*https://dx.doi.org/10.22161/ijhaf.3.2.3* *ISSN: 2456-8635*

# Evaluation of Heavy Metals in Commonly Edible Vegetables available in Markets of Akure-South Local Government, Ondo State, Nigeria

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***Abstract*****—** *Vegetables are considered vital given that they supply to humans vitamins, minerals, nutritional fiber, and phytochemicals. This study aimed to evaluate the concentrations of heavy metals in common vegetables, locally available in Akure South LGAs markets for consumers. Samples of vegetables belonging to Amaranthaceae, Malvaceae, Cucurbitaceae, and Basellaceae families were procured from local markets of different areas of Akure south LGAs and analyzed for Cu, Pb, Fe, Zn and Mnby Atomic Absorption Spectrophotometry (AAS). The results indicated that the trace metal content of Telfariaoccidentalis, Corchorusolitorus, Amaranthushybridusand Abelmoschusesculentus from Oja Oba were higher than the other markets. Basellaalba purchased from Isikan possessed the highest metal content. Maximum concentration of Fe was found to be 1.93µg/g in Basellaalba, Zn 0.76 µg/g in Basella alba, Mn 1.12 µg/g in Basella alba, Cu 0.76µg/g in Telfairiaoccidentalis. The overall content of metals appeared to be within the limit laid down for safe human consumption.*

***Keywords*****— Leafy vegetables, phyto-remediation, toxicity, pollution.**

## I. INTRODUCTION

Vegetables are considered as "Protective supplementary food" containing large quantities of minerals, vitamins, carbohydrates, essential amino acid and dietary fibers (Okunlola and Adunola, 2017). They occupy a very important place in the human diet (Zurera et al., 1999, okunlola and Akinrinola, 2014), they however, but unfortunately constitute a group of food which contributes maximally to nitrate and other anions as well as heavy metal consumption.

As human activities increases especially with the application of modern technology, pollution and contamination of human food chain has become inevitable (Agrawal, 2011). Heavy metals deposition are associated with a wide range of sources such as small scale industries (including battery, metal smelting and cable coating industries); vehicular emissions, and diesel generator sets. Several common pesticides used fairly extensively in agriculture and horticulture contained substantial concentration of metals. Certain animal wastes such as poultry, cattle, and pig manures produced in agriculture are commonly applied to crops and pastures either as solids or slurries (USEPA, 1994, Raskin and Enslem, 2014) may also have the potential to cause metal contamination of the soil (Weggler et al., 2004).

Large quantities of fertilizers are regularly added to soils in intensive farming systems to provide adequate N, P, and K for crop growth (Sumner, 2000). The compounds used to supply these elements contain trace amounts of heavy metals (e.g., Cd and Pb) as impurities, which, after continued fertilizer application may significantly increase their content in the soil (Ayeni*et. al*. 2012). The application of numerous bio-solids (e.g., livestock manures, composts, and municipal sewage sludge) to land inadvertently leads to the accumulation of heavy metals such as Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Molybdenum, Zn, etc., in the soil (Lasat, 2000; Okunlola and Abdul-Azeez, 2018).

Vegetable gets its nutrients by absorbing nutrients from the soil which include heavy metals. Soils polluted with heavy metals have become common across the globe due to increase in geologic and anthropogenic activities (Chibuike, 2013). The determination of metal content in vegetables is important from the view point of crop yield technology, food nutrition and health impacts (Makinde*et. al*. 2012). In event of their excess presence, these metals enters into the body and may disturb the normal functions of central nervous system, liver, lungs, heart, kidney and brain, cause hypertension, abdominal pain, skin eruptions, intestinal ulcer and different types of cancer (Huheey*etal*., 2000). Based on persistent nature and cumulative behavior as well as the probability of potential toxicity effects of heavy metals as a result of consumption of leafy vegetables and fruits, there is need to test and analyze these food items to ensure that the levels of these metals meet the agreed international requirements (Okunlola and Abdul-Azeez, 2018). This is particularly important in this part of the world

*https://dx.doi.org/10.22161/ijhaf.3.2.3* *ISSN: 2456-8635*

where only limited data on heavy metal contents of such highly consumed agricultural produce are available.

The study therefore aimed to assess the contents of heavy metals in different vegetables available in local market for the consumers in Akure south local government, Ondo State, Nigeria.

