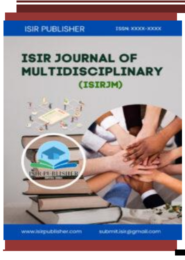
ISIR Journal of Multidisciplinary (ISIRJM) ISSN: XXXX-XXXX (Online)

Published: 25-Jan-2025



ISIR Journal of Multidisciplinary (ISIRJM)
ISSN: XXXX-XXXX (Online)
Frequency: Bimonthly
Published By ISIR Publisher
Journal Homepage Link- https://isirpublisher.com/isirjm/
Volume 1, Issue 1, January-February, 2025

ISIR PUBLISHER
ESTD: 2024

Assessment of Heavy Metals Contents in Some Selected Vegetables Sold in Five Different Markets in Gombe Metropolis

By

*ABDULLAHI YAHAYA MOHAMMED

Department of Biochemistry, Faculty of Sciences, Gombe State University, Gombe Nigeria.

Article History

Received: 05/01/2025
Accepted: 20/01/2025
Published: 25/01/2025

Vol – 1 Issue – 1

PP: 27-32

Abstract

This study aimed to assess the levels of heavy metals, specifically Lead (Pb), Cadmium (Cd), and Chromium (Cr), in selected vegetables sold at five different markets in Gombe State, Nigeria: Arawa Market, Tumfure Market, Kasuwan Mata, Pantami, and Main Market. The concentrations of these heavy metals were determined using Atomic Absorption Spectrophotometer (AAS). The results indicated that Lead levels ranged from 0.007 to 0.010 mg/kg, Cadmium from 0.013 to 0.057 mg/kg, and Chromium from 0.733 to 2.333 mg/kg across all samples, except for Capsicum annuum and Lycopersicon esculentum, which were not detected in any of the market sites. The highest concentration of Chromium (2.333 mg/kg) was found in Capsicum annuum at Pantami Market, while the lowest Lead concentration (0.007 mg/kg) was found in Capsicum chinense. All detected heavy metal concentrations were within the permissible limits of 0.3 mg/kg for Lead and 0.10 mg/kg for Cadmium, except for the concentration of Chromium in Capsicum annuum from Pantami Market, which exceeded the FAO/WHO (2001) stipulated limit of 2.30 mg/kg. Therefore, while consumption of these vegetables may not pose a risk for Lead and Cadmium toxicity, it may lead to Chromium toxicity if Capsicum annuum from Pantami Market is consumed in significant quantities.

Keywords: *** Heavy metals, vegetables, Gombe Metropolis, health risks, food safety.*

INTRODUCTION

Heavy metals are among the major contaminants of food supply and may be considered the major problem to our environment. Such problem is getting more serious all over the world especially in developing countries such as North and South Africa, Turkey, Yemen, Zimbabwe, Nigeria, Tanzania and Egypt (Radwan and Salama, 2006). Contamination of vegetables with heavy metals may be due to irrigation with contaminated water, the addition of fertilizers and metal-based pesticides, industrial emissions, transportation, the harvesting process, storage and/or at the point of sale (markets) (Husain, *et al.*, 2008). Human beings are encouraged to consume more vegetables and fruits, which are beneficial for health. Heavy metals may enter the human body through inhalation of dust, consumption of contaminated drinking water and consumption of food plants grown in metal contaminated soil (Radwan and Salama, 2006).

The term vegetable applies to edible part of the plant that stores food in roots, stems, or leaves. Vegetables are green and leafy-like in appearance bearing edible stems or leaves and roots of plants (Sharma, 2004). Vegetables constitute essential diet components by contributing carbohydrates, proteins, vitamins, iron, calcium and other nutrients that are in short supply. Vegetables also contain both essential and toxic elements over a wide range of concentrations. Metals in vegetables pose a direct threat to human health. Plants and vegetables take up elements by absorbing them from contaminated soils and waste water used for irrigating them as well as from deposits on different parts of the plants exposed to the air from polluted environment (Funtua*et al.*, 2008).

Vegetables, especially those of leafy vegetables grown in heavy metals contaminated soils, accumulate higher amounts of metals than those grown in uncontaminated soils because of the fact that they absorb these metals through their roots (Muhammad *et al.*, 2008). Vegetables accumulate heavy metals in their edible and non-edible parts. Absorption capacity of heavy metals depends upon the nature of vegetables and some of them have a greater potential to accumulate higher concentrations of heavy metals than others (Akan *et al.*, 2009).

