Heavy Metal Contamination Of Some Fruits Sold In Lugbe -Abuja Municipal Area Council, Nigeria.

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Abstract: This study determined the concentrations of Copper (Cu) and Lead (Pb) in oranges (*Citrus sinensis*) and apples (*Malus pumila*) sold in Lugbe fruit market, Abuja- Nigeria. These fruits were randomly collected from the study area. Samples were processed and analysed for the concentration of Cu and Pb using the Atomic Absorption Spectrometer. The results of this study showed that Pb concentration of the two fruits screened were not significantly different ($p > 0.05$). However, Pb concentration (68.18 ± 6.89 mg/kg) of orange was higher than that of apple (65.81 ± 2.14 mg/kg), while Cu concentration in the two fruits screened showed a significant difference ($p < 0.05$) with apple having higher Cu (21.67 ± 1.35 mg/kg) concentration than orange 15.25 ± 1.39 mg/kg). Both trace metal concentrations of fruits in this study were above the permissible limits respectively set by FAO/WHO for human consumption. The values of these elements in this study suggest that these fruits might posed a potential health risk to human, who consume them. Potential sources of contamination of these fruits are also discussed and useful recommendations made.

Introduction

Fresh fruits are very important component of human diet, because they are sources of vitamins and minerals salts. They are also sources of essential nutrients in good proportion. According to Elbagermi *et al.*, (2012) reported that they are generally used for culinary purposes and are rich sources of vitamins, mineral and fibres which have beneficial anti-oxidant properties. Sobukola *et al.*, (2007) also reported that the presence of water, calcium, iron, sulphur and potash in most fruits. According to D'mello, (2003), fruits are very important protective food, which are useful for health maintenance, prevention and treatment of various types of diseases with particular reference to enormous and diverse nutrients in orange. Earlier study by Radwan and Salama, (2006) reported low calories, no saturated fats or cholesterol in fruits. This study also reported that fruits are very rich in dietary fibre and pectin, which are very effective in managing obesity According to Radwan and Salama (2006) orange and other other citrus fruits are power natural anti-oxidants as they contain high amount of vitamin C. This same study (Radwan and Salama, 2006) also reported a variety of phytochemical, high levels of vitamin A and other flavonoid antioxidants such as alpha and beta-carotenes in oranges.

Crop Life Foundation, 2011 in Wikipedia, 2017 reported that apples are mportant ingredient in many desserts such as apple pie, apple crumble, apple crisp and apple cake. Apples are also often eaten whole, baked, stewed, dried or eaten soaked in liquid such as water and alcohol (Crop Life Foundation, 2011).

Ribeiro *et al.*, (2014) as cited by Wikipedia, (2017) stated that apples are also a rich source of various phytochemicals including flavonoids (e.g catechins, flavonols and quercetin) and other phenolic compounds (e.g., epicatechin and procyanidins, which are often found in the skin, core, and pulp of the apple. Preliminary researches by Gerhauser, (2008); Ribeiro *et al.*, (2014) as cited by Wikipedia, (2017) suggested that the nutrients and phytochemicals in apples may preventive properties against the risk of certain types of cancer.

In spite of the substantial amount of vitamin, minerals and anti-oxidants present in fruits Radwan and Salama (2016) have reported the presence of toxic heavy metals over a wide range of concentrations in fruits. Amoah, (2008) defined heavy metals as non-bio degradable and persistent environmental contaminants, which may be deposited on the surfaces and could be potentially absorbed into plant tissues. Amoah (2008); also reported that plants may also take up heavy metals from polluted soil and water which may contain very high concentrations of toxic metals. When this happens, it could potentially impact on the food chain and subsequently pose a health risk. Amoah, (2008) stated that these elements at concentration exceeding the physiological requirements of fruits, could not only be toxic to plants but also to consumers of fruits from such plants. Studies by (Adriano, 1984; Salveska *et al.*, 1998; Divrikli *et al.*, 2003; Dundar and Saglam, 2004; Colak *et al.*, 2005) have reported positive and negative effects of heavy metals on human health. Zaidi et al.,

(2005) stated that heavy metals such as cadmium (Cd), lead (Pb), and mercury (Hg) are mainly contaminants of food supply and can be considered the most important problem to our environment, while trace metals like iron (Fe), zinc (Zn) and copper (Cu) are essential for biochemical reactions in the body at certain concentration. There are various sources through which plant material could be contaminated. According Divrikli *et al.*, (2006) plants materials could also be contaminated through washing of fruits with waste water by farmers before bringing them into the market. Severe heavy metals contamination of varied farm produce have been reported (Orisakwe *et al.*, 2012; Akinola *et al.*, 2008; Anju *et al.*, 2011; Sobukola *et al.*, 2010; Daili *et al.*, 2012).

