EAS Journal of Nutrition and Food Sciences
Abbreviated Key Title:EAS J Nutr Food Sci
ISSN: 2663-1873 (Print) & ISSN: 2663-7308 (Online)
Published By East African Scholars Publisher, Kenya
Volume-4 | Issue-2 | Mar-Apr; 2022 | DOI:10.36349/easjnfs.2022.v04i02.002

OPEN ACCESS

Original Research Article

Heavy Metal Level Evaluation in Commonly Cultivated Vegetables from Different Farming Areas in Kano State

Sheshe SM[1*], Yunusa A[1], Mikail TA[1], Abdullahi AN[1], Muazu SA[1], Ismail SY[1], Khalid GM[2], Muhammad MI[1]
[1]Department of Biochemistry, Kano University of Science & Technology, Wudil, Kano, Nigeria
[2]Department of Pharmaceutics, Bayero University Kano, Nigeria

Article History
Received: 26.01.2022
Accepted: 02.03.2022
Published: 13.03.2022

Journal homepage:
https://www.easpublisher.com

Quick Response Code

Abstract: Metal toxicity on food substances has been a major cause of diseases and conditions in many parts of the world including African countries. In Nigeria, vegetables, which are an integral part of dishes and delicacies, could be liable to heavy metal toxicity and consumption of such could have devastating health consequences. This study aimed to evaluate levels of some heavy metals in vegetables sources from major farming areas in Kano, Northern part of Nigeria. Samples of some commonly consumed vegetables and irrigation waters were obtained from 4 different farming locations in Kano. The samples including the irrigation waters were oven dried and subjected to digestion processes using acid methods. The solution obtained was used to determine levels of Pb, As, Cd, Ni, Zn and Cu using spectrophotometry. The results showed elevated levels of Pb and Cd in water and vegetables from 2 farming sites compared to other location. The results were also higher than the acceptable limits by WHO/FAO. From these results, it was inferenced that vegetables from such areas have significant higher levels of some of these toxic heavy metals and should be point of concern for food monitoring authorities.
Keyword: Vegetables, Heavy-metals, Kano, spectrophotometry, health, toxic.

INTRODUCTION

Heavy metals have been known to accumulate due to various human and environmental activities (O E Orisakwe *et al.*, 2017). The quality of ecosystem becomes altered, when heavy metals find their way, somehow, into it through human and natural activities *(Tchounwou et al.*, 2012). Human activities including mining processes improper waste disposal and other activities have been reported as major causes of accumulation and intoxication by heavy metals (Jaishankar *et al.*, 2014). These metals bio-accumulate in plants grown in these areas. The metals have detrimental effects on agricultural production, decreasing both yield and quality of vegetables when their concentrations reach toxic levels (Singh *et al.*, 2011). In addition, through bio-multification, the accumulated metals' levels increases in amount resulting addition deposits of the heavy metals in various plants' parts including stem, roots and leaves (Krupa & Swida, 1997).

Heavy metals have been known to have devastating health effects and are associated with many human diseases and conditions (Singh *et al.*, 2011). The metals, having large structural densities include but not limited to Pb, Co, Cd, Ni, Fe, Cu, Hg etc. Although some of these metals are required for proper body physiology, a lot of them should be carefully considered and monitored (Gillis *et al.*, 2012). Thus various regulatory bodies such as the World health organizations (WHO), FAO, NAFDAC etc have all set recommende levels or ranges for each metal in different sources including drinking water, vegetables and other food stuff (Jan *et al.*, 2015). Thus metals such as Pb should not exceed certain recommended value set by WHO. Higher levels of Pb for example, is associated with respiratory difficulties and anemia (Wani *et al.*, 2015). It is an inhibitor of porphobilinogen synthase and ferrochelatase and strongly reduced heme biosynthesis. Pb has also been shown to be associated with oxidative stress and free radical generation (Gillis *et al.*, 2012). Finally, it has been strongly implicated in cognitive dysfunction and neurological impairment. Once it enters the body, Pb is easily distributed in the kidney, liver, brain, muscles and bones (Kim *et al.*, 2015). Similarly, Ni, Co, Cd, accumulations have shown to be associated with respiratory failure,

***Corresponding Author:** Sheshe SM
Department of Biochemistry, Kano University of Science & Technology, Wudil, Kano, Nigeria

cardiovascular diseases and even cancer (Mohammad *et al*., 2017).