## II. METHODOLOGY

**Study area:** This study was conducted atthe Department of Crop, Soil and Pest Management and the Central Laboratory of the Federal University of Technology, Akure, Ondo State, Southwest Nigeria. Ondo State is one of the six states in the South-West zone of Nigeria. The State is located in the forest zone with bi-modal rainfall pattern. The temperature ranges from 21 to 29 degree centigrade with a high relative humidity. The annual rainfall varies between 1150 and 2000mm in the Northern and Southern parts, respectively. The state is endowed with luxuriant vegetation and pockets of swamp (Fadama) land located in different local government authorities in the State. These features provide a favorable environment for production of both cash and food crop. More importantly, pocket of fadama plots in the state supports the growth of different types of vegetables, especially during the dry season.

**Sample collection**

Thevegetables were purchased from; Oja-Oba, Isikan and Isolothe major markets where vegetables are sold on a large scale in the LGA. Akure south local government was selected as one of the densely populated area characterised by different commercial enterprises as potential sources of pollution and relatively heavy traffic around and within the area.

**Pretreatment:** All glass wares and containers required for experimentations were washed with distilled water and then soaked in 10% nitric acid for few hours to prevent contamination. The vegetable samples were thoroughly washed to remove mud and dust and then rinsed with distilled water.They were then sliced with knife into small pieces. After, the samples were dried in air for few days and then in microwave oven at the temperature between 45 to 80oC till the constant weight was obtained. After drying, they were ground by electric grinder to tiny particles and stored in fresh plastic containers for further analysis.

Wet acid digestion was done by standard methods reported by AOAC, 1990. 1.0 gm of each dried sample was added to 10 ml of conc. HNO3 in 50 ml beaker and placed on the electric hot plate for 1 hour to get semi dried sample. Again 10 ml of conc. HNO3 and 4ml of H2O2 were added and again kept on hot plate and heated vigorously. Addition of HNO3 and H2O2 was continued tillcolorless solution was obtained and its volume reduced up to 2-3ml. It was cooled and filtered with the help of Whattmann filter paper. The filtrate was stored in 10 ml sample bottles. It was diluted up to 25 ml by de-ionized water before taken to Atomic Absorption Spectrometer. Metal contents in the prepared samples were analyzed using Atomic Absorption Spectrophotometer. All data collected were analyzed using SPSS version 17.0 and mean separation was done using Duncan's New Multiple RangeTest (DMRT) at $P<0.05$.

## III. RESULTS

Table 1 revealed the comparative concentrations of trace metals in *Abelmoschusesculentus* purchased from the three markets. It showed the concentration of trace metals (Cu, Fe, Zn and Mn) in the vegetable. This study indicated the elemental values of *Abelmoschusesculentus* purchased from Isikan market as (Cu = 0.51mg/kg), (Fe=0.55mg/kg), (Zn = 0.15mg/kg) and (Mn = 0.723mg/kg). The elemental value of *Abelmoschusesculentus*purchased from Isolo market as (Cu = 0.05mg/kg), (Fe= 1.577mg/kg), (Zn = 0.253mg/kg) and (Mn = 0.64mg/kg)0.27mg/kg), (Fe= 1.59mg/kg), (Zn = 0.647mg/kg) and (Mn = 0.67mg/kg) and the elemental value of A*belmoschusesculentus* purchased from Oja-oba market as(Cu = 0.27mg/kg).

*Analysis of Abelmoschusesculentus*

| *Abelmoschusesculentus* | Cu | Fe | Zn | Mn |
|---|---|---|---|---|
| IM | 0.050a | 1.577b | 0.253a | 0.640a |
| IsM | 0.510a | 0.550a | 0.150a | 0.723a |
| OO | 0.270a | 1.590b | 0.647b | 0.670a |

*Means in column that do not share the same letters are significantly difference according to Duncan test. *IM = Isolo market, IsM = Isikan Market and OO = Oja Oba market.

**Analysis of *Amaranthushybridus***

Table 2revealed the comparative concentrations of trace metals in *Amaranthushybridus*purchased from the three markets. It showed the concentration of trace metals (Cu, Fe, Zn and Mn) in the vegetable. This study indicated the elemental values of *Amaranthushybridus* purchased from Isolo market as (Cu = 0.093mg/kg), (Fe=0.55mg/kg), (Zn = 0.15mg/kg) and (Mn = 0.50mg/kg). The elemental value of *Amaranthushybridus* purchased from Isikan market as(Cu = 0.001mg/kg), (Fe= 0.56mg/kg), (Zn = 0.024mg/kg) and (Mn = 0.723mg/kg) and the elemental value of *Amaranthushybridus* purchased from Oja-oba market as(Cu = 0.006mg/kg), (Fe= 1.59mg/kg), (Zn = 0.367mg/kg) and (Mn = 0.223mg/kg).

https://dx.doi.org/10.22161/ijhaf.3.2.3 ISSN: 2456-8635

*Table.2: Trace metal composition in Amaranthushybridus purchased from the markets (mg/kg)*

| *Amaranthushybridus* | Cu | Fe | Zn | Mn |
|---|---|---|---|---|
| IM | 0.093b | 0.550a | 0.150b | 0.500b |
| IsM | 0.001a | 0.560a | 0.024a | 0.723b |
| OO | 0.006a | 1.590b | 0.367c | 0.223a |

*Means in column that do not share the same letters are significantly difference according to Duncan test. *IM = Isolo market, IsM = Isikan Market and OO = Oja Oba market.