Certain trace metals are required in human diet for healthy growth and development. However, when the concentration of these trace metals exceed the recommended limit, they become acutely or chronically toxic. Reports by WHO (2006) have shown that heavy metal toxicity could result in damaged or reduced mental and nervous functions, low energy levels, damage to important organs such as the liver, lungs, kidneys and blood formation and composition. WHO (2006) also implicated long term exposure to heavy metals in gradual progression in degeneration of the body, muscles and neurons and development of cancer.

*However, it is known that metals bio-accumulate in the vital organs of human system-lungs, kidney, heart, liver and the brain, over a long period due largely to the consumption of contaminated fruits. The intake of heavy metal contaminated fruits crops may pose a risk to human health; hence heavy metal contamination of food is one of the most important aspects of food quality assurance, (Elbagermi *et al.*, 2012; Ismail *et al.*, 2011). Metal accumulation and uptake by plants may pose health risk to human, when such plants are grown on or near contaminated areas. Metal accumulation in plants depends on plants species, genetics, types of soil and metal, soil conditions, weather and environment. Other factors are stage of maturity and supply route to the market, (Chang *et al.*, 1984; Zahir *et al.*, 2009; Ismail *et al.*, 2011; Inoti *et al.*, 2012).

Some heavy metals toxic levels can be just above the background concentrations naturally found in nature. Therefore, it is important to learn about heavy metals and take protective measures against excessive exposure. The association of symptoms indicative of acute toxicity is not difficult to recognize because they are usually severe, rapid in onset, and associated with a known ingestion or exposure. Symptoms include: cramping, nausea and vomiting; sweating; headache difficulty in breathing impaired cognitive motor, and language skills, mania and convulsions symptoms of

chronic exposure (impaired cognitive and language skills, learning difficulties; nervousness and emotional instability; and insomnia, nausea, lethargy, and feeling ill) are also usually recognized; however, they are much more difficult to associate with their cause (Jarup, 2003). Symptoms resulting from chronic exposure are very similar to symptoms of other health conditions and often develop slowly over months or even years. Sometimes, symptoms of chronic exposure subside; thinking the symptoms are related to something else people postpone seeking treatment (Khillare *et al.*, 2004).

In small quantities, certain heavy metals are nutritionally essential for a healthy life. Those elements, or some form of them, fruits and vegetable are in commercially available multivitamin products (WHO, 2006). Recent knowledge has exposed the fact that plants require at least seven other elements in trace amounts (B, Cu, Cl, Mn, Mo, Na, and Zn). The ultimate source of trace elements is the soil (Hala, 2012). Trace elements do not provide any calorie but they play an important role in the metabolic regulation of the human body if present in required amounts. For example, they are co-enzymes and co-factors in human system which plays different roles in growth, metabolism and immune system development (Ismail *et al.*, 2011).

Lead is one of the limited class of element that can be described as having purely a toxic classification according to covalent index. Its widespread use has caused extensive environmental contamination and health problems in many parts of the world. Lead is a cumulative toxicant that affects multiple body systems. It is found in low level in earth's crust. It has no known level of (www.chem.unep.ch/pops/pdf/lead/lead_exp.pd, 2014) beneficial effect in the body. There are several routes of exposure to lead, this include the following: occupational exposure, pica, soil to plant route and inhalation of Pb contaminated dust (Daland, 2000).

Lead affect the body system by encephala apathies in the central nervous system (CNS); it also has effect on IQ of children and behaviour, preterm delivery in women and alterations in sperm and decreased fertility in men (Julie *et al.,* 2007).