Vegtables are important food components particularly in African countries *(Bar-On et al.*, 2018). Most local dishes in Nigeria are vegetable based (Sheshe *et al*., 2019). Additionally, they form the largest food sources in the North-western part of Nigeria. In Kano, Spinach, Cabbage, Lettuce, water leaf, etc are the most common vetegables widely grown in specified areas (Mohammad *et al*., 2017). Most of the areas in Kano where these vegetables are grown are usually water close areas (State *et al*., 2010). The vetegables grown in these areas cover over 90% of the total amount of vegetables consumed in Kano, Jigawa, and some parts of Kaduna and Katsina states (Sheshe *et al*., 2019).

This study aims at determining and comparing levels of some heavy metals in widely consumed vegetables grown in 4 major areas of Kano state. Specific objectives of the study include;

i. Determining the levels of the heavy metals As, Pb, Cd, Ni, Zn and Cu in vetegables; Cabbage, Lettuce, Spinach and water samples from Wudil farm areas
ii. Determining the levels of the heavy metals As, Pb, Cd, Ni, Zn and Cu in vetegables; Cabbage, Lettuce, Spinach and water samples from Noomansland farm areas
iii. Determining the levels of the heavy metals As, Pb, Cd, Ni, Zn and Cu in vetegables; Cabbage, Lettuce, Spinach and water samples from Sharada farm areas
iv. Determining the levels of the heavy metals As, Pb, Cd, Ni, Zn and Cu in vetegables; Cabbage, Lettuce, Spinach and water samples from Shirmu farm areas

2.0 MATERIALS AND METHODS

Sample collection and Preparation

Vegetable and water samples were collected from Wudil, Noomansland, Shirmu and Sharada areas of Kano state in Nigeria. Vegetables samples were oven-dried, grinded and sieved. The samples were then transferred into to labelled sample bottles which were then subjected to ashing and digestion. Water samples were labelled in containing vessels and were filtered using Whatman glass tube fiber filters. The extracted was further extracted (digested) using HNO_3. The levels of metals were determined using Atomic Absorption Spectrometer in all the samples.

Methods of Ashing and Digestion

PLANTS SAMPLES

1gram of each sample was weighed and put into the 250 ml beaker. 30 ml of aqua regia (HCL +HNO_3) was poured into the beaker, placed on hot plate and added to the samples each. The mixture was initially heated low temperature and later rigorously at a temperature of 90 - 95°C for an 1hr until a transparent solution. The solution was then transferred into 50cm^3 volumetric flack and then made up to the mark with deionized water. Two small sample bottles were used for each metal.

WATER SAMPLE

Similarly, 100cm^3 of water sample was put into the 250cm^3 Beaker. 50cm of conc. Nitric acid was added into the Beaker and placed on hot plate for a while. The residue was then transferred into 100cm^3 volumetric flack and then made up to the mark with deionized water. The digest was used for heavy metal analysis.

Absorbance Measurement

The absorbance of the metals was determined by Atomic Absorption Spectrophometer Agilent technologies 200 series (model No: 240FS).

The concentration of the metals in each sample were analyzed statistically using the Graphpad Prism version 6.0.1 for windows 32-bits. Data for each sample were subjected Unpaired t-test with values considered significantly different when $p<0.05$

RESULTS

Table-1: Showing data of Heavy metals from Sharada farm areas

Samples	Pb (mg/kg)	Cd (mg/kg)	Ni (mg/kg)	Zn (mg/kg)	Cu (mg/kg)	As (mg/kg)
Cabbage	0.426±0.055^b	0.215±0.005^b	ND	8.13±1.203^b	10.85±0.926^b	ND
Water Leaf	8.723±0.243^b	0.637±0.0176^a	ND	6.09±2.241^b	20.25±1.415^b	ND
Lettuce	36.28±0.291^b	0.283±0.020^b	0.953±0.043^b	3.55±1.730^b	14.57±0.271^b	ND
WHO/FAO	10.00	0.2	67.00	100.00	73.00	ND
Water(mg/l)	0.078±0.005^a	ND	ND	0.104±0.005^a	0.091±3.333^a	ND