*Corresponding Author: ABDULLAHI YAHAYA MOHAMMED.

Heavy metal accumulation in plants depends upon plant species, and the efficiency of different plants in absorbing metals is evaluated by either plant uptake or soil-to plant transfer factors of the metals. Dietary exposure to heavy metals, namely cadmium (Cd), lead (Pb), zinc (Zn), copper (Cu) and other has been identified as a risk to human health through the consumption of vegetable crops. Heavy metals are given special attention throughout the globe due to their toxic and mutagenic effects even at very low concentration (Sharma and Chettri, 2005).

Vegetables comprise about 15% of the daily diet of the Nigerian population. The high quality of vegetables production means good health for the consumers (Jipanin*et al.*, 2001). However, the environmental pollutants may harm the quality of vegetables which ultimately can induce harmful effects on the consumer's health. The main environmental pollutants in vegetables are toxic heavy metals from agronomic sources particularly agricultural, chemical and processing operations (Suruchi and Khanna, 2011). Human activities may also increase the concentration of heavy metals in the environment (Tuan and Popova, 2013). Several studies have shown that some of the common vegetables are capable of accumulating high levels of metals from the contaminated soil (Wilberforce and Nwaabue, 2013). Many people were diseased resulting from consumption of contaminated vegetables (Ismail, 2009).

Materials and Methods

Study Area

The study was conducted in Gombe Metropolis, Nigeria, focusing on five markets: Arawa Market, Tumfure Market, Kasuwan Mata, Pantami, and Main Market.

Sample Collection

Vegetable samples were collected randomly from each market. The selected vegetables included commonly consumed varieties.

Heavy Metal Analysis

The concentrations of Lead, Cadmium, and Chromium in the vegetable samples were determined using Atomic Absorption Spectrophotometry. The samples were prepared following standard protocols for heavy metal analysis.

Data Analysis

The data were analyzed using descriptive statistics, and comparisons were made against permissible limits set by FAO/WHO.

Results

The findings revealed the following concentrations of heavy metals in the vegetable samples:

Lead (Pb): Ranged from 0.007 to 0.010 mg/kg

Cadmium (Cd): Ranged from 0.013 to 0.057 mg/kg

Chromium (Cr): Ranged from 0.733 to 2.333 mg/kg

Notably, Capsicum annuum and Lycopersicon esculentum were free from heavy metal contamination in all market sites. The maximum concentration of Chromium (2.333 mg/kg) was detected in Capsicum annuum from Pantami Market, surpassing the FAO/WHO limit.

Table 1: heavy metals concentration of three vegetables

Location Samples	Concentrations (mg/kg)		
	Cadmium (Cd)	Chromium (Cr)	Lead (Pb)
ARW Chilli pepper	0.053±0.047	0.733±0.643	ND
ARW Hot pepper	ND	1.500±0.265	0.010±0.017
ARW Tomato	0.057±0.042	1.333±0.416	ND
PTM Chilli pepper	0.043±0.035*	2.333±0.321*	ND
PTM Hot pepper	0.057±0.006*	1.533±0.231*	ND
PTM Tomato	ND	2.200±0.265*	ND
TMF Chilli pepper	0.013±0.023*	1.700 ±0.529	ND
TMF Hot pepper	0.013±0.023*	1.500±0.265	ND
TMF Tomato	0.053±0.047*	1.533±0.208	ND
KMT Chilli pepper	0.047±0.045	1.500±1.300*	ND
KMT Hot pepper	0.017±0.030	0.967±0.950*	ND
KMT Tomato	0.033±0.035	1.467±1.274*	ND
MMT Chilli pepper	0.047±0.057	1.167±1.012	ND
KMT Hot pepper	0.033±0.058	1.367±1.185	0.007±0.012
KMT Tomato	0.020±0.035	1.167±1.150	ND
FAO/WHO	0.100	2.300	0.300 (mg/kg)

*Corresponding Author: ABDULLAHI YAHAYA MOHAMMED.

