. L., Sato, T., Xing, B. S. and Tao, S. (2005). Health Risk of Heavy Metals to the General Public in Tianjin, China through Consumption of Vegetables and Fish. *Science of the Total Environment*, 350:28-37.

WHO/FAO, (2013). *Guidelines for the safe use of wastewater and foodstuff*. Wastewater use in Agriculture, World Health Organization, Geneva. Volume 2:1-14, 998.