Table-2: Showing data of Heavy metals from Nomansland farm areas

Samples	Pb (mg/kg)	Cd (mg/kg)	Ni (mg/kg)	Zn (mg/kg)	Cu (mg/kg)	As (mg/kg)
Cabbage	ND	0.215 ± 0.005[b]	ND	18.13 ± 1.203[b]	10.85 ± 0.926[b]	ND
Water Leaf	8.723 ± 0.243[b]	0.637 ± 0.018[b]	ND	1.847 ± 0.035[b]	ND	ND
Lettuce	ND	0.870 ± 0.056[b]	ND	24.06 ± 0.198[b]	23.46 ± 0.272[b]	ND
WHO/FAO	10.00	0.2	67.00	100.00	73.00	ND
Water	0.049 ± 0.001[a]	ND	ND	0.072 ± 0.001[a]	0.061 ± 0.005[a]	ND

Table-3: Showing data of Heavy metals from River Wudil Farm areas

SAMPLE	Pb (mg/kg)	Cd (mg/kg)	Ni (mg/kg)	Zn (mg/kg)	Cu (mg/kg)	As (mg/kg)
Cabbage	5.223±0.064[b]	ND[a]	ND	22.42±0.409[b]	12.69±0.371[b]	ND
Water leaf	14.75±0.179[b]	0.530±0.046[b]	ND	111.4±0.549[b]	18.37±0.381[b]	ND
Lettuce	9.703±0.249[b]	0.633±0.044[b]	ND	89.81±0.164[b]	22.14±0.201[b]	ND
WHO/FAO	10.00	0.2	67.00	100.00	73.00	ND
Water(mg/l)	ND	ND	ND	0.78±0.1[a]	0.1±0.03[a]	ND

Table-4: Showing data of Heavy metals from Shirmu farm areas

SAMPLE	Pb (mg/kg)	Cd (mg/kg)	Ni (mg/kg)	Zn (mg/kg)	Cu (mg/kg)	As (mg/kg)
Cabbage	13.73 ± 0.15[b]	0.41 ± 0.01[b]	ND[a]	15.00 ±0.14[a]	10.01 ±0.02[b]	ND
Water leaf	2.12 ± 0.11[a]	0.17 ± 0.02[b]	ND[a]	29.42 ±0.21[b]	22.15 ±0.14[b]	ND
Lettuce	9.39 ± 0.19[b]	0.22 ± 0.01[b]	1.89 ± 0.05[b]	39.69 ±0.36[b]	18.81 ±0.11[b]	ND
WHO/FAO	10.00	0.2	67.00	100.00	73.00	ND
Water(mg/l)	0.0089±0.023[a]	ND[a]	18.06±0.024[a]	0.24 ± 0.02[a]	6.14 ± 0.009[a]	ND