The values are given as mean ± SD and the results are means of three replicates.
Mean values in the same column followed by the (*asterisk) are significantly different (p<0.05).
Key:
ND= Not Detected
ARW= Arawa
PTM= Pantami
TMF= Tumfure
KMT= Kasuwar Mata
MMT= Main Market

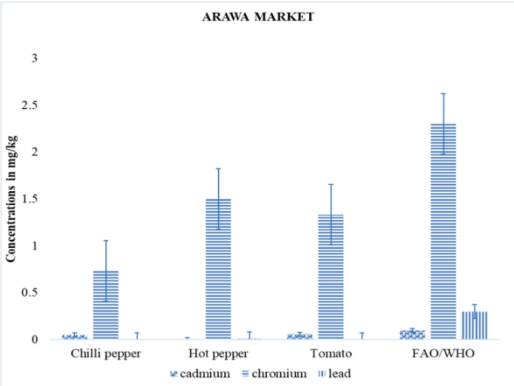


Figure 1: Heavy metals concentration (Mg/Kg) in vegetables from Arawa Market

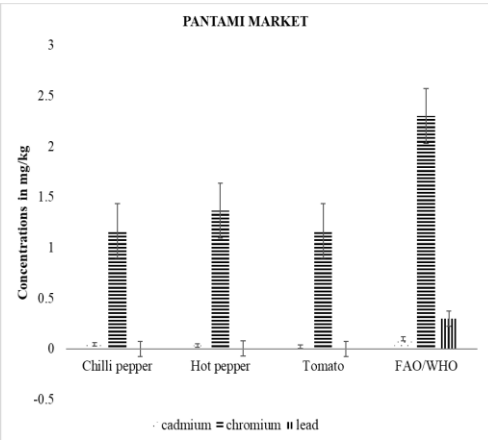


Figure 2: Heavy metals concentration (Mg/Kg) in vegetables from Pantami Market

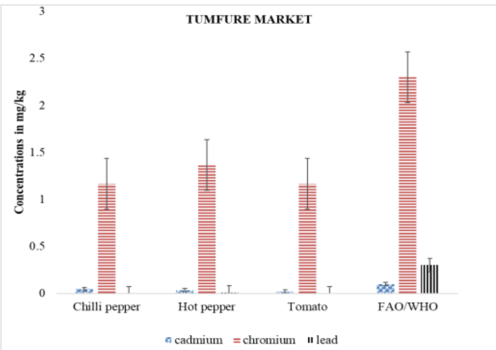


Figure 3: Heavy metals concentration (Mg/Kg) in vegetables from Tumfure Market

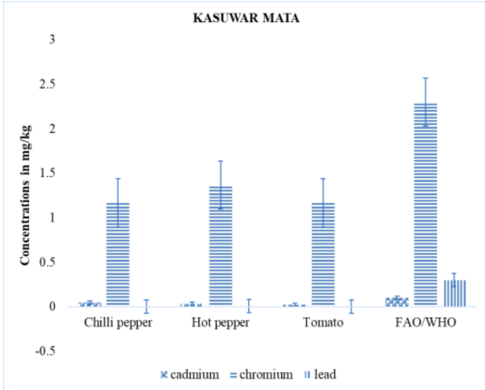


Figure 4: Heavy metals concentration (Mg/Kg) in vegetables fromKasuwarmata.

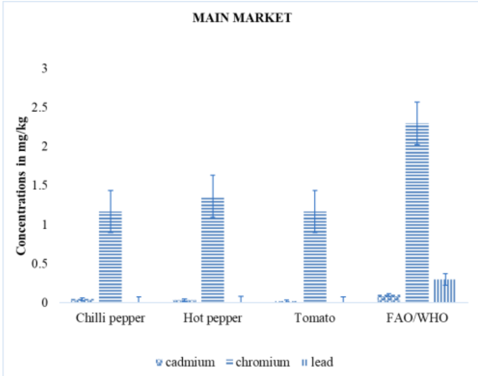


Figure 5: Heavy metals concentration (Mg/Kg) in vegetables frommain Market.

