

Assessment of Trace Metal Contaminations in Vegetables Around Riparian Area of Ogbomoso

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Abstract

Different types of waste consisting of everyday items from different sources that are discarded by the public are commonly disposed at the bank of a river in which vegetables are planted. The vegetables planted are assumed to be polluted with some heavy metals as a result of municipal waste. These heavy metals accumulate in the body and enter through the food. The heavy metals sometimes are so much in the body that they pose a great hazard to human body. Four heavy metals Lead (Pb), Chromium, (Cr), Cadmium (Cd), and Zinc (Zn) were studied in comparison with FAO/WHO standard. The research was carried out in Ogbomoso at three different locations Arada, Ikose and Beulah. Vegetables sample were uprooted at the river bank of these locations at three varying distances (10m, 15m and 20m) away from the river. The vegetables samples were kept in a labeled brown envelopes and oven dried for 48 hours at 23°C to remove moisture. The dried samples were then taken to the Institute of Agricultural Research and Training at Ibadan for analysis. The results showed that the level of concentration of Pb, Cr, Cd and Zn found in the vegetable planted in riparian area of Ogbomoso are safe for human consumption because the metals found were in conformation with FAO/WHO standard.

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INTRODUCTION

Vegetables are essential components of natural ecosystems, they are a highly beneficial food for humans and large amounts are consumed daily (Cobb *et al.*, 2000). Vegetable represents the first compartment of the terrestrial food chain. However, some leafy vegetables are well-known trace metal accumulators, making accumulation of trace metals in the edible parts of vegetables a direct pathway for their incorporation into the human food chain (Florigin, 1993). Due to their capacity of toxic metals accumulating, when they grow on soils polluted with such metals, they represent a threat to the living beings which consume them. Extensive usage of agrochemicals in intensive agricultural systems could have negative impacts on the environment (Remarathna *et al.*, 2011). The main sources of heavy metals to vegetable crops are their growth media from which these are taken up by the roots. A better understanding of metals sources, their accumulation in the soil and subsequent uptake by plant species is particularly important in present day research on risk assessment (Mohajer and Mohammed, 2012).

The uptake of metal ions has been shown to be influenced by the metal species and plant parts (Odoh and Kolawole, 2011). All plants show a certain reaction to the increasing of toxic elements concentration in soil, depending upon the sensitivity of plants exposure, intensity and species. Some species of plants disappear from such lands, while the growth of others, on the contrary, are stimulated by these elements. On lands containing metals – some plant species (metalophytes) have developed tolerance towards metals, and others (hyper-accumulators) are characterized by the capacity to accumulate high quantities of metals in their tissues (Smical, *et al.* 2008; Cox, 2000). Trace metals are also important environmental pollutants that are a threat to the health of human populations and natural ecosystems. Trace metals can affect the quality of agricultural soils, including phytotoxicity and food chain contamination (Nicholson *et al.*, 2003). Many researchers have documented that synthetic fertilizers and pesticides contain trace metals as impurities or active ingredients (McLaughlin *et al.*, 2000; Pierzynski *et al.*, 2000). Crops contaminated by trace metals are one of the most important sources of trace metal contamination for humans (Florijin, 1993). Trace metal accumulation in plants depends on plant species, growth stage, type of soil and metals, soil condition, weather and environment (Chang *et al.*, 1984; Petruzzelli, 1989; Domergue and Vedy, 1992).

Plant habitats and communities along the river margins and banks are called riparian vegetation, characterized by hydrophilic plants. Riparian zones are important in ecology, environmental management, and civil engineering because of their role in soil conservation, their habitat biodiversity, and the influence they have on fauna and aquatic ecosystems, including grasslands, woodlands, wetlands, or even non-vegetative areas. Often, fertilizers, pesticides, and other waste find their way into the water bodies. Also, different types of waste consisting of everyday items from different sources are commonly disposed at the bank of a river which can lead to the buildup of residual chemicals in plants and crop planted the river bank.

This study was undertaken to identify the extent of metal contamination in vegetables planted in the riparian zones of Ogbomoso.

MATERIALS AND METHODS

Study Area

The study was carried out in Ogbomoso (Longitude 4°10'E, latitude 8°14'E, 314 m asl) Oyo state, in Nigeria. Ogbomoso is located in the derived guinea savannah zone of Southwestern Nigeria. Farming is the major occupation of the people of the area. The research was carried out in three locations (Ikose, Beulah and Arada) within riparian areas in Ogbomoso.

Sample Collection

Identified edible vegetables were collected from the selected river-banks. Vegetable samples were taken along three transects (10 m, 15 m, and 20 m) away from the river. The vegetables along the riparian was randomly selected with the use of 1m x 1m quadrat at the distances indicated. Vegetables with the quadrat was uprooted and put in separate labelled paper envelopes. The enveloped samples were then taken to the laboratory of the Department of Agronomy, Ladoké Akintola University of Technology, Ogbomoso to analyse for the concentration of Lead (Pb), Chromium (Cr), Cadmium (Cd) and Zinc (Zn).