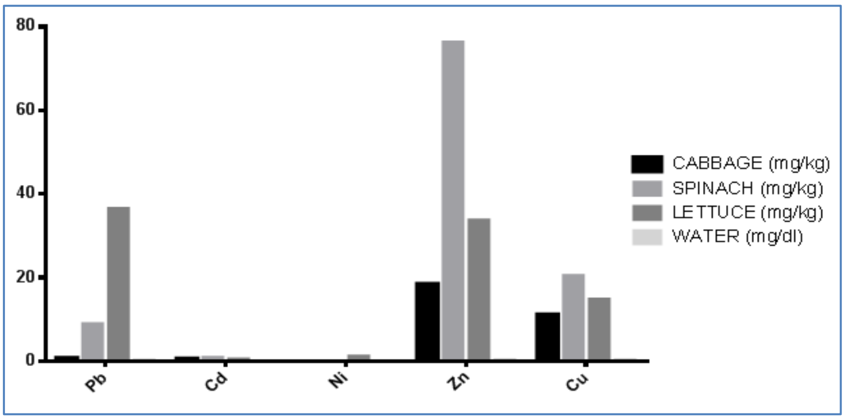

Fig-1: Levels Heavy metals in 3 vegetables grown in Sharada farm area

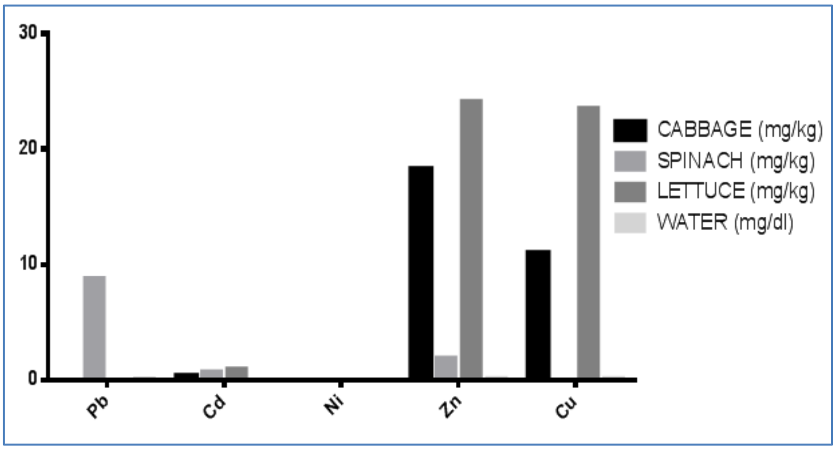

Fig-2: Levels Heavy metals in 3 vegetables grown in Nomansland farm area

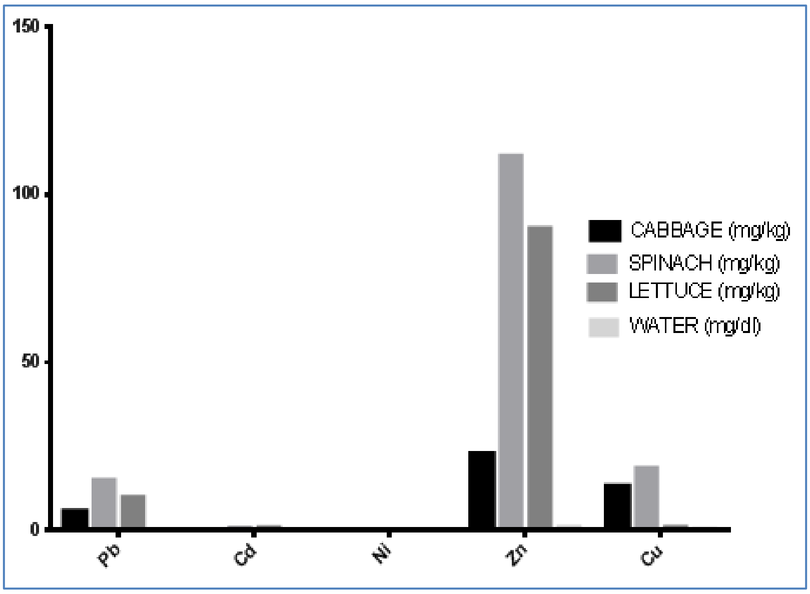

Fig-3: Levels Heavy metals in 3 vegetables grown in Wudil farm area

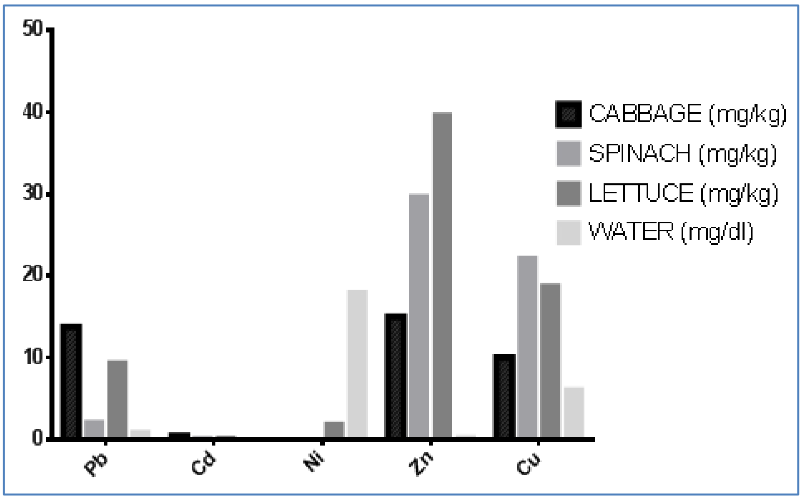

Fig-4: Levels Heavy metals in 3 vegetables grown in Shirmu farm area

The results obtained from table 1and figure 1 confirmed the presence of the heavy metals in Sharada farm areas of Kano Municipal Local government. The heavy metals analyzed were Pb, Cd, Ni, Zn and Cu. The Concentration of Pb Ranges from 36.28±0.291 to 0.007±0.005 mg/kg while Cd ranges from 0.637±0.17 to 0.215±0.005 mg/kg in the 3 analyzed vegetables. Ni is only present in the lettuce among the samples. Zn concentration ranges from 76.09±2.24 to 0.14±0.005 mg/kg, while the concentration of Cu in the Sharada area is between 20.25±1.415 to 0.09±3.33 mg/kg. Table 2 showed the results obtained from Nomansland area of Fagge Local Government. Ni was not detected in the samples while Pb was only detected in Water leaf and found to be 8.723±0.243 mg/kg. Table 3 showed results from River Wudil area. Data showed Ni was not detected in all the samples analyzed although Pb, Cd, Zn and Cu detected. The Pb concentration ranges from 14.75±0.179 mg/kg in water leaf, 9.703±0.249 mg/kg in Lettuce and 5.22±0.06 mg/kg in Cabbage. Cd ranges from 0.633 ± 0.044 to 0.530 ± 0.046mg/kg.

Lastly, Table 4 showed results from Shirmu area with Pb 13.73 ± 0.15mg/kg in Cabbage 2.12 ± 0.11 mg/kg in Waterleaf and 9.39 ± 0.19 in Lettuce. Ni was however not detected in both Cabbage and Waterleaf while all other metals were significantly detected in all samples. Water samples from the 4 locations used in growing these vegetables are also analyzed and the results showed Cd and Ni were not detected in Sharada and Nomansland areas. Pb, Cd, and Ni were not detected in River Wudil farm areas while only Cd was not significantly detected in Shirmu areas.

DISCUSSION

Results of the study showed a varying comparison of the metals in the 3 vegetable samples in addition to the water samples used at the locations of growing these vegetables. The present study revealed that the Pb concentrations in Cabbage and Waterleaf from Sharada farm areas were below acceptable value by WHO/FAO while the concentration was higher in

