Heavy Metal Profile of Vegetables Sold in Markets of Amukpe and Abraka, Delta State Nigeria

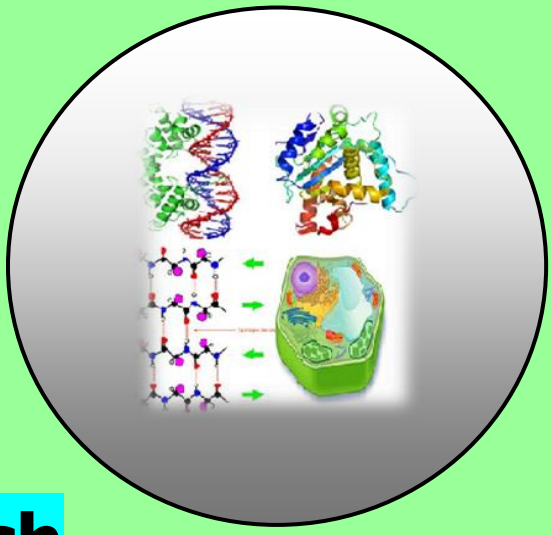
By

Obi-Iyeke, G. E. and Nwadinigwe, A.O.

ISSN 2319-3077 Online/Electronic
ISSN 0970-4973 Print

Journal Impact Factor: 4.275
Global Impact factor of Journal: 0.876
Scientific Journals Impact Factor: 3.285
InfoBase Impact Factor: 3.66
Index Copernicus International Value
IC Value of Journal 47.86 Poland, Europe

J. Biol. Chem. Research
Volume 33 (1) 2016 Pages No. 352-358



Journal of Biological and Chemical Research

An International Peer Reviewed / Referred Journal of Life Sciences and Chemistry

Indexed, Abstracted and Cited in various International and National Scientific Databases

Published by Society for Advancement of Sciences®

J. Biol. Chem. Research. Vol. 33, No. 1: 352-358, 2016
(An International Peer Reviewed / Refereed Journal of Life Sciences and Chemistry)
Ms 33/1/68/2016

ISSN 0970-4973 (Print)
ISSN 2319-3077 (Online/Electronic)

http:// www.sasjournals.com
http:// www.jbcr.in
jbiolchemres@gmail.com

RESEARCH PAPER

Received: 11/01/2016 **Revised: 21/03/2016** **Accepted: 22/03/2016**

Heavy Metal Profile of Vegetables Sold in Markets of Amukpe and Abraka, Delta State Nigeria

G.E Obi-Iyeke and * A.O. Nwadinigwe
Department of Botany, Faculty of Science, Delta State University, Abraka, Delta State Nigeria
***Department of Plant Science and Biotechnology, Faculty of Biological Science, University of Nigeria Nsukka**

ABSTRACT

An investigation was carried out to determine the concentration of heavy metals in five vegetables viz: Amaranthus cruentus (green), Talinum triangulare (water leaf), Telferia occidentalis (fluted pumpkin), Occimum grattisimum (scent leaf) and Vernonia amygdalina (bitter leaf) collected from selected markets in Abraka and Amukpe in Delta State, Nigeria in 2015. The vegetables were dried; wet digested and analyzed using atomic absorption spectrophotometer following the additive method. The results indicated that the mean concentration of heavy metals in vegetable samples in Amukpe market exceeded those from Abraka which could be related to oil activities in Amukpe. Variations of the metals in the vegetables were in the order Mn>Cu >Pb >Fe >Zn > Cr in all the analysed samples. The result also showed a highly significant (P≤ 0.05) difference relative to Abraka values. The results revealed that the levels of the metals in the vegetable were within the recommended ranges in plants and below the recommended permissible level by FAO and WHO standards. However, a continuous study in these areas is recommended to ascertain long-term effects of anthropogenic impact and the possible risk associated with consumption of contaminated food materials.
Keywords: Heavy metals, Contamination, Vegetables and Health Risk.

