

this assertion, it might be justified that the metal contaminated vegetable is among the contributors of health challenges in the study area (Maiduguri).

5. Conclusion

Irrigation with contaminated water with heavy metals poses threat to human beings. Slow exposure of humans to poisoning by heavy metals due to the indiscriminant disposal of wastewater into the river Ngadda that contaminates the vegetable grown with irrigation by contaminated water sources were evident. With this therefore, *Abelmoschus esculentus* in Maiduguri from River Ngadda is risky for human consumption which might be justified that the metal contaminated vegetable is among the contributors of health challenges in the study area (Maiduguri).

6. Reference

- [1] Akan, J. C, Mohmoud, S., Yikala, B.S., & Ogugbuaja, V. O (2012): Bioaccumulation of Some Heavy Metals in Fish Samples from River Benue in Vinikilang, Adamawa State, Nigeria. *American Journal of Analytical Chemistry* **3** (11) 727-735
<https://doi.org/10.4236/ajac.2012.311097>
- [2] Akan, J. C., Abdulrahman F.I., Sodipo O.A. & Lange A. G. (2010): Physicochemical Parameters in Soil and Vegetable Samples from Gongulon Agricultural Site, Maiduguri, Borno State, Nigeria *Journal of American*
- [3] Alipour, H., and Banagar, G. R. (2018). Health risk assessment of selected heavy metals in some edible fishes from Gorgan Bay, Iran. *Iranian Journal of Fisheries Sciences*, *17*(1), 21-34.
- [4] Anakel, W.U, Adie, G.U and Osibanjo, O. (2009). Heavy metals pollution at municipal solid waste dumpsite in kano and kaduna state in Nigeria. *Bull. Chem.Soc.Ethiop.*, **23**(1) 281- 289
<https://doi.org/10.4236/ajac.2012.311097>
- [5] Audu, A.A. and Lawal, A.O, (2005). Variation in metal contents of plants in vegetable gardens sites in kano metropolis. *Journal of applied science Environmental management* **10**: 105- 109
<https://doi.org/10.4314/jasem.v10i2.43680>
- [6] Baird, C. (2002). Environmental Chemistry. Bookman, Porto Alegre, RS, Brazil (in Portuguese).
- [7] Balkhair , K.S, and Ashraf, M. A., (2016). Field Accumulation risks of heavy metals in soil and vegetable crop irrigated with sewage water in western region of Saudi Arabia *Saudi Journal of Biological Sciences* **23**: S32–S44
<https://doi.org/10.1016/j.sjbs.2015.09.023>
- [8] Bhatta S.C., (2002): *Environmental Chemistry*. CBS Publishers and distributors, New Delhi Pp 442
- [9] Bi, C., Zhou, Y., Chen, Z., Jia, J., & Bao, X. (2018). Heavy metals and lead isotopes in soils, road dust and leafy vegetables and health risks via vegetable consumption in the industrial areas of Shanghai, China. *Science of The Total Environment*, **619**, 1349-1357. 2002. Daily intake of TBT, Cu, Zn, Cd and As for fishermen in Taiwan. *The Science of the Total Environment* **285**, 177e185.
<https://doi.org/10.1016/j.scitotenv.2017.11.177>
- [10] Copat, C., Bella, F., Castaing, M., Fallico, R., Sciacca, S. and Ferrante, M. et al. (2012). Heavy Metals Concentrations in Fish from Sicily (Mediterranean Sea) and Evaluation of Possible Health Risks to Consumers. *Bull. Environ. Contam. Toxicol.*, **88**: 78–83.
<https://doi.org/10.1007/s00128-011-0433-6>
- [11] Damenna, J. & Nacleau, E. (1993): *Atomic Absorption Spectrophotometer Manual*. Buck Scientific Inc. East Norwork Connecticut. 53pp.
- [12] Dimari, G.A. Abdulrahman. F.I, Akan J.C. and Garba S.T. (2008): Metals Concentrations in Tissues of *Tilapia gallier*, *Crarias lazera* and *Osteoglossidae* Caught from Alau Dam, Maiduguri,. Borno State, Nigeria *American Journal of Environmental Sciences* **4** (4): 373-
<https://doi.org/10.3844/ajessp.2008.373.379>
- [13] EPA, U., 2002. United State, Environmental Protection Agency, Region 9, Preliminary remediation goals. <<http://www.epa.gov/region09/waste/sfind/prg>>
- [14] Falade, K.O., Omojola, B.S., 2010. Effect of processing methods on physical, chemical, rheological, and sensory properties of okra (*Abelmoschus esculentus*). *Food Bioprocess Technol.* **3** (3), 387–394.
<https://doi.org/10.1007/s11947-008-0126-2>
- [15] Gallaher, R.N., Weldon, C.O. and Frutrary, C. (1975): An Aluminium Block Digester for Plant and Soil Analysis. *Soil Science Society America Proceeding*, **39**, 803-806.
<https://doi.org/10.2136/sssaj1975.03615995003900040052x>