Lettuce sample. Further, Pb concentrations were found higher in few vegetables from Shirmu (Cabbage) and Wudil (Waterleaf) farm areas. Similarly, water sample from the Sharada area contained Pb below the WHO/FAO in drinking water (0.01mg/L). Although Pb accumulation in plants is mostly seen in areas widely associated with mining activities, it amounts could be higher in moving waters due industrial waste contamination as well as domestic activities such as battery parts burning. Sharada area being one areas with a significant number of industries could be subjected to irrigation water intoxication by Pb. Such waters are mostly used by Sharada farms growing many vegetables, fruits and berries which are widely consumed within Kano and beyond. Shirmu and Wudil areas contain moving waters which might have linked with moving waters from Sharada areas. Babandi *et al*. (2012) showed the levels of Pb to significantly higher in Onion, Lettuce, Moringa and Okra as well as soil samples also grown within industry Zones of Sharada (Phase 3). Additionally, Reports showed slight increase in Pb amounts in some vegetables', water and soil samples from Barkin Ladi and Bukuru in Jos, central part of Nigeria (Orish Ebere Orisakwe *et al*., 2017). Pb is a metal with confirmed toxic effects on organs that include kidneys, liver, lung and spleen that cause different biochemical defects (Assi *et al.*, 2016).

Cd concentrations in Cabbage and lettuce were slightly higher than the WHO/FAO acceptable value (Godt *et al*., 2006). However, the concentration was higher when compared with the previous vegetables as well as the WHO acceptable value. Similar higher values of Cd were seen in a number of leafy vegetables grown and irrigated with moving waters from Southern Bangkok province, Thailand *(Choprathumma et al*., 2019). Cd is becoming an increasing health concern in wastewater irrigated agriculture as it's associated with damage of kidneys, bones and its probable carcinogenic nature (Alina *et al*., 2012).

The Ni contents of the samples were mostly non detectable from the 3 locations. Few vegetables having Ni content were all below the permissible limit set by WHO in our study. Sheshe *et al*. (2019) showed lower Ni contents as well in certain medicinal plants commonly used in Kano. It contents in moving waters and soil samples was also largely not detected in Kwakwaci and Jakara areas of Kano (Dawaki *et al*., 2013). Nickel has been considered trace though its presence in higher levels could have neurological implications element for human and animal health (Nazir *et al.*, 2015).