**Analysis of *Basellaalba***

Table 3revealed the comparative concentrations of trace metalsin *Basellaalba* purchased from the three markets. It showed the concentration of trace metals (Cu, Fe, Zn and Mn) in the vegetable. This study indicated the elemental values of *Basellaalba* purchased from Isolo market as (Cu = 0.011mg/kg), (Fe= 1.333mg/kg), (Zn = 0.763mg/kg) and (Mn = 1.123mg/kg). The elemental value of *Basellaalba* purchased from Isikan market as(Cu = 0.27mg/kg), (Fe= 1.937mg/kg), (Zn = 0.71mg/kg) and (Mn = 1.093mg/kg) and the elemental value of *Basellaalba* purchased from Oja-oba market as(Cu = 0.02mg/kg), (Fe= 0.573mg/kg), (Zn = 0.153mg/kg) and (Mn = 0.537mg/kg).

*Table.3: Trace metal composition in Basellaalbapurchased from the markets (mg/kg)*

| *Basella alba* | Cu | Fe | Zn | Mn |
|---|---|---|---|---|
| IM | 0.011a | 1.333b | 0.763b | 1.123b |
| IsM | 0.270b | 1.937c | 0.710b | 1.093b |
| OO | 0.020a | 0.573a | 0.153a | 0.537a |

*Means in column that do not share the same letters are significantly difference according toDuncan test. *IM = Isolo market, IsM = Isikan Market and OO = Oja Oba market.

**Analysis of *Corchorusolitorus***

Table 4revealed the comparative concentrations of trace metalsin*Corchorusolitorus* purchased from the three markets. It showed the concentration of trace metals (Cu, Fe, Zn and Mn) in the vegetable. This study indicated the elemental values of *Corchorusolitorus* purchased from Isolo market as (Cu = 0.05mg/kg), (Fe= 0.607mg/kg), (Zn = 0.123mg/kg) and (Mn = 0.67mg/kg). The elemental value of *Corchorusolitorus* purchased from Isikan market as(Cu = 0.005mg/kg), (Fe= 0.44mg/kg), (Zn = 0.06mg/kg) and (Mn = 0.603mg/kg) and the elemental value of *Corchorusolitorus* purchased from Oja-oba market as(Cu = 0.513mg/kg), (Fe=1.443mg/kg), (Zn = 0.253mg/kg) and (Mn = 0.14mg/kg).

*Table.4: Trace metal composition in Corchorusolitorus purchased from the markets (mg/kg)*

| *Corchorusolitorus* | Cu | Fe | Zn | Mn |
|---|---|---|---|---|
| IM | 0.050a | 0.607a | 0.123b | 0.670b |
| IsM | 0.005a | 0.440a | 0.060a | 0.603b |
| OO | 0.513b | 1.443b | 0.253c | 0.140a |

*Means in column that do not share the same letters are significantly difference according toDuncan test. *IM = Isolo market, IsM = Isikan Market and OO = Oja Oba market, ND = Not detected

**Analysis of *Telfariaoccidentalis***

Table 5revealed the comparative concentrations of trace metalsin *Telfariaoccidentalis* purchased from the three markets. It showed the concentration of trace metals (Cu, Fe, Zn and Mn) in the vegetable. This study indicated the elemental values of *Telfariaoccidentalis* purchased from Isolo market as (Cu = 0.043mg/kg), (Fe= 1.433mg/kg), (Zn = 0.063mg/kg) and (Mn = 0.11mg/kg). The elemental value of *Telfariaoccidentalis* purchased from Isikan market as(Cu = 0.03mg/kg), (Fe= 0.993mg/kg), (Zn = 0.011mg/kg) and (Mn = 0.093mg/kg) and the elemental value of *Telfariaoccidentalis* purchased from Oja-oba market as(Cu = 0.757mg/kg), (Fe=1.673mg/kg), (Zn = 0647mg/kg) and (Mn = 0.827mg/kg).