- [16] Gupta, A., Rai, D. K., Pandey, R. S. & Sharma, B. (2009): Analysis of some heavy metals in the riverine water, sediments and fish from river Ganges at Allahabad. *Environmental monitoring and assessment*, **157**, 449-458.
<https://doi.org/10.1007/s10661-008-0547-4>
- [17] Gupta, S., Satpati, S., Nayek, S., Garai, D., (2010). Effect of wastewater irrigation on vegetables in relation to bioaccumulation of heavy metals and biochemical changes. *Environ. Monit. Assess.* **165** (1-4), 169-177.
<https://doi.org/10.1007/s10661-009-0936-3>
- [18] Hallenbeck, W.H., 1993. *Quantitative Risk Assessment for Environmental and Occupational Health*. Lewis, Chelsea, MI, P.S., McNulty, D., Alloway, B.J., Aitken, M.N., (1997). Plant availability of heavy metals in soils previously amended with heavy applications of sewage sludge. *J. Sci. Food Agric.* **73** (4), 446-454.
[https://doi.org/10.1002/\(SICI\)1097-0010\(199704\)73:4%3C446::AID-JSFA749%3E3.0.CO;2-2](https://doi.org/10.1002/(SICI)1097-0010(199704)73:4%3C446::AID-JSFA749%3E3.0.CO;2-2)
- [19] Horiguchi, H., Oguma, E., Sasaki, S., Miyamoto, K., Ikeda, Y., Machida, M., Kayama, F., (2004). Dietary exposure to cadmium at close to the current provisional tolerable weekly intake does not affect renal function among female Japanese farmers. *Journal of Environ. Res.* **95** (1), 20-31. Hu, B.F.; Wang, J.Y.;
[https://doi.org/10.1016/S0013-9351\(03\)00142-7](https://doi.org/10.1016/S0013-9351(03)00142-7)
- [20] Jin, B.; Li, Y.; Shi, Z. (2017) Assessment of the potential health risks of heavy metals in soils in a coastal industrial region of the Yangtze River Delta. *Environ. Sci. Pollut. Res. Int.*, **24**, 1-11.
- [21] Ikeda, Y., Horiguchi, H., Oguma, E., Sasaki, S., Miyamoto, K., Machida, M., and Kayama, F., (2000). Dietary exposure to cadmium at close to the current provisional tolerable weekly intake does not affect renal function among female Japanese farmers. *Journal Environ. Res.* **95** (1), 20-31.
[https://doi.org/10.1016/S0013-9351\(03\)00142-7](https://doi.org/10.1016/S0013-9351(03)00142-7)
- [22] Jan, F.A., Ishaq, M., Khans, S., Ihsanullah, I., Ahmad, I., Shakirullah, M. (2010). A irrigated soil (lower Dir), *Journal of Hazard materials*, **179**:612-621.
<https://doi.org/10.1016/j.jhazmat.2010.03.047>
- [23] Jiménez, B., & Asano, T. (2008): Water reclamation and reuse around the world. *Water reuse: An international survey of current practice, issues and needs*, **20**, 3.
- [24] Jolly, Y. N., Islam, A., & Akbar, S. (2013). Transfer of metals from soil to vegetables and possible health risk assessment. *Springer Plus*, **2**, (1), 385-391.
<https://doi.org/10.1186/2193-1801-2-385>