Zn and Cu levels were mostly significantly higher in Waterleaf and Lettuce compared with Cabbage. Both metals in all the samples were below the WHO acceptable values. Although both essential elements, these heavy metals levels if higher than acceptable limits could pose serious human health risk. Additionally, Zn and Cu were not usually found in higher amounts in drinking or moving irrigation waters (Dawaki *et al*., 2013).

CONCLUSION

The Results of these study higher levels of some heavy metals in the vegetables samples collected from widely known irrigation sites in Kano. Interestingly, there is also higher levels of these heavy metals in the water samples of locations where such metals concentrations are higher. It could be concluded that such areas might be susceptible to certain metal intoxication which could prove fatal in the long term. Addition, it could also be concluded that a proportional correlation exist between other domestic activities such battery and car spare part burning, disposal in moving waters and heavy metals accumulation in these vegetables grown with such water samples.

RECOMMENDATION

This study covered a limited area of vegetable farming and growing which served as a source for public consumption. We recommend that further studies be expanded to related and diverse areas within Kano and beyond to have a comprehensive data on the levels of these heavy metals. Additionally, it is further recommended that more samples of the vegetables, more irrigation & moving water and soil samples are analyzed to further elucidate the correlation between heavy metal accumulation in plants and irrigation with such waters and the growing soil.

ACKNOWLEDGEMENT

The authors acknowledge the support of Tertiary Education Trust Fund (TETFUND). The funding of this project was provided through the Institution Based Research (IBR) grant provided by TETFUND
(TETF/DR&D/UNI/WUDIL/RG/2018/VOL.I)

REFERENCES

- Alina, A., Mohd, Y., Mohd, Z., Mohd, I., & Effendi, M. R. (2012). Heavy Metals in Selected marine fish and Shellfish along the Straits of Malaca. *Int. Food Res*, *19*(1), 135–140.
- Assi, M. A., Hezmee, M. N. M., Haron, A. W., Sabri, M. Y. M., & Rajion, M. A. (2016). The detrimental effects of lead on human and animal health. *Veterinary World*, *9*(6), 660–671. https://doi.org/10.14202/vetworld.2016.660-671
- Babandi, A., Atiku, M.K., Alhassan, A.J., Ibrahim, A., & Shehu, D. (2012). Level of heavy metals in soil and some vegetables irrigated with industrial waste water around sharada industrial area. *Chemsearch Journal*, *3*(2), 34–38.
- Bar-On, Y. M., Phillips, R., & Milo, R. (2018). The biomass distribution on Earth. *Proceedings of the*

National Academy of Sciences of the United States of America, *115*(25), 6506–6511. https://doi.org/10.1073/pnas.1711842115