Chemical Analysis

The dry samples of vegetables were analyzed for metal content. Atomic absorption spectrophotometry (AAS) was used to determine concentration of trace metals. The concentrations of Cd, Cr, Pb, and Zn metals were measured by an atomic absorption spectrometer (AA500F) in mg/kg (Okuku and Peter 2012).

Statistical Analysis

Data collected were analyzed using analysis of variance. Significance means were separated by least significant difference at 0.05 probability level and compared with the standard FAO/WHO (2010) standard using t-test

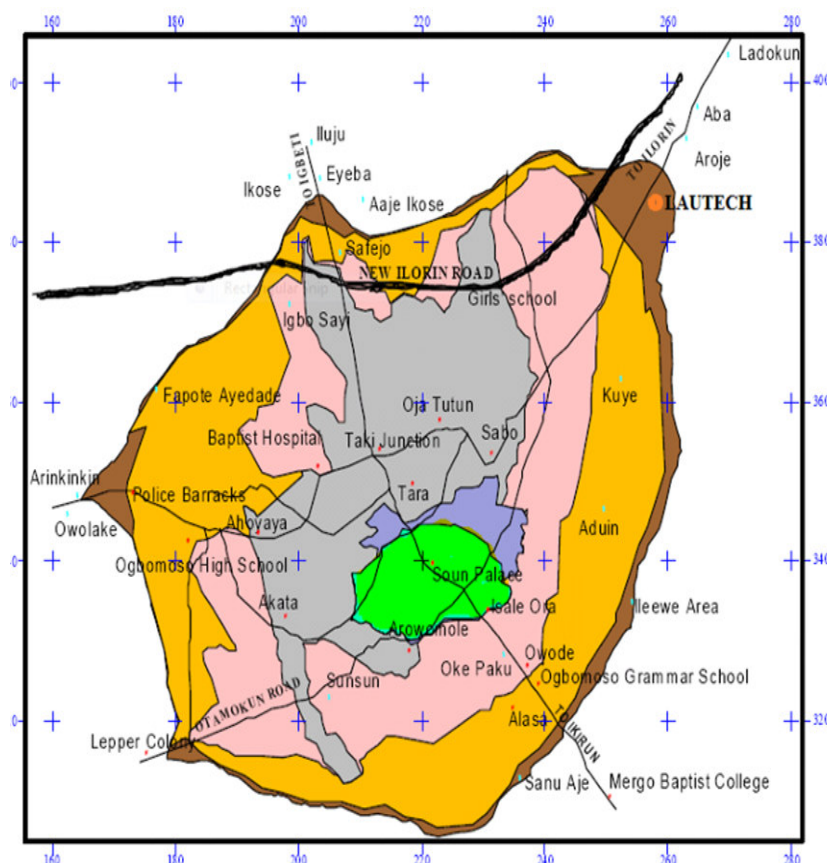


Figure 1: Map of Ogbomoso Town (Adeboyejo, 2007).

RESULTS AND DISCUSSIONS

Heavy Metal Concentration in Vegetable Samples

The results show that the concentration of heavy metal around the riparian area was not affected by the distance. Tables 1, 2 and 3 shows the heavy metal concentration in the vegetables.

Lead, Pb Concentration

Distance away from the river bank does not have significant effect on the concentration of the heavy metals in the vegetables. At distances of 10 m, 15 m, 20 m in Arada, the Pb concentration were; 0.08 mg/kg, 0.09 mg/kg and

0.08 mg/kg respectively. For Beulah, the concentration of Pb obtained was 0.18 mg/kg at the distances. Also, at Ikose the concentration of Pb was 0.12 mg/kg at the 3 distances.

Cadmium, Cd Concentration

At Arada, the Cd concentration was 0.01 mg/kg at the 3 distances, while it was 0.02 mg/kg at 10 m and 15 m but 0.03 mg/kg at 20 m in Beulah. The concentration of 0.02 mg/kg, 0.01 mg/kg and 0.02 mg/kg were found at 10 m, 15 m, 20 m respectively in Ikose.

Chromium, Cr Concentration

The soil at Arada soil does not have Cr but 0.03 mg/kg, 0.04 mg/kg and 0.06 mg/kg was recorded at distances in Beulah while 0.05 mg/kg, 0.05 mg/kg and 0.04 mg/kg at distances in Ikose.

Zinc, Zn Concentration

The concentration of Zn was higher than other metals. In Arada, Zn, 1.48 mg/kg, 1.44 mg/kg and 1.36 mg/kg were taken at distances, while in Beulah, Zn concentration of 5.89 mg/kg, 4.99 mg/kg and 5.87 mg/kg were recorded at distances. At Ikose, Zn concentration of 2.46 mg/kg, 2.88 mg/kg and 2.75 mg/kg were obtained at distances.