- [25] Li, Q., Chen, Y., Fu, H., Cui, Z., Shi, L., Wang, L., Liu, Z., (2012). Health risk of heavy metals in food crops grown on reclaimed tidal flat soil in the Pearl River Estuary, China. *J. Hazard. Mater.* **227-228**, 148-154.
<https://doi.org/10.1016/j.jhazmat.2012.05.023>
- [26] Lokeshappa, B., Shivpuri, K., Tripathi, V., & Dikshit, A. K. (2012): Assessment of toxic metals in agricultural produce. *Food and public Health*, **2**(1), 24-29.
<https://doi.org/10.5923/j.fph.20120201.05>
- [27] Luo, C., Liu, C., Wang, Y., Liu, X., Li, F., Zhang, G., Li, X., (2011). Heavy metal contamination in soils and vegetables near an e-waste processing site, south China. *J. Hazard. Mater.* **186** (1), 481-490.
<https://doi.org/10.1016/j.jhazmat.2010.11.024>
- [28] Mabberley, D.J., (1997). *The plant book: a portable dictionary of the vascular plants; utilizing Kubitzki's the families and genera of vascular plants (1990-), Cronquist's an integrated system of classification of flowering plants (1981) and current botanical literature arranged largely on the principles of editions 1-6 (1896/97-1931) of Willis's A Dictionary of the Flowering Plants and Ferns*, Cambridge University Press.
- [29] Mahaffy, K. R., (1990). Environmental lead toxicity: Nutrition as a component of intervention. *Environmental health perspective* **89**: 75-78
<https://doi.org/10.1289/ehp.908975>
- [30] Mapanda F., Mangwayana E. N., Nyamangara J. and Giller K. E. (2005): The Effect of Long Term Irrigation Using Wastewater on Heavy Metal Contents of Soils Under Vegetables in Harare, Zimbabwe. *Journal Agriculture, Ecosystem and Environment* **107**:151-165.
- [31] Mohammad Rusan, M.J., Hinnawi, S., Rousan, L., (2007). Long term effect of wastewater irrigation of forage crops on soil and plant quality parameters. *Desalination* **215**: (1-3), 143-152.
<https://doi.org/10.1016/j.desal.2006.10.032>
- [32] Muchuwati M., Birkett J. W., Chinyanga E., Zvauya R., Scrimshaw M. D. and Lester J. N. (2006): Heavy Metal Content of Vegetables Irrigated With Mixtures of Wastewater and Sewage Sludge in Zimbabwe: Implications For Human Health. *Journal of Agriculture, Ecosystem and Environment*. **112**, 41-48
<https://doi.org/10.1016/j.agee.2005.04.028>
- [33] Nabulo, G., Black, C.R., Young, S.D. (2011). Trace metal uptake by tropical vegetables
- [34] NPC, (2007): Nation Population Commission: Population Census Of the Federal Republic Of Nigeria, NPC, Abuja
- [35] Obasohan E, Oronsaye J and Eguavoen O. (2008) A Comparative Assessment of the Heavy Metal Loads in the Tissues of a Common Catfish (*Clarias gariepinus*) From Ikpoba and Ogba Rivers in Benin City. *Nigeria AfrSci* **9**, 13-23.