Discussion

Cadmium (Cd)

Cadmium is highly toxic heavy metal and it does not have a role in biological process in living organisms. Thus, even in low concentration Cadmium could be harmful to living organisms (Ambedkar and Muniyan, 2013). High concentrations of Cadmium in living system could lead to anaemia, renal damage, bone disorder and cancer of the lungs (Edward *et al.*, 2013). Cadmium (Cd) is a non-essential in foods and natural waters and it accumulates principally in the kidney and liver (Dakiky*et al.*, 2002). According to Kimani*et al.*, (2011), Cadmium is toxic to human even at low concentration. It is reported to cause osteomalacia. It badly affects the cardio vascular system and kidney functioning. The different concentrations of Cadmium absorbed by vegetables from the study area may be due to the contents of heavy metals present in the soil, fertilizer and or environmental pollution.The result shows that the concentration of Cadmium ranges (0.013-0.057 mg/kg). Results also showed a significant variation in the levels of Cadmium between the test vegetables ((p<0.05). From the result obtained, the concentrations of Cadmium in all the study area were within the permissible limit (0.2 mg/kg) set by FAO/WHO (2001).

Chromium (Cr)

*Corresponding Author: ABDULLAHI YAHAYA MOHAMMED.

Chromium is one among the toxic heavy metals. High concentration of Chromium in living system could lead to ulcer, skin irritation, liver and kidney damage (Kumar *et al.*, 2006).The result shows that the concentration of Chromium ranges from (0.733-2.333 mg/kg) which were the highest in all the sample analyzed.The high level of Chromium in *Capsicum annuum*from pantami market (which is from bomaladadda) could be attributed to the possible high levels of metal in contaminated wastewater being used for irrigation.Results also showed a significant variation in the levels of Chromium between the test vegetables ((p<0.05).result from this study shows that levels of Chromium are within the permissible limit (2.30 mg/kg)set by FAO/WHO (2001), except for *Capsicum annumm*(2.333 mg/kg) from pantami market.

Lead (Pb)

Lead has been shown to have toxic impact on a variety of metabolic process essential to plant growth and development including photosynthesis, transpiration, DNA synthesis and mitotic activity (Kimani*et al*., 2011). Lead toxicity leads to anaemia, neurotoxicity, hemotoxicity, nephrotoxicity and toxic metabolic encephalopathy. It targets organs and tissues including the heart, bones, brain, intestines, kidneys and the reproductive system, thus capable of disrupting metabolic processes (Deng *et al.*, 2006). The level of Lead from this study was not detected or are below detection limit in all the samples except0.007±0.012 mg/kg for *Capsicum Chinense* in main market and 0.01±0.017 mg/kg for *Capsicum Chinense* in Arawa market which shows no significance difference between the locations((p<0.05). All these are lower than the permissible limit (0.3 mg/kg) set by FAO/WHO (2001). Lead (Pb) is a toxic element that can be harmful to plants, although plants usually show ability to accumulate large amounts of lead without visible changes in their appearance or yield. In many plants, Pb accumulation can exceed several hundred times the threshold of maximum level permissible for human consumption (Muhammad *et al.*, 2008). The high levels of Pb in some plants may probably be attributed to pollutants in irrigation water, farm soil or due to pollution from the highways traffic (Qui et *al.*, 2004).

The analysis revealed that there was significant variation in the concentrations of Chromium across different markets. The highest levels of Chromium were observed in Capsicum annuum from Pantami market (2.333 mg/kg), while the lowest were found in Capsicum chinense from Gombe Main market. Lead and Cadmium concentrations were relatively consistent across markets, with all values falling below the FAO/WHO permissible limits.

Conclusion

The study concludes that the consumption of vegetables from Gombe Metropolis may not pose significant risks for Lead and Cadmium toxicity; however, caution should be exercised regarding the consumption of Capsicum annuum from Pantami Market due to its high Chromium content. Further studies are recommended to assess the sources of these heavy metals and to develop strategies to mitigate their presence in vegetables.