Copper is critical for energy production in the cells. It is also involved in nerve Conduction, connective tissue, the cardiovascular system and the immune system (Obuobie *et al.*, 2000; Anju *et al.*, 2005a). Copper is closely related to estrogens metabolism, and is required for women's fertility and to maintain pregnancy. It plays an important role in several metabolic processes, it activates enzymes and it is involved in protein synthesis and in carbohydrates, nucleic acid and lipids metabolic (Anju *et al.*, 2005a). It maintains a healthy nervous system,

prevents anaemia and inter-related with the function of Zn and Fe in the body through the food chain and can damage the liver and kidneys. (Akinyele and Osibanjo, 1982).

Deficiency of copper has an effect on thyroid function and could cause vascular lesions, central nervous system disorder, convulsion and hair abnormalities (Tsugutoshi, 2004). Elevated concentrations of copper could cause decreased haemoglobin and erythrocyte levels, death and cancer (David 1989).

Heavy metal contamination of fruits cannot be underestimated. Fruits are very rich in essential trace metals and are also comparatively cheaper sources of vitamins. Generally, heavy metal contamination of food items is one of the most important aspect of food quality assurance. International and national regulations have been made on food qualities in order to lower levels of toxic metals in food items. This is to ensure that the risk they pose to the food chain is reduced. However, earlier works have shown that there is still a significant contamination of developing nation's food base in especially Nigeria. This research work focuses on oranges and apples because of their wide range consumption and nutritional benefits to the Nigerian local population and globally. It is very pertinent to know the heavy metal contamination status of these fruits.

The aim of this work is to determine the concentration of Pb and Cu in oranges and apples sold in Lugbe fruit market, Abuja Municipal Area council, Federal Capital Territory, Abuja, Nigeria and to compare the determined concentrations of these trace metals with the tolerable limits in fruits in order to provide information on their safety.

Some previous studies have been carried out to ascertain different levels of heavy metals in soil and water samples, but this project specifically targets heavy metals e.g. Pb and Cu in fruits and the present data on the levels of Pb and Cu will contribute to the baseline data for the Federal Capital Territory on heavy metal contamination of fruits.

Materials And Methods
Study Area
Lugbe is one of the popular suburban settlements in Abuja Municipal Area Council (AMAC). It is largely residential and densely populated. Lugbe is about 17 minutes' drive from the Central Business District of Abuja and 13 minutes' drive to Abuja Airport along the airport road. Lugbe is divided into five districts namely Lugbe south, Lugbe north, Lugbe central, Lugbe west and Lugbe east (www.abuja-ng.com, 2014)

Though Lugbe is not in the Federal Capital City (FFC), its proximity to the city centre and also to the Abuja airport has brought it into lime light and attracted significant development to the area such as the situation of the National Space Development and Research Agency, Federal Housing Estate and the Voice of Nigeria Transmission Station Estates (www.abuja-ng, 2014).

Sample Collections
Oranges and apples predominantly sold in this market were sampled. Ten samples each of the two fruits were purchased randomly from sellers at Lugbe fruit market, FCT Abuja. The sellers were identified and informed about the collections and time of collection. Fruits samples collected were put into separate polythene bags and labelled accordingly. Sampling was done between June and August; 2016. The samples were stored in polythene bags until analysis at a temperature of $10\pm5°C$.

Sample Preparations and Digestion
Fruits samples collected were washed and rinsed thoroughly under a running tap water and the peel removed. The edible part of the fruits were then sliced into small pieces and the seeds removed. Samples for analysis were then dried using the oven dry method at 105 ° C for 24 hours as described by AOAC, (2006). An herbage mill was used to homogenise the samples while preventing overheating, and was transferred into a clip seal bag (to prevent air from penetrating) and properly labelled.

Acid Digestion
One gram (1.0 g) of the samples were weighed and digested in a mixture of 5 ml of HCL, 2 ml of Concentrated H_2SO_4 and 20 ml of Concentrated HNO_3 in a conical flask under a fume hood (All acids were of analytical grade). The content was mixed and heated gently at 180-220 °C for about 30 minutes on a hot plate as described by Sobukola et al., (2007). The content was continuously heated until dense white fumes appeared. It was then finally heated strongly for about 30 minutes and then allowed to cool before it was filtered into a volumetric flask using Whatman filter paper. The filtered sample was made up to the mark of 50 ml with distilled water. This was repeated for all the samples, duplicates and reagent blanks. The samples were analysed for Cu and Pb using Atomic Absorption Spectrometer (Model AAS 6300) in accordance with AOAC official method (2006). Reagent blanks, Duplicate samples and certified reference materials (CRM) BCR-60 were incorporated into the batch for analysis to check for contamination, estimate precision and bias respectively.