*Table.5: Trace metal composition in Telfariaoccidentalis purchased from the markets (mg/kg)*

| *Telfariaoccidentalis* | Cu | Fe | Zn | Mn |
|---|---|---|---|---|
| IM | 0.043a | 1.433ab | 0.063a | 0.110a |
| IsM | 0.030a | 0.993a | 0.011a | 0.093a |
| OO | 0.757b | 1.670b | 0.647b | 0.827b |

*Means in column that do not share the same letters are significantly difference according to Duncan test. *IM = Isolo market, IsM = Isikan Market and OO = Oja Oba market.

*https://dx.doi.org/10.22161/ijhaf.3.2.3* *ISSN: 2456-8635*

## IV. DISCUSSION

Vegetable are key components of Nigerian diet. These vegetables are sources of vitamins, minerals, dietary fiber and antioxidants. The three different markets (Oja-oba, Isinkan and Isolo) purchased their vegetables from the same farm at Ogbese vegetable farm, Ondo state but results revealed different concentration of heavy metals in the vegetables; the differences might be due to the type and quality of packaging materials used which could influence the heavy metal contents (Pescod, 1999). The market women often used unclean woven sacks to pack these vegetables from the farm to the market. Another factor is the means of transporting the vegetables to the market. Vegetables are usually transported in vehicles that have open roof, and usually than not unclean which could influence the metal concentration of the vegetables. In addition, exhausts from vehicles which settles on the leaf surface of the vegetables could be absorbed as it settles on the vegetables (Nwajei et al., 2012**).** Both lethal and vital elements present in the vegetables, could also have been absorbed through contaminated soils and irrigation water. Although, certain heavy metals like copper (Cu), Zinc (Zn), Manganese (Mn), etc., are essential components for various biological activities within the human body, elevated levels can cause numerous health consequences.

In Akure, the major leafy vegetables consumed by residence of the community include *Telfariaoccidentalis, Corchorusolitorus;* consumed by residents who are from Lagos state and Oyo state, *Amaranthushybridus,* and *Basellaalba*among others. More so, majority of the residence of this community produce their vegetables through backyard farming, so, they apply irrigation water to their vegetables especially during dry season when there is no rain fall. They apply different water from different sources ranging from flowing stream, drainage deposit water, fish pond water, well water, sewage water, industrial water among others (Okunlola and Abdul-Azeez, 2018). The aforementioned irrigation systems contains different level of minerals and metals which the vegetables are exposed to for absorption.

Analytic result of the vegetables purchased from the three major markets indicates that at an average, the heavy metal composition of *Telfariaoccidentalis, Corchorusolitorus, Amaranthushybridus*and *Abelmoschusesculentus*that were purchased from the Oja Oba market were higher than the composition of heavy metals in vegetables purchased from other markets. *Basellaalba*purchased from Isikan market possess the highest heavy metal level as compared to other markets. Lead was not detected in the vegetables purchased from the markets.

The study also indicate that vegetables purchased from the market contain higher level of heavy metals compared to the vegetables cultivated in the screen house; this can be as a result of the deposition of superficial dust on the surface of the vegetables when displayed for sale at the various markets. It was reported that superficial dust contains significant amount of heavy metal that settles on the leaf surface of the vegetables and invariably absorbed through the stomatal pores. It was also inferred that different water types from different sources contain different level of heavy metal contents. Stream or water bodies flowing around industrial areas, waste dump sites, sewage/drainage deposits, mechanic workshops do contain higher level of heavy metals, which is due to the elemental composition of the substances that flow into the water bodies.

Different plants have different ability to absorb and accumulate heavy metals, this study indicates that *Telfariaoccidentalis*and *Corchorusolitorus*accumulates heavy metals more than other vegetables. It also indicates that *Basella alba* purchased from the various markets has higher heavy metal content compared to other vegetables purchased from the markets, showing that *Basella alba* accumulates heavy metals at an higher ratemarkets, vegetables are displayed in the open without any covering for sale, thereby exposing them to superficial dust which settles on the leave surfaces and absorbed into the plant (Zurera et al., 1999).

The environmental situation or structure of the markets were also studied in order to assess if the environment can affect the concentration of trace/heavy metals in the vegetables. Isikan market was the smallest of the market but its road were not tarred, it has a big refuse dump site very close to it. Oja-Oba market is the biggest of markets, close to the highway with heavy traffic and vehicular movement and refused dump site. Isolo market has tarred road which allows the movement of vehicles

This study compared the amount of trace metals in the vegetables. The result of the vegetables purchased from the three major markets indicated that at an average, the trace metal composition of *Telfariaoccidentalis, Corchorusolitorus, Amaranthushybridus*and *Abelmoschusesculentus*that were purchased from the Oja Oba market were higher than the composition of trace metals in the vegetables purchased from other markets. *Basellaalba*purchased from Isikan market possessed the highest trace metal level compared to other markets. Lead was not detected in the vegetables purchased from all the markets.