INTRODUCTION

Heavy metal accumulation in agricultural products and the resulting health effects present some of the biggest challenges currently affecting the world. Heavy metals are natural components of the earth's crust usually present in all environmental matrics (Duffus, 2002; Sharma *et al*. 2006). However, the concentration of several heavy metals has increased in some ecosystem as a result of anthropogenic activities hence affecting food quality and

human health. Environmental contamination by heavy metal is of global concern due to the toxicological risk posed by such metals (Singh and Kumar, 2006). When taken up by plants in toxic levels and transferred to man through the food chain. Although some heavy metals such as Cu, Zn, Mn and Fe are essential in plant nutrition, many heavy metals do not play any significant role in plant physiology (Haiyan and Stuanes, 2008 ; Okunola *et al* 2008). These metals are non-biodegradable and can undergo global ecological circles (Bassey *et al,* 2014). Environmental quality of food production is a matter of growing concern thus heavy metal analysis is an important part of environmental pollution studies (Nwajei, 2009).

Heavy metal contamination of vegetables cannot be underestimated because vegetables play appreciable role in sustainable development through food and nutritional security. Vegetables are vital to human diet as they contain essential nutrients needed by the human body (Demirezen and Atosy, 2006). Vegetables contain about 90%-96% water in the form of colloidal bound or constitution water which plays vital role in reproduction and other physiological processes (Idah *et al*, 2007). Vegetables are rich in mineral substances than fruits (Ewekeye *et al*. 2013) normally between 0.60 and 1.80%. Unique quantities of potassium and absence of sodium chloride gave high dietic value to vegetables and their processed products (Droby, 2006). Consumption of contaminated food crops is one of the most important pathways by which heavy metals enter the food chain (Iwegbue *et al*, 2011). Heavy metals persisting in the environment are non-biodegradable and have the potential to accumulate in different body organs (Radwan and Salama, 2006). The uptake of metals from the soil depends on different factors such as their solubility, soil pH, plant growth stages types of species (Jiang *et al*, 2001). As a result, it leads to contamination of the food chain, because vegetables, especially leafy vegetables absorb heavy metals from the polluted soil, air and water. Prolonged consumption of unsafe concentration of heavy metals through contaminated food stuffs may lead to chronic accumulation of heavy metals in the kidney and liver of humans causing disruption of numerous biochemical processes, leading to cardiovascular, nervous, kidney and bone disease (Jarup, 2003). A study was conducted in September, 2015 in Amukpe town (host community of SHELL oil well number 25) and Abraka (a non-oil producing town) both in Niger delta region of Delta State to determine the concentration of heavy metals (Iron, lead, chromium, manganese, copper, and zinc) in vegetables sold in markets of Amukpe and Abraka ,Delta State, Nigeria and to compare the obtained heavy metal value with permissible level of heavy metals concentration stipulated by World Health Organization (WHO) and Food Agriculture Organization (FAO).This study will help to provide baseline information on the health hazards associated with consuming these vegetables by indigenious populace.

MATERIAL AND METHODS

STUDY AREA

Abraka lies within the tropical rain forest zone at latitude 5^0 45′ to 5^0 50′N and longitude 8^0 06′ to 8^0 15′E of the equator. Abraka dry season is from November to February while the rainy season lasts for months. Rainfall peaks in July and October (Efe and Arueqodore, 2003). Amukpe is located on longitude 05^044^1E and latitude 05^051^1N on the south bank of River Ethiope (Atakpo and Akpoborie, 2008). It is located in the tropical rainforest zone with an annual rainfall of 2500m that stretches for about eight months with peak between May and July and a sudden break in August.

Sunshine hours are low and the relative humidity is high. Average temperature is about 25^0C - 29^0C. The natural vegetation of Amukpe is tropical rainforest, except along drainage streams where swampy areas exist. Presently, the vegetation is transiting to derived savannah as a result of excessive cultivation, reduced fallow period caused by increased population pressure, rapid industrial development and devastating effects of oil spillage (Atakpo and Akpoborie, 2008).The rich alluvial soil coupled with fresh and salt water bodies provided the necessary incentives for the people who are predominantly farmers and fishers.