Statistical Analysis
The statistical analysis software SPSS version 21 for Windows was used to analyse data from this study. The Independent sample t-test was used to compare between fruits and metals concentrations at 95% confidence interval.

Result

The Pb concentration of the two fruits analysed are shown in Table 1. Lead concentration in orange was 68.18±6.89 mg/kg, while that of apple was 65.81±2.14 mg/kg.

Copper concentration in orange was 15.25±1.39, while that of apple was 21.67±1.35 (Table 1).

Table 1: Mean levels (mg/kg) of Pb and Cu in apples and oranges from Lugbe fruit market Abuja, Nigeria.

Fruits		Heavy Metal	
Common Name	**Scientific Name**	**Lead (Pb)**	**Copper (Cu)**
		Mean ± SEM (mg/kg)	Mean ± SEM (mg/kg)
Orange	*Citrus sinensis*	68.18±6.89	15.25 ±1.39
Apple	*Malus pumila*	65.81±2.14	21.67±1.35
Recommended Value		0.3 mg/kg	10.0 mg/kg

Key: SEM- Standard error on the mean.

A comparison of the Pb concentration of the two fruits showed no statistically significant (P>0.05) difference even though higher in orange than apple. However Cu concentrations differed significantly (p<0.05) between the two fruits, with apple having 40 % higher Cu values than orange. When both metal concentration were compared between the two fruits, Pb concentration in both fruits was thrice as high as Cu (Figures 1). This showed that both fruits are more contaminated with Pb than Cu.
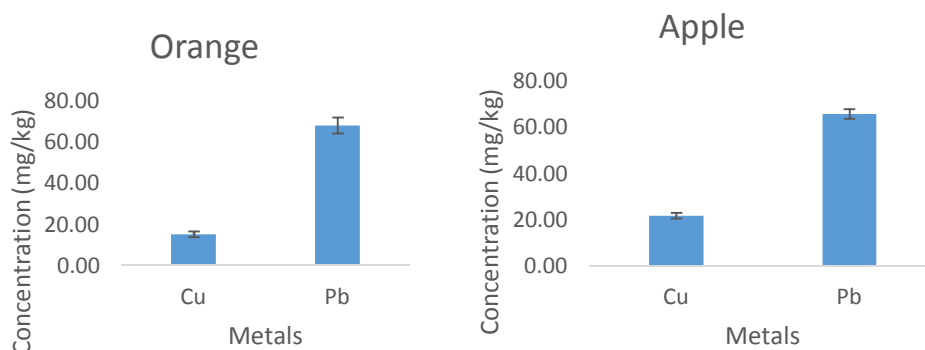

Figure 1: Comparison of Pb and Cu concentrations in Oranges and apples, Error bars represent two standard error on the mean.

Discussion

The results obtained were compared with the recommended limits as established by the (WHO, 2010) to assess the levels of heavy metal concentration of the two fruits screened. Results showed that both metal concentrations were above the WHO permissible limit. This suggest that consumption of these fruits from the studied area might pose a potential health risk. This is in line with previous works by Zigham et *al.,* (2012) which suggested potential toxicity of these elements if continuously consumed in the fruits.

In terms of the level of Pb in the both fruits, orange recorded a higher value than apple. This also agrees with a study by Divrikli et *al.,* 2006. The contamination associated with these fruits may also be linked with their source of supply. For instance, from interview with the sellers, apples sold in this region were predominantly exported from a country, which have a history of soil contamination via mining activities. This suggest that possible contamination could be traced to the soil where the fruits were grown. It is known (Narin et *al.,* 2005; Adeleye, 2005) that contaminated soil is one major potential source of contamination of foods and vegetables. However further investigation will be required to validate this source. This high level of these contaminants could also be attributed to air-borne contamination from leaded fuels, vehicle emissions and other industrial processes as suggested by previous studies by Divrikli et *al.,* (2006); Khillarie et *al.,* (2004) and Jassir et *al.,* (2005). Colak et *al.,* (2005); Narin et *al.,* (2005) also reported that emissions from industrial processes, heavy machinery/vehicles, the use of an artificial and organic fertilizer, plant protective agents such as pesticides and rodenticides also contributes to the high