- Choprathumma, C., Thongkam, T., Jaiyen, C., Tusai, T., Apilux, A., & Kladsomboon, S. (2019). Determination of toxic heavy metal contaminated in food crops in Nakhon Pathom province , Thailand. *แก่นเกษตร*, *47*(1), 83–94. https://doi.org/10.14456/kaj.2019.20
- Dawaki, U. M., Dikko, A. U., Noma, S. S., & Aliyu, U. (2013). Heavy Metals and Physicochemical Properties of Soils in Kano Urban Agricultural Lands. *Nigerian Journal of Basic and Applied Sciences*, *21*(3), 239–246.
- Gillis, B. S., Arbieva, Z., & Gavin, I. M. (2012). Analysis of lead toxicity in human cells. *BMC Genomics*, *13*(1), 1. https://doi.org/10.1186/1471-2164-13-344
- Godt, J., Scheidig, F., Grosse-Siestrup, C., Esche, V., Brandenburg, P., Reich, A., & Groneberg, D. A. (2006). The toxicity of cadmium and resulting hazards for human health. *Journal of Occupational Medicine and Toxicology (London, England)*, *1*, 22. https://doi.org/10.1186/1745-6673-1-22
- Jaishankar, M., Tseten, T., Anbalagan, N., Mathew, B. B., & Beeregowda, K. N. (2014). Toxicity, mechanism and health effects of some heavy metals. *Interdisciplinary Toxicology*, *7*(2), 60–72. https://doi.org/10.2478/intox-2014-0009
- Jan, A. T., Azam, M., Siddiqui, K., Ali, A., Choi, I., & Haq, Q. M. R. (2015). Heavy Metals and Human Health: Mechanistic Insight into Toxicity and Counter Defense System of Antioxidants. *International Journal of Molecular Sciences*, *16*(12), 29592–29630. https://doi.org/10.3390/ijms161226183
- Kim, H.-C., Jang, T.-W., Chae, H.-J., Choi, W.-J., Ha, M.-N., Ye, B.-J., Kim, B.-G., Jeon, M.-J., Kim, S.-Y., & Hong, Y.-S. (2015). Evaluation and management of lead exposure. *Annals of Occupational and Environmental Medicine*, *27*(1), 30. https://doi.org/10.1186/s40557-015-0085-9
- Krupa, J., & Swida, J. (1997). Concentration of certain heavy metals in the muscles, liver and kidney of goats fattened in the Bieszczady Mountains. *Animal Science Papers and Reports*, *1*(15), 55–59.
- Mohammad, I., Daniel, A. K., Kiyawa, S. A., & Kutama, A. S. (2017). Phyto-Accumulation of Lead and Chromium in Common Edible Green-Leafy Vegetables Consumed in Dutse Metropolis , Jigawa State , Nigeria. *International journal of chemical, material and environmental research*, *4*(3), 131–136.
- Nazir, R., Khan, M., Masab, M., Rehman, H. U. R., & Rauf, N. U. R. (2015). Accumulation of Heavy Metals (Ni , Cu , Cd , Cr , Pb , Zn , Fe) in the soil , water and plants and analysis of physico-chemical parameters of soil and water Collected from Tanda Dam kohat . *Journal of Pharmaceutical Sciences and Research*, *7*(3), 89–97.
- Orisakwe, O E, Oladipo, O. O., Ajaezi, G. C., & Udowelle, N. A. (2017). Horizontal and Vertical Distribution of Heavy Metals in Farm Produce and Livestock around Lead-Contaminated Goldmine in Dareta and Abare, Zamfara State, Northern Nigeria. *Journal of Environmental and Public Health*, *2017*, 3506949. https://doi.org/10.1155/2017/3506949
- Orisakwe, Orish Ebere, Dagur, E. A., Mbagwu, H. O. C., & Udowelle, N. A. (2017). Lead Levels in Vegetables from Artisanal Mining Sites of Dilimi River, Bukuru and Barkin Ladi North Central Nigeria: Cancer and Non-Cancer Risk Assessment. *Asian Pacific Journal of Cancer Prevention : APJCP*, *18*(3), 621–627. https://doi.org/10.22034/APJCP.2017.18.3.621
- Sheshe, S. ., Kiyawa, S. A., Maryam, A. D., Haris, J. B., Abdullahi, M. L., & Abdulkadir, Y. M. (2019). *Level of Heavy Metals in Cassia Occidentalis , Leptadenia Hastata and Guiera Senegalensis Used As Medicinal Plants in Kano , Northern Nigeria*. *7286*, 44–48.
- Singh, R., Gautam, N., Mishra, A., & Gupta, R. (2011). Heavy metals and living systems: An overview. *Indian Journal of Pharmacology*, *43*(3), 246–253. https://doi.org/10.4103/0253-7613.81505
- State, Z., Dooyema, C. A., Investigation, V., State, Z., & November, O. (2010). *Childhood Lead Poisoning Associated with Gold Ore Processing: a Village-Level Investigation—Zamfara State, Nigeria, October–November 2010*. *November 2015*.
- Tchounwou, P. B., Yedjou, C. G., Patlolla, A. K., & Sutton, D. J. (2012). Heavy Metals Toxicity and the Environment. *EXS*, *101*, 133–164. https://doi.org/10.1007/978-3-7643-8340-4_6
- Wani, A. L., Ara, A., & Usmani, J. A. (2015). Lead toxicity: A review. *Interdisciplinary Toxicology*, *8*(2), 55–64. https://doi.org/10.1515/intox-2015-0009

Cite This Article: Sheshe SM, Yunusa A, Mikail TA, Abdullahi AN, Muazu SA, Ismail SY, Khalid GM, Muhammad MI (2022). Heavy Metal Level Evaluation in Commonly Cultivated Vegetables from Different Farming Areas in Kano State. *EAS J Nutr Food Sci*, *4*(2), 34-39.