SAMPLE COLLECTION

Five Leafy Vegetables: *Amaranthus cruentus* (green), *Talinum triangulare* (water leaf), *Telferia occidentalis* (fluted pumpkin), *Vernonia amygdalina* (bitter leaf) and *Ocimum gratissimum* (scent leaf) were procured from Amukpe and Abraka Markets directly from the farmers.

SAMPLE TREATMENT

Vegetables were kept in clean polythene bags and labeled according to the sites from which they were collected. Samples were washed with distilled water to remove dust and other particles, air dried in a dust free room then transferred in an oven at 70Oc for 48hours to a constant weight. The dried plant samples were gently crushed in an agate mortar with a pestle and finally ground into fine powder using a stainless steel blender. Dry powdered leaves were digested with 60% HclO4, concentrated HNO3 and H2SO4. The digest samples were analysed for the various heavy metals using atomic absorption spectrophotometer (GBC scientific equipment SENS AA, Melbourne, Australia).

Data collected were subjected to Analysis of Variance (ANOVA) and the significant means were separated with the Duncan's Multiple Range Test Using SAS.

RESULT AND DISCUSSION

Table 1. Heavy metal concentration (mg/kg) dry weight in vegetables in Abraka and Amukpe markets

SAMPLES	HEAVY METALS											
	FE		ZN		CR		CU		PB		MN	
	ABK	AMU	ABK	AMU	ABK	AMU	ABK	AMU	ABK	AMU	ABK	AMU
Bitter leaf	0.02^{c}	0.07^{c}	0.03^{b}	0.09^{a}	0.01^{b}	0.08^{a}	0.01^{d}	0.09^{d}	0.04^{c}	0.10^{c}	0.18^{c}	0.31^{b}
Water leaf	0.03^{b}	0.09^{b}	0.01^{c}	0.05^{c}	0.01^{b}	0.07^{b}	0.21^{b}	0.37^{a}	0.05^{b}	0.08^{d}	0.17^{d}	0.29^{c}
Pumpkin leaf	0.04^{a}	0.16^{a}	0.03^{b}	0.10^{a}	0.01^{b}	0.08^{a}	0.24^{a}	0.27^{b}	0.10^{a}	0.17^{a}	0.21^{b}	0.28^{c}
Scent leaf	0.04^{a}	0.06^{c}	0.03^{b}	0.09^{a}	0.02^{a}	0.03^{d}	0.20^{b}	0.26^{b}	0.03^{d}	0.11^{b}	0.36^{a}	0.46^{a}
Green leaf	0.03^{b}	0.05^{d}	0.04^{a}	0.07^{b}	ND	0.04^{c}	0.18^{c}	0.19^{c}	0.02^{e}	0.09^{e}	0.16^{e}	0.24^{d}

Values with different superscript in the same column are significantly different using Duncan Multiple Range Test

Key:

ABK = Abraka
AMU = Amukpe
ND = Not Detected

The results of heavy metal concentration in selected vegetable samples showed that the values of chromium (Cr), manganese (Mn), copper (Cu), iron (Fe), zinc (Zn) and lead (Pb) varies between the different locations of study.

The mean concentration of total heavy metals in the five leafy vegetables analyzed are presented in the table 1. The observed concentrations of Fe, Zn, Cr, Cu, Pb and Mn in these vegetables were compared with the recommended limits established by the FAO/WHO to ensure the safety and well being of consumers (FAO, 2002; WHO 2000). The mean heavy metal concentration varied from 0.0100 mg/kg and 0.2960 mg/kg in both Amukpe and Abraka markets. The concentration of the total heavy metals in vegetable samples from Amukpe were significantly higher ($p<0.050$) than that of the same vegetable from Abraka market.