References

1. Akan, J.C., Abdulrahman, F.I., Ogugbuaja,V.O.andAyodele J.T. (2009). Heavy metals and anion levels in some samples of vegetables grown within the vicinity of Challawaindust.Area, Kano state, Nigeria.*Journal.Applied Science*.6 (3):534-542.
2. Amare, H. (2007). Metal concentration in vegetables Grown in Northern Addis Ababa and part of Rift Valley (Ziway), Ethiopia. A thesis submitted to the school of graduate studies, university of Addis Ababa: 4-59.
3. Ambedkar, G. andMuniyan, M. (2012). Analysis of heavy metals in water, sediments and selected fresh water fish in collected from Gadilan River Tamilnadu, India. *International Journal of toxicology. Applied Pharmacology.* 2(2): 1-7.
4. Atayese, M.O., Eigbadon, A.J., Oluwa, K.A.andAdesodun, J.K. (2009). Heavy metal contamination of Amaranthus grown along major highways in Lagos, Niger.*Afr. Crop Sci. J.* 16(4):225-235.
5. Avino, R.B., Lopez, J.R..andAvino, J.P. (2008). Trace Elements as Contaminants and Nutrients: Consequences in Ecosystems and Human Health, Ed. Health Implications: *Trace Elements in Cancer* M.N.V. Prasad, John Wiley & Sons, Inc., 495-522.
6. Chiroma, T., Hymore, F. and Ebawele, R. (2003). Heavy metal contamination of soils irrigated with sewage water in Yola. *Nigeria Journal of Environmental Research and Development*. 2(3):251-263.
7. Dakiky, M.K., Khamis, M.H., Manassra, A.N. andMerebM.R.(2002). Selective Adsorption of Chromium (VI) in Industrial Waste Water using Low-Cost Abundantly available Adsorbents. *Journal of Advance in Environmental Ressearch*.6:533-540.
8. Davis,A., Sherwin, D., Ditmars, R. and Hoenke,K.A. (2001). An Analysis of Soil Arsenic Records of Decision.*Environ Sci. Technology*; 35(12): 2401-2406.
9. Dayan,W.P. and Paine, B.W. (2001). Environmental Science: *A Global Concern6th edition.* McGraw-Hill Companies, Inc.
10. Deng, D.,Welz, B. and Wang, J.L. (2006).Biosorption of copper (II) by chemically modified biomass of *saccharomycescerevisiae*.*Process Biotechemistry*.37: 847-850.
11. DeVault,N. (2010). Consequences of Not Eating Fruits and Vegetables. WEB:www.livestrong.com/article/286624-consequences-of-not-eating-fruitsvegetables. Accessed on 4th July, 2018.
12. Edward, J.B., Idowu, E.O., Oso, J.A. andIbidapo O.R. (2013). Determination of heavy metals concentration in fish samples, sediment and water

*Corresponding Author: ABDULLAHI YAHAYA MOHAMMED.

from Odo-Ayo River in Ado-Ekiti, Ekiti State, Nigeria. *International Journal of Environmental monitoring Analysis. 1(1): 27-33.*