levels of these heavy metals in the environment which eventually end up on crops. It has also been reported by Divrikli *et al*., (2006) that such trace metal contaminant cannot be completely washed off the fruits by water. They have been found to be toxic to the red blood cell, Kidney, nervous and respiratory system (Taupeau *et al*., 2001; Tsugutoshi, 2004; Lars, 2014). This elevated concentration of both trace metal studied in these fruits may probably be attributed to pollutants in irrigation water, farm soil or due to pollution from the highways traffic. This is supported by earlier works of Qui *et al*., (2000) and Zaldi *et al*., (2005). However, values of trace metals in this study are slightly higher compared to earlier studies on some fruits by Onianwa *et al.,* (2001), Parveen *et al*. (2003), Ozcan (2004) and Radwan and Salama (2006). The reason for this slightly elevated concentrations of these trace metals in this current study is not specifically known, but sources of supply, contamination via transportation, aerial deposition, contaminated soil and water could be potential sources of contamination of these fruits.

Conclusion

Results from this study showed that test fruits have significant accumulation of Pb and Cu which were above the WHO/FAO permissible limits of Cu and Pb in food and crops. In view of this finding, these fruits might pose a potential health risk based on this permissible limit.

Recommendation

Based on the results of this study, it is therefore recommended that;

- Fruits sold in our markets should be screened for contamination with potentially toxic elements.
- Farmers in developing nations like Nigeria should be sensitized on the health effects of heavy metals in order to minimize the use of polluted water for irrigation.
- Future research to ascertain the concentrations of other heavy metals such as Arsenic, Nickel, and Cobalt etc in a variety of fruits should be encouraged.
- Water sources used for irrigation could also be screened for contamination with trace metals before use.
- Environmental education of the general public on the possible dangers of consuming contaminated fruits would also be very useful.
- The use of industrial and waste dump sites for farming should also be discouraged.
- Good transportation measures and marketing system should be employed to prevent exposure of fruits to environmental pollution.

- The use of synthetic/artificial fertilizers should be discouraged and when applied it should be done with caution to avoid contamination of the soil and plants growing on them.

References

1. Adriano D.C (1984). *Trace metals in the terrestrial Environment*. New York: Verlag Spiegler, PP 45-54.
2. Anju, D., Arun, N. and Sayeed, A. (2011). Metals analysis in *Citrus sinensis* fruit Peel and *Psidium guajava leaf. Toxicology International* 18(2):163168.
3. Agrawal, M.G (2011). Enhancing food chain integrity: quality assurance   Mechanism for air pollution impacts on fruits and vegetable System *Final technicalreport for Department of International Development*, UK, P,   7530.
4. AOAC (2006), Official Method of Analysis. Association of Official Analytical Chemists, Arlington, USA.
5. Adeleye, E.I. (2005). Trace Metals in soils and plants from Fadama farm In Ekiti state, Nigeria. *Bulletin of chemical society of Ethiopia* 19:23-24.
6. Akinola, M.O. and Adenuga, A.A. (2008). Determination of the levels of Some heavy metal in African pear (Dacryodesedulis) marketed in Lagos metropolis Nigeria *J. Appl. Sci. Environ. Management* Vol. 33-37.
7. Amoah, P; (2008). Waste Water irrigated Vegetable production: Contamination pathway for health risk reduction in Accra, Kumasi And Tamale-Ghana. *Ph.D. Thesis*, Kwane and Krumah University of science and Technology, Kumasi Ghana pp: 74-75.
8. Anju, D., Arun, N. and Sayeed, A. (2011). Metal analysis in *Citrus sinensis* Fruit peel and Psidumhuajava leaf. *Toxicol. Intl*. 18(2): 163-168.
9. Akinyele IO, Osibanjo O (1982). Levels of trace elements in hospital diet. *Food Chem*. 8:247-251.
10. Colak H, Soylak M, Turkogu O. (2005). Determination of trace metal
11. Content of herbal and fruit teas produced and marketed from *Trace Elem*. Elec. 22:192-195. Turkey.
12. Chang, A.C., A.L. Page, J.E. Warneke and E. Grgurevic, (1984). Sequential Extraction of soil heavy metals following sludge *Application. J. Environ. Qual*., 1:33-38.
13. Crop Life Foundation (2011).*European Organic Apple Production Demonstrates the Value of Pesticides"* (PDF, Washington, DC. December 2011. *Retrieved 23 February 2017*.
14. Divrikli, U., Saracoglu S, Soylak M, Elci, L.