Cu varies between 0.01 mg/kg - 0.37mg/kg in *Talinum triangulare* (water leaf) from Amukpe accumulated more concentration of Cu than any other tested vegetable. Mn variation among the tested vegetables is between 0.17mg/kg – 0.36mg/kg with the highest value of Mn (0.36mg/kg) obtained from scent leaf from Amukpe while the lowest value (0.17mg/kg) was obtained from water leaf from Abraka Cr variation among the tested vegetables was 0.01mg/kg to 0.08mg/kg. Cr was not detected in green leaf vegetable from Abraka. Pb uptake was highest (0.17mg/kg) in *Telferia occidentalis* (fluted pumpkin leaves) from Amukpe while the least value (0.02mg/kg) was obtained in green leaf vegetable from Abraka. Zn varies between 0.01mg/kg – 0.10mg/kg with the highest value (0.10mg/kg) obtained in *Telferia occidentalis* from Amukpe. Generally, vegetable in Amukpe accumulated more concentration of metal when compared with the same vegetable obtained from Abraka this was probably due to industrial activities in the area than Abraka which is more residential area and a non oil producing community. Plant species vary in their capacity to remove and accumulate heavy metals (Singh *et al* 2010) Uptake of metals by plants is affected by several factors including the type and age of plant, type of soil, pH of soil, organic matter content of the soil, redox potential, cation exchange capacity of soil, surface area and texture of soil particles, the presence and concentration of foreign ions, growth rate and growth conditions. Depending on plant species, metal tolerance may result from two basic strategies: metal exclusion and metal accumulation (Haiyan and Stuanes, 2008). The exclusion strategy comprises avoidance of metal uptake and restriction of metal transport to the shoots (De Vos *et al.*, 2002). In this study, mean concentration of Cu and Mn in vegetables from Amukpe was higher when compared with the value obtained from the same vegetables grown and sold in Abraka. This could be due to oil exploitation activities prevalent in Amukpe community. The finding agreed with the prior reports by Sobukola *et al*., (2010) that there were elevated concentrations of heavy metals in leafy vegetables from selected market in Lagos. The mean concentration of Cr (0.06mg/kg) and Cu (0.236 mg/kg) in vegetable samples in this study exceeded those (0.01mg/kg for Cr and 0.18mg/kg for Cu) levels reported by Iwegbue *et al*. (2011).

Mean concentration of Zn (0.08mg/kg) in vegetable sample in this study is lower than (5.67mg/kg) reported by Obi-iyeke (2011) in vegetables around the vicinity of NNPC refinery, Warri Delta state. Studies on Cd, Cu and Ni levels in vegetables from industrial and residential areas of Lagos City, Nigeria carried out by Yusuf and Osibanjo(2006) revealed that the levels of Cd, Cu and Ni in different edible vegetables along with its soils on which they were grown were higher in industrial areas than those of the residential areas due to pollution. The concentration of heavy metal in vegetables from Amukpe was significantly higher ($p>0.05$) than the value from the vegetable in Abraka. This was probably due to dominating industrial and petroleum activities in Amukpe. In the study of socio-economic activities of oil in the community of Edjeba And Kokori in Delta state, Agbogidi *et al.,* (2005) report that oil activities exerted negative significant influence on kokori community stemming from oil pollution /spillage resulting in environmental degradation that have a significant effect on their farming activities. The observed variation in metal accumulation among the vegetables could be attributed in part to the innate behavior of species studied which agrees with findings of Oluyemi *et al* (2008) and Arora *et al* (2008)who reported that plants respond differently depending in the genetic makeup as influenced by other environmental factors. Generally, this study demonstrated evidence of bioaccumulation of heavy metals in the vegetables obtained in Amukpe when compared to Abraka. The level were however observed to be within the recommend safe limit 0f 0.2, 2.3, 5.0, 1.4, 0.2 and 30mg/kg for Zn, Pb, Cu, Cr, Mn and Fe respectively by WHO (2007) and FAO (2002) standards. Though these metals fall below the critical permissible concentration, their persistence in soil may lead to increase uptake by plants including the test vegetables though the transfer ratio differs among plants. With gradual and steady accumulation and biomagnifications process of these non- degradable elements rise to lethal and harmful level may result in inherent health hazards. This emphasizes the importance of monitoring the great risk posed by the accumulation of these heavy metals on the health or population of man and animal in the area.