13. Emsley, B.T. (2001). Phytoremediation:A novel strategy for the removal of toxic metals from the environment using plants.*Biotechnology*13:468-474.
14. Eslami, A., Khaniki,R.J.,Nurani, M., Meharasbi, M., Peyda, M. and Azimi, R. (2007). Heavy metals in edible green vegetables grown along the sites of the Zanjan roads Iran.*Journal of Biological Sciences.***7**: 943-948.
15. Fatoba, P.O., Ogunkunle, C.O. and Okewole, G.A. (2011). Mosses as bio-monitors of heavy metal deposition in the atmosphere. *International Journal of EnvironmentalSciences*, 1(2), 56-62.
16. Fergusson, J.E. (2004). The heavy element:*Chemistry, environmental Impact and health effects*. Oxford: pergamon press.
17. Ferner, S.T. (2001). Heavy metal accumulation in *Solanaceae*-plants grown at contaminated area. Proceedings of the Balkan Scientific Conference of Biology in Plovdiv (Pulgaria): 452–460.
18. FAO/WHO, (2001). Food additives and contaminants, Joint Codex Alimentarius Commission, FAO/WHO.Food standards Programmed, ALINORM 01/12A.
19. Kimani, M.Z., Mohiuddin, S., Naz, F., Naqvi, I.I. and Zahir E. (2011). Detection of heavy metals in pepper.*J. Basic and Applied Science*. 7(2): 89-95
20. Funtua, M.A., Agbaji, F.B., andAjibola, V.O. (2008). Assessment of the heavy metal contents of spinach and lettuce grown along the bank of river Getsi, Kano. *J. Chem. Soc. Niger.* 5(1):11-14.
21. Gonzalez, C.G. (2005). Cadmium and lead concentrations of commercially grown vegetables and of soils in the lower Fraser valley of British Columbia. Can. *Journal of Soil Sci.*, 77: 51-57.
22. Hingston, R. (2001). Integrated assessment of heavy metal (Pb, Zn, Cd) highway pollution: Bioaccumulation in soil, *Graminaceae*and land snails. Chemosphere, 55(10): 1349-1359
23. Husain, A., Baroon, Z., Al-khalafawi, M., Al-Ati, T. And Sawaya, W. (2008). "Toxic metals in imported fruits and vegetables marketed in Kuwait," *Environment International journal.*vol. 21, no. 6, pp. 803–805.
24. Ibrahim, A.U., Maleki,A. and Zarasv, M.A. (2008). Heavy Metals in Selected Edible Vegetables and Estimation of Their Daily Intake in Sanandaj, Iran.*South East Asian J. Trop. Med. Public Health;* 39(2): 335-339.
25. Ismail,B.N. (2009). Heavy Metals Determination in Brinjals and *Lycopasicumesculentum*. Final Year Project Report Submitted in Partial Fulfilment of the Requirements for the Degree of Bachelor of Science Chemistry in the Faculty of Applied Sciences, University Technology Mara Selangor: 1-12.
26. Jarup, L. (2003). *Hazards of heavy metal contamination.* Br. Med. Bull., 68: 167–182.
27. Jipanin, C.A., Barman, S.C. and Lal, M.M. (1994). Accumulation of heavy metals (Zn, Cu, Pb and Cd) in soil and cultivated vegetables and weeds grown in industrially polluted fields. *J. Environmental. Biology*; 15: 107-115.
28. Kabata,P.A.andmukherjee, A.B. (2007).*Trace Elements from Soil to Human*, Springer Berlin Heidelberg, New York.
29. Kawatra, B.L. and Bakhetia, P. (2008). Consumption of heavy metal and minerals by adult women through food in sewage and tube-well irrigated area around Ludhiana city (Punjab, India). *Journal of Human Ecology***.23**: 351- 354.
30. Khairiah, J., Zalifah, M.K., Yin, Y.H. and Aminha, A. (2004). The uptake of heavy metals by fruit type vegetables grown in selected agricultural areas. *Pakistan Journal of Biological Science.***7:** 1438-1442.
31. Kisku, G.C., Barman,S.C.and Bhargava, S.K. (2011). Contamination of soil and plants with potentially toxic elements irrigated with mixed industrial effluent and its impact on the environment. *Water Air Soil Pollution*. 120: 121-137.
32. Kumar, S., Mehta1, U.J. and HazralS. (2008). Accumulation of cadmium in growing peanut (*Arachishypogaea*L.) seedlings effect on lipid per oxidation and on the antioxidative Enzymes catalase and guaiacol peroxidase. *Journal of Plant Nutritional Soil Science.*171: 440–447.
33. Ladipo,M.K.andDoherty, V.F. (2011). Heavy metal levels in vegetables from selected Markets in Lagos, Nigeria Africa. *Journal Food Sci. Technol.* 2(1):18-21.
34. Lide, H. (2000). *Long-term trend analysis of Heavy metal content and translocation in soils.* C.R. Acad. Agric., 60: 975-982.
35. Mangajji, U. (2009). Vegetable nutrition facts and health benefits of vegetables. http://www.nutrition-and-you.com/vegetable-nutrition.html. Accessed on 5th July, 2018.
36. Maria,F., Mangwayana, E.N., Giller,K.E. and Nyamangara, J. (2007). Uptake of Heavy Metals by Vegetables Irrigated Using Wastewater and the Subsequent Risks in Harare, Zimbabwe: 2-12.
37. Mocanu, M., Roman, C., Levei, E., Senila, M., Abraham, B. and Cordos, E. (2006). Heavy metals availability for plants in a mining area from North-Western Romania. Research Institute for Analytical Instrumentation: 5-9.
38. Muhammad, F., Farooq,A.and Umar, R. (2008). Appraisal of heavy metal contents in different vegetables grown in the vicinity of an industrial area. Pak. *Journal of Botany*. 40(5):2099-2106.
39. Nwajei, G.E. (2009). Trace elements in soils and vegetation in the vicinity of shell Petroleum

*Corresponding Author: ABDULLAHI YAHAYA MOHAMMED.

Development Company operating area in Ughelli, delta state of Nigeria. American Eurasian.*Journal of Sustainable Agriculture*.**3**: 574-578.