(2003). Determination of trace Heavy metal contents of green Vegetables samples from Kayseri Turkey by Flame atomic absorption spectrometer. Fresenius *Environment Bull*. 12: 1123-1125.

15. Divrikli, U., Horzum, N., Soylak, M. and Elci, L. (2006). Trace heavy Metals Contents of some species and herbal plants from western Anatolia, Turkey. *Int. J. Food Sci. Technol*. 41: 712-716.

16. David L. Watts, D. C., Ph. D., F.A.C.E.P. the Nutritional Relationships of Copper, *Journal of Orthomolecular Medicine* Vol. 4, No.2, 1989.

17. Daland R. Juberg, PhD; Lead and Human Health an Update, *American Council Science and Health*, Inc July 2000.

18. Daili Mahmud, N. J., Oniye, S. J., Balarabe, M. L., Anta J. and Caudugi. A.S. (2012). Toxicological implication of polluted water from Makara Drain. D'mello JPF (2003*). Food safety: Contamination and Toxins*. CABI Publishing, Wallingford, Oxon, UK, Cambridge, M.A. pp. 480. Dundar MS, Saglam HB (2004). Determination of Cadmium and Vanadium In tea varieties and their infusions in comparison with 2 infusion Processes. *Trace Elem. Elect*. 21:60-63.

19. Elbagermi, M.A., Edwards, H. G.M. and Alajtal, A.I. (2012). Monitoring of Heavy metal content in fruits and vegetables. *International scholarly Research Network Analytical Chemistry*. Article ID 827645, 5 Pages Doi: 10. 5402 / 2012/ 827645.

20. Hala, E. (20012) Concentration the heavy element in toombak in Khartoum, *M.sc in Chemistry* University of Khartoum 2012. Pp.145-158.

21. Gerhauser, C (2008). "Cancer chemopreventive potential of apples, apple juice, and apple components". Planta Medica. 74 (13): 1608–24. *PMID 18855307. doi:10.1055/s-0028-1088300.*

22. Ismail, F., M.R. Anjum, A. N. Mamon and T.G. Kazi, (2011). Trace Metal

23. Contents of vegetables and fruits of Hyderabad Retail Market. *Pak. J. Nutur*., 10:365-372. Inoti, Kiende Judy, Kawaka Fanuel, Orinda George and Okemo Paul, (2012). Assessment of heavy metal concentrations in Urban grown Vegetables in Thika Town, Kenya. *Afr. J. Food Sci*., 6:41-46.

24. Julie L., Gerber ding MP. Dr. PH and Howard Frumk (2007) in m.pdr.ph Toxicological profile for Lead public Health Service *Agency for Toxic Substances and Disease* Registry Atlanta, Georgia, pp. 30-33.

25. Jarup, L., (2003). Hazard of heavy metal contamination. *Br. Med. Bull,* 68:167-182.

26. Jassir, M. S., Shaker, A.g and Khaliq, M., (2005).

Deposition of heavy Metals on green leafy vegetables sold on road side of Riyadh city, Saudi Arabia. *Bull. Environ. Contam. Toxicol*., 75: 1020-1027.

27. 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.

28. Lars Jarup Hazadr (2014) of Heavy metal contamination, Department of Epidemiology And Public Health, Imperial College, London, UK. Download from *http://bmb*. *Oxford Journals.Org/* by guest on April 18, 2014. *www.chem.unep.ch/pops/pdf/lead/exp.pd* Lead exposure and human health April/28/2014. 6.04 pm.

29. Narin, L., Tuzen, M., Sari, H. and Soylak, M., (2005). Heavy metal content of Potato and corn chips from Turkey. *Bull. Environ. Cont. Toxicol*. 74:1072-1077.