- [36] Rattan, R.K., Datta, S.P., Chhonkar, P.K., Suribabu, K., Singh, A.K., (2005). Long-term impact of irrigation with sewage effluents on heavy metal content in soils, crops and groundwater—a case study. *Journal of Agric. Ecosyst. Environ.* **109** (3–4), 310–322.
<https://doi.org/10.1016/j.agee.2005.02.025>
- [37] Sabo, A.; Nayaya, A.J.; and Galadima, A. I. (2008): Assessment of some heavy metals in, water, sediment and freshwater mudfish (*Clarias gariepinus*) from river Gongola in Yamaltu-deba, Gombe, Nigeria. *International journal of pure and applied science.* **2**(4): 6-12
- [38] Sharma RK, Agrawal M, and Marshall FM. et al. (2007): Heavy metals contamination of soil and vegetables in suburban areas of Varanasi, India. *Ecotoxicol Environ Saf* **66**, 258–66.
<https://doi.org/10.1016/j.ecoenv.2005.11.007>
- [39] Sharma S. and Prasad F. M. (2009): Accumulation of Lead and Cadmium in Soil and Vegetable Crops along Major Highways in Agra, India. *Journal of environmental Chemistry.* **74**, 1174–1183.
<https://doi.org/10.1155/2010/678589>
- [40] Sharma, R. K., Agrawal, M., & Marshall, F. (2006): Heavy metal contamination in vegetables grown in wastewater irrigated areas of Varanasi, India. *Journal of Bulletin of environmental contamination and toxicology*, **77**(2), 312–318.
<https://doi.org/10.1007/s00128-006-1065-0>
- [41] Singh A., Sharma R. K., Agrawal M. and Marshall F. M. (2010): Risk Assessment of Heavy Metal Toxicity through Contaminated Vegetables from Wastewater Irrigated Areas in Varanasi, India. *Journal of Tropical Ecology* **2**: (51) 375–387.
- [42] Singh, S., Kumar, M. (2006). Heavy metal load of soil, water and vegetables in peri-Urban Delhi. *Environ. Monit. Assess.* **120**: (1–3), 79–91.
<https://doi.org/10.1007/s10661-005-9050-3>
- [43] Storelli, M.M. (2008). Potential human health risks from metals (Hg, Cd, and Pb) and polychlorinated biphenyls (PCBs) via seafood consumption: Estimation of target hazard quotients (THQs) and toxic equivalents (TEQs). *Journal of Food Chem. Toxicol.*, **46**, 2782–2788.
<https://doi.org/10.1016/j.fct.2008.05.011>
- [44] USEPA, (2000). Risk-based Concentration Table. United States Environmental Protection Agency, Philadelphia, PA; Washington DC Uwah, E. I., & Ogugbuaja, V. O. (2012). Investigation of some heavy metals in *Citrullus vulgaris*, *Cucumis sativus* and soils obtained from gardens being irrigated with wastewater in Maiduguri, Nigeria. *Global Research Journal of Agricultural and Biological Sciences*, **3**(5), 373–380.
- [45] Waziri, M. (2007): Trends in Population Dynamics and Implication for Contemporary Socio-economic Development in the Chad Basin. Paper Presented at the Kanem Borno Millennium Conference, Maiduguri. In: (Eds) M. Waziri, A. Kagu, and K.M, Abubakar, *Issue in the Geography of Borno State.* **1**: 6-8.
- [46] Yabanli, M., & Alparslan, Y. (2015). Potential health hazard assessment in terms of some heavy metals determined in demersal fishes caught in Eastern Aegean Sea. *Bulletin of environmental contamination and toxicology*, **95**(4), 494–498.
<https://doi.org/10.1007/s00128-015-1584-7>
- [47] Zhuang, P., Zou, B. Li, N.Y. and Li, Z.A. (2009). Heavy metals contamination in soil and food crops around Dabaoshan mine in Guangdong, China: Implication for human health. *Journal*
<https://doi.org/10.1007/s10653-009-9248-3>