40. Nwoko, D.E. Equnobi, G.O. and (2002). Effect of spent engine lubricating oil on the growth of *Capsicum annuum*and *Lycopersiconesculentum*, Mill.*EnvironmentalPollution*.88,361-364.
41. Obuobie, E.B., Keraita, G.,Danso, P.,Amoah, O. L.,Raschid, S. and Drechsel,P.(2006). Irrigation urban vegetable production in Ghana: characteristics, Benefits and Risks. IWMI-RUAF-CPWF, Accra, IWMI, Ghana, pp: 150.
42. Qiu, Y., Cui, Y.J., Zhu, Y.G., Zhai, R.H., Chen, D.Y., Huang, Y.Z. and Liang, J.Z., (2004). Transfer of metals from soil to vegetables in an area near a smelter in Nanning, China. *Environment International*.30:785–791.
43. Radwan, M.A. and Salama, A.K. (2006). “Market basket survey for some heavy metals in Egyptian fruits and vegetables,” *Food and Chemical Toxicology*, vol. 44, no. 8, pp. 1273–1278.
44. Rosen, M. (2010). Dietary exposure to metals and other elements in the UK Total Diet Study and some trends over the last 30 years.*Food Additive Contamination* 26**:** 32–79.
45. Reilly, (2004). *The Nutritional Trace Metals*. Blackwell Publishing Ltd, Oxford, UK.
46. Shanker, A.K. (2008). *Mode of Action and Toxicity of Trace Elements*, In: Trace Elements as Contaminants and Nutrients: Consequences in Ecosystems and Human Health, Ed. M.N.V Prasad, John Wiley & Sons, Inc., 525-553.
47. Sharma, O.P. (2004). *A textbook of Botany, 2nd edition*.Hills EconomyArish press Dhaka, Bangladesh, pp. 18-21.
48. Sharma,B. and Chettri, M.K. (2005). Monitoring of Heavy Metals in Vegetables and Soil of Agricultural Fields of Kathmandu Valley.Ecoprint; 12: 1-6.
49. Singh, S., Zacharias, M., Kalpana, S. and Mishra, S. (2012). Heavy metals accumulation and distribution pattern in different vegetable crops. *Journal of Environmental Chemistry and Ecotoxicology;* 4 (4): 75-81.
50. Suruchi, M. and Khana, P. (2011). Assessment of heavy metal contamination in Different vegetables grown in and around urban areas.*Research Journal of Environmental Toxicology;* 5(3):162-179.
51. Smical, A.I., Hotea, V., Oros, V., Juhasz, J. and Pop, E. (2008). Studies on transfer and bioaccumulation of heavy metals from soil into lettuce.*Environmental engineering and Management Journal;* 7(5): 609- 615.
52. Thompson, H.C. and Kelly, W.C. (2009). *Vegetable Crops5th Edition*. McGraw Hill Publishing Company Ltd., New Delhi.
53. Tuan,T. and Popova, A. (2013). Impact of Mining Sector Investment in Ghana: *A Study of the Tarkwa Mining Region, Draft Report for SAPRI*: 3-70.
54. Turpeinen, R. (2002). Interactions between metals, microbes and plants-bioremediation of Arsenic and lead contaminated soils: 9-19.
55. Vailliers, E.C., Itanna, F. and Allen, S.E. (2010). Bioavailability of lead concentration in vegetable plants grown in soil from a reclaimed industrial site: Health implications. *International Journal of Food Safety*.**6:** 31-34.
56. Volesky, B. (2007). Biosorption of heavy metals by *Saccharomyces Cerevisiae. Journal of applied Microbiology Biotechnology*.42:797-806
57. WHO, (2003). Evaluation of certain food additives and contaminant: Hg, Pb, Cd. 16th Report of Expert committee, WHO Technical Report Series. No 51.
58. Wilberforce, J.O. and Nwaabue, F.I. (2013) Heavy metals effect due to contamination of vegetables from Enyigba lead mine in Ebonyi state, Nigeria. *Environment and Pollution* 2(1), p. 19-26.
59. Wilson, L. (2001). Toxic heavy metals and human health.The centre for development.http://drlwilson.com/articles/toxic%20 metals.htm.Accessed on 12th August, 2018.
60. Yasar, U., Ozyigit, I.I. and Serin, M. (2010). Judas tree (*Cercissiliquastrum*L. subsp. *siliquastrum*) as a possible biomonitor for Cr, Fe and Ni in Istanbul (Turkey). *Rom Biotech Lett*. 15 (1), 4979-4989.

*Corresponding Author: ABDULLAHI YAHAYA MOHAMMED.