CONCLUSION

The study demonstrated that there is a high metal concentration in analyzed leafy vegetables in Amukpe market when compared with the value recorded for the same vegetables in Abraka a nonoil producing community. Although the results revealed that the levels of the metals in the vegetable were within the recommended ranges in plants, and below the permissible levels recommended by the WHO (2002) and FAO (2002), indicating that consumption of these vegetables may not pose health hazards to humans at the time of study. However, biomonitoring of heavy metals in vegetables should be continued to forestall all possible consumption of contaminated vegetables or food stuff because with time and gradual bioaccumulation process, a rise to a lethal level is envisaged with the inherent risk. Regular monitoring is also required over long period as the vegetables are transported from different sources. It is essential that the farmers be educated and encourage to reduced such contamination by controlling the use of pesticide, herbicide and avoiding use of wastewater and cultivating in field far from highway, oil explorating zone and industrial area.

ACKNOWLEDGMENTS

Authors are grateful to Prof G. E. Nwajei of analytical central laboratory, Department of chemistry, Delta state university Abraka, Delta state for analyzing the samples.

REFERENCES

Agbogidi, O.M., Okonta, B.C and Dolor, D.E. (2005). Social- Economic and environmental impact of crude oil exploration and production of agricultural production: A case study of Edjegba and Kokori Communities in Delta State of Nigeria. *Global Journal of Environmental Science* **4**(2):171-176.

Arora, M., Kira, B., Rani, S., Rani, A., Kaur, B. and Mittal, N. (2008). Heavy metal accumulation in vegetables impacted with water from different sources. *Food Chemistry* **111**: 811-815.

Atakpo, E. A. and Akpoborie, A. I. (2008). Geoelectric mapping of Amukpe area of Delta state, Nigeria. *Nigerian Journal of Science and Environment* **1:** 73-82.

Audu, A. and Lawal, A. (2005). Variation in metal contents of plants in vegetable garden sites in Kano metropolis. *Journal of Applied Science and Environmental Management*, 10 (2): 105-109

Bassey, F.I., Iwegbue, C.M.A., Obi-iyeke, G.E., Rotu, A.R. and Tsafe, A.I. (2014). Heavy metals in soil and tomatoes grown in urban fringe environment in Asaba, Delta State Nigeria. *Nigerian journal of basic and applied sciences* **22**(2): 27-31

De Vos, W., Lofts, S., Tipping, E., Meili, M., Groenenberg, J.E., Schütze, G., (2002). Impact of soil properties on critical concentrations of cadmium, lead, copper, zinc, and mercury in soil and soil solution in view of ecotoxicological effects. *Reviews of Environmental Contamination and Toxicology* **191**, 47–89.

Demirezen, D. and Atosy, A. (2006). Heavy metal level in vegetables in Turkey and within safe limit for Cu, Zn, Ni and exceeded for Cd and Pb. *Journal of Food Quality* **29**:252-265.

Doherty, V.F., Sogbanmu, T.O Kamse, V.C. and Wright, O. (2012). Heavy metals in vegetables collected from selected farm and market sites in Lagos, Nigeria. *Global Advanced* Research *Journal of Environmental Science and Toxicology* **1**(6):137-143.

Droby, S. (2006). Improving quality and safety of fresh fruits and vegetables after harvest by the use of biocontrol agents and natural materials. *Actahorticulture* **709**: 45-51.

Duffus, J.H. (2002). Heavy metals: A meaningless term (IUPAC Technical Report). *Pure and Applied Chemistry* **74**:793-807.

Efe, S.I. and Aruegodore, P. (2003). Aspect of microclimates in Nigerian Rural Environment: The Abraka Experience, Nigeria. *Journal of Research and Production* **2** (3): 48-57.

Ewekeye, T.S., Oke, O.A., Quari, A.I., Isikalu, A.O. and Durosinmi, M.L. (2013). Post harvest deteriotion of some fruits and vegetables. *American Journal of Research Communications* **1** (10): 209-223.

Food Agricultural Organization, (2002). World Agriculture: Towards 2015/2030. Summary Report, Rome.