30. Orisakwe, O. E., Nduka, J. K., Amadi, C. N., Dike, D. O. and Bede, O. (2012). Heavy metals health risk assessment for population via Consumption of food crops and fruits in Owerri, south Eastern, Nigeria. *Chem. Central. J*. 6 (1): 77-82.

31. Obuobie, E., B. Keraita, G.Danso, P.Amoah, O.O., L. Raschid-sand P.Drechsel, (2006). Irrigation urban vegetable production in Ghana Characteristics, Benefits and risk. *IWMI-RUAF-CPWF, Accra, IWMI*, Ghana, pp: 150.

32. Onianwa P.C, Lawal J.A, Ogunkeye A.A, Orejimi B.M (2000). Cadmium and Nickel composition of some Nigerian Foods. *J. Food Anal*. 13: 961-969.

33. Ozcan M (2004). Mineral contents of some plants used as condiments in Turkey. *Food Chem*. 84: 437-440.

34. Parveen Z, Khuhro M.I, Rafiq N. (2003). Market basket survey for lead, Cadmium, copper, chromium, nickel and zinc in fruits and vegetables. *Bull. Environ. Toxicol*. 71: 1260-1264.

35. Qui X.X, Huang D.F, Cai S.X, Chen F, Ren Z.G, Cai Y.C (2000). Investigations On vegetables pollution and pollution sources and its control in Fuzhou, Fujian Province. Fujian *J. Agric. Sci*. 15: 16-21.

36. Radwan. M. A and Salama, A. K. (2006). Market basket survey for some Heavy metals in Egyptian fruits and vegetables. *Food Chem. Toxicol*. 44(8): 1273-1278.

37. Ribeiro FA, Gomes de Moura CF, Aguiar O Jr, de Oliveira F, Spadari RC, Oliveira NR, Oshima CT, Ribeiro DA (2014). "The chemopreventive

activity of apple against carcinogenesis: antioxidant activity and cell cycle control". European Journal of Cancer Prevention (Review). 23 (5): 477–80. *PMID 24366437. doi*:*10.1097/CEJ.0000000000000005*.

38. Sobukola O.P, Dairo O.U (2007). Modelling drying Kinetic of fever leaves (Ocimum Viride) in a convective hot air dyer. Niger. *Food J.* 25 (1) 145-153.

39. Sobukola, O. P., Adeniran, O. M., Odedairo, A. A. and Kajihausa, O. E. (2010). Heavy metal level of some fruits and leafy vegetables from Selected markets in Lagos, Nigeria. *African Journal of found Sci. Vol.* 4 (2), PP 389-393.

40. Tsugutoshi AOKI, (2004). Copper Deficiency and the Clinical Practice. *Japan Medical Association Journal*,—Vol. 47, No. 8.

41. Taupeau, C., Poupson, J., Nome, F. and Lefevre, B. (2001). Lead accumulation in the mouse Ovary after treatment-induced follicular atregia. *Reproduction Toxicology* 15(4):385-389.

42. www.abuja-ng.com (2014). Information centre for Business and leisure. WHO, (2006). Guidelines for the safe use of waste water, excretera and Grey water; waste water use in agriculture (volume). *Geneva, WHO*, 20:219. World health organization. (2010). Codex Alimentarius Commission. Food Addictives and Contaminants. *Joint FAO/WHO food standards programs,* ALINORM 01/12A:1-289.

43. Zaidi MI, Asrar A, Mansoor A, Farooqui M.A (2005). The heavy metal Concentrations along road side trees of Quetta and its effects on Public health. *J. Appl. Sci*. 5 (4): 708-711.

44. Zahir, E., I. I. Naqvi and S. M. Uddin, (2009). Market basket survey of Selected metals in fruits from Karachi City (Pakistan). *J. Basic and Appl. Sci*., 5: 47-52.

45. Zaigham, Hassan, Zubair, Anwar, Khalid, Usman, Khattak, Mazhar Islam, Rizwan Ullah, Khan, Jabar, Zaman, Khan. And Khattak. (2012), Civic Pollution and its Effect on Water Quality of River Toi at District Kohat, NWFP", *Research Journal of Environmental and Earth Sciences, 4: 234-256.*

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