## V. CONCLUSION

The environmental situation of the markets affect the composition of heavy metals in the vegetables sold in the various markets, it also affirms that the settlement of superficial dust on the surface of the vegetables affects the trace metal composition of the vegetables. The market should be kept clean always andproper care should be ensured to prevent the contamination of the vegetables by foreign materials while transporting the vegetables from the farm to the markets. The packaging materials used should

*https://dx.doi.org/10.22161/ijhaf.3.2.3* *ISSN: 2456-8635*

also be clean and free of dirt whilethe vegetables should be sprayed regularly with water while on display for sale.

## REFERENCES


**[1] Agrawal, M., 2011**. Enhancing food chain integrity: quality assurance mechanism for air pollution impacts on fruit and vegetable system. Final technical report for department of international development, UK, P. 7530.

[2] **Awobajo, F.O, Olatunji-Bello, I. I , Obilade, T.T , and Odugbemi,T.O (2010)**Knowledge of the Nutritional and Medicinal Use of Some Vegetables among aCross Section of Market Women in Two Major Food Markets inLagos State, South West Nigeria. *Pakistan Journal ofNutrition* 9 (3): 216-221

[3] **Ayeni, L.S, Adeleye, E.O and J.O Adejumo (2012).** Comparative effects of organic, organomineral and mineral fertilizers on soil properties, nutrient uptake, growth and yield of maize (*Zea mays*). *International Research of Journal of Agricultural Science and Soil Science*. Vol 2(11): 493-497.

[4] **Bender DA; Mayes PA; Murray RK; Botham KM; Kennelly PJ; Rodwell VW; Weil PA (2013)**. "Chapter 44. Micronutrients: Vitamins & Minerals". Harper's Illustrated Biochemistry (28th ed.). New York: McGraw-Hill. Archived from the original on 2010-09-07.

[5] **Chibuike U, 2013.** "*Use of mycorrhiza in soil remediation: a review*," Scientific Research and Essays, vol. 8, no. 35, pp. 1679–1687.

[6] **Khillare, P.S., Balachandran, S., and Meena, B.R., 2004**. *Spatial and Temporal variation of heavy metals in atmospheric aerosols of Delhi*. *Environ*. Monit. Assess, 90:1-21.

[7] **Makinde EA, Ayeni LS and Ojeniyi SO (2010).** Morphological Characteristics of Amaranthus as influenced by Kola Pod Husk, organomineral and NPK fertilizers in Southeastern Nigeria. *New York Science Journal*. 3(5): 130-134.

[8] **Nwajei, G.E.** (**2009**). Trace Elements in soils and vegetations in the vicinity of shell petroleum company operation area in Ughelli Delta State of Nigeria. *American Eurasian Journal of sustainable Agriculture***3**(3) 574-578.

[9] **Nwajei,G.E.; Okwagi, P; Obi-iyeke, G.E. and Nwajei, R.I.(2012)** Analytical assessment of trace elements in soils, tomato leaves and fruits in the vicinity of paint industry, Nigeria. *Researchjournalofrecentsciences***1**(4):22-26

[10] **Pescod, M.D., 2009**. *Waste water treatment and use in agriculture FAO irrigation and drainage* paper no.47, food and agriculture organization of the United Nations, Rome, Italy pp: 125-156.

[11] **Sobukola OP, Adeniran OM, Odedairo AA and Kajihausa O. E. (2010).**,*Heavy metal levels of some fruits and leafy vegetables from selected markets in Lagos, Nigeria*. African Journal of Food Science, 2010. 4(2): 389-393.

[12] **Subramanian, R., Gayathri, S., Rathnavel, C. and Raj, V.(2012).***Analysis of mineral and heavy metals in some medicinal plants collected from local market*. Asian Pacific Journal of Tropical Biomedicine, 2012. 2(1): 74-78.

[13] **WHO, 2006.** Guidelines for the safe use of waste water, excetera and grey water: Waste water use in agriculture (volume 2). Geneva, WHO, 2:219.

[14] **Zurera, G., Moreno, R., Salmeron, J., and Pozo, R., 1999.***Heavy metals uptake from greenhouse border soils for edible vegetables*. J. Sci. Food and Agric., 49:307-314.