Haiyan, W. and Stuanes, A.O. (2008). Heavy metal pollution in air-water-soil-plant system of Zhuzhou City, Human Province, China. Water, Air and Soil Pollution **147**:79-107.

Idah P.A., Ajisegiri, S.E and Yisa, M.C. (2007). Fruits and vegetables handling and transportation in Nigeria. *Australian Journal of Technology* **10** (3): 176-183.

Iwegbue, C.M.A., Overah, C.L., Ebigwai, J.K., Nwozo, S.O., Nwajei, G.E. and Eguavoen, O. (2011). Heavy metals contamination of some vegetable and spices in Nigeria. International *Journal of Biological and Chemical Sciences* **5** (2):766-773.

Jarup, L. (2003). Harzards of heavy metal contamination. *British Medical Bulletin*, **68**: 167-182.

Jiang, B., Lan, C. and Wang, B. (2001). Heavy metals economical effects of irrigation with Lnadf fill site Leachate. *Environmental Science* **21**(2):1-6.

Nwajei, G.E. (2009). Trace elements in soils and vegetations in the vicinity of Shell Petroleum Development Company operating area in Ughelli, Delta State of Nigeria. *American Eurasian Journal of Sustainable Agriculture,* **3**(3): 574 – 578.

Nwajei, G.E., Obi-iyeke, E.G. and Okwagi, P. (2012). Analytical assessment of trace elements in soil, tomato leaves and fruits in the vicinity of paint industry, Nigeria. *Research Journal of Recent Sciences*, **1**(4):22-26.

Obi-Iyeke, G.E. (2014). Trace metal dynamics in some leafy vegetables consumed in Warri, Niger Delta region Nigeria. *International Journal of Research and Review in Applied Sciences* **18**(3): 279-284.

Okunola. O.J., Uzairu A., Ndukwe, G.I and Adewusi, S.G. (2008). Assessment of Cd, Zn in roadside surface soil and vegetables along some roads of Kaduna metropolis, Nigeria. *Research Journal of Environmental Science* **2**:266-274.

Oluyemi, E.A., Feuyi, G., Oyekunle, J.A. and Ogunfowoko, A.O. (2008). Seasonal variations in heavy metal concentration in soil and selected crops in a land fill in Nigeria. African *Journal of Environmental Science and Toxicology* **2**(5): 89-96.

Radwan, M.A and Salama, A.K. (2006). Market basket survey for some heavy metals in Egyptians Fruits and vegetables. *Food Chemical Toxicology* **44**:1273-1278.

Sharma R.K., Agrawal, M. and Marshall, F.M (2006). Heavy metal contamination in vegetable and grown in wastewater irrigation areas of Varanasi India. *Bulletin of Environmental Contamination and Toxicology* **77**:312-318.

Singh, A., Sharma R.K., Agrawal, M. and Marshall, F.M. (2010). Risk assessment of heavy metal toxicity through contaminated vegetables from waste water irrigation area of Varanasi, India. *Journal of Tropical Ecology* **51** : 375-387.

Singh, S. and Kumar, M. (2006). Heavy metals load in soil water and vegetables in peri-urban Delhi. *Environmental Monitoring Assessment* **120**:79-91.

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

World Health Organization (2000). Environmental lead exposure: a public health problem of global dimension. In: Tong, S., Yasimin, E., Von, S. and Prepamantol, T. (eds). WHO Bulletin, Geneve, Switzerland.

World Health Organization (2007). Health risks of heavy metals from long range Health transmitting air pollution. Joint Task Force on the Health Aspect of long range Transboundary Air Pollution Geneva.

Yusuf, F.A. and Osibanjo, O. (2006). Trace element in water and sediments from Ologe Lagoon, Southwestern Nigeria and Pakistan *Journal of Science and Industrial Research* **49**: 88-96.

Corresponding author: Obi-Iyeke, Environmental Ecology Unit, Department of Botany, Faculty of Science, Delta State University, Abraka, Nigeria.
Email: ekygee@yahoo.com alfreda.nwadinigwe@unnn.edu.ng
Phone: +2348034235271