Table 1: Heavy metal concentration in the riparian vegetables with different distances from the river bank in Arada

Distance (m)	Metals (mg/kg)			
	Pb	Cd	Cr	Zn
FAO/WHO	0.30	0.20	2.30	99.40
10	0.08	0.01	0.00	1.48
15	0.09	0.01	0.00	1.44
20	0.08	0.01	0.00	1.36
LSD			0.00	

Table 2: Heavy metal concentration in the riparian vegetables with different distances from the river bank in Beulah

Distance (m)	Metals (mg/kg)			
	Pb	Cd	Cr	Zn
FAO/WHO	0.30	0.20	2.30	99.40
10	0.18	0.01	0.03	5.87
15	0.18	0.02	0.04	4.99
20	0.18	0.02	0.06	5.86
LSD			0.00	

Table 3: Heavy metal concentration in the riparian vegetables with different distances from the river bank in Ikose

Distance (m)	Metals (mg/kg)			
	Pb	Cd	Cr	Zn
FAO/WHO	0.30	0.20	2.30	99.40
10	0.12	0.02	0.05	2.46
15	0.12	0.02	0.04	2.88
20	0.12	0.01	0.04	2.75
LSD			0.00	

CONCLUSION AND RECOMMENDATION

The bioaccumulation of metals in plants is essential since some metals are dietary elements required by humans and animals provided they are deposited in appropriate amounts. In other words, heavy metals such as Zn, Cu, Mn and Fe are essential for the growth and wellbeing of living organisms including man. However, they can exhibit toxic effects when organisms are exposed to levels higher than normally required.

All the metals tested for this study Zn, Pb, Cr, Cd (3.24mg/kg, 0.13mg/kg, 0.03mg/kg and 0.02mg/kg) were found in the vegetable at proportions that are lower than the maximum concentration permissible by FAO/WHO, 2010 (99.40 mg/kg, 0.30 mg/kg, 2.30 mg/kg and 0.20 mg/kg).

Therefore, phytoavailability of heavy metals in the study areas is low and since, the metals found are below the maximum residue limits then, the vegetables are said to be safe for consumption for the time under study (Wangboje and Ekundayo, 2013). However, routine heavy metal analysis of vegetable cultivated along riparian zones should be carried out in order to provide data for monitor the rising risk of contamination from pollution of water bodies and bioaccumulation that may result in human health problems.

REFERENCES

Chang, A.C., Page, A.L., Foster, K.W. and Jones, T.E. 1984. A comparison of cadmium and zinc accumulation by four cultivars of barley grown in sludge-amended soils. *J. Environ. Qual.* 11(3): 526-654.

- Cox S., (2000), Mechanism and Strategies for Phytoremediation of Cadmium, Online at: <http://lamar.colostate.edu/~samcox/INTRODUCTION.html>
- Domergue, F.L. and Vedy, J.C. 1992. Mobility of heavy metals in soil profiles. *Int. Environ. Chem.* 46: 13-23.
- Florigin, P. J. 1993. Differential distribution of cadmium in lettuce (*Lactuca sativa* L.) and maize (*Zea maize* L.). *Intern.*
- FAO/WHO, 2010. Human Vitamin and Mineral Requirements. Report of a joint FAO/WHO (Food and Agricultural Organization, World Health Organization) expert consultation Bangkok, Thailand. Food and Nutrition Division, FAO Rome. (2010).
- Florigin, P. J. 1993. Differential distribution of cadmium in lettuce (*Lactuca sativa* L.) and maize (*Zea maize* L.). *Intern. Environ. Chem.* 46: 23-31.
- McLaughlin, M. J., Hamon, R. E., McLaren, R. G., Speir, T. W. and Rogers S. L. 2000. Review: A bioavailability-based rationale for controlling metal and metalloid contamination of agricultural land in Australia and New Zealand. *Aust. J. Soil Res.* 38: 1037-1086.
- Mohajer R., Salehi M. H., and J. Mohammed. (2012). Accumulation of cadmium and lead in soils and vegetables of Lenjanat Region in Isfahan Province, Iran. *International Journal of Agronomy and Plant Production.* 3(12): 576-578.
- Nicholson A, Davis A, and S. Helgen (2003). Element influencing cost allocation in water, Arizona, USA.
- Odoh R., and S. A. Kolawole. (2011). Assessment of trace heavy metal contaminations of some selected vegetables irrigated with water from River Benue within Makurdi, Benue State, Nigeria. *Advances in Applied Sciences Research.* 2(25):590-601
- Okuku, E.O., and Peter, H. K, (2011). Choose of Heavy Metals Pollution Biomonitors: A Critic of the Method that uses Sediments total Metals Concentration as the Benchmark. *Int. J. Environ. Res.* 6(1):313-322, Winter 2012.
- Oladimeji, A. A. (1983). Trace metals – A Potential Threat to our Fishing Industry. In:- Proceeding of the Third Annual Conference of the Fisheries Society of Nigeria. FISON, Maiduguri, 22nd – 25th May, pp. 202 – 205
- Petruzzelli, G. (1989). Recycling wastes in agriculture: heavy metal bioavailability. *Agric. Ecosyst. Environ.* 27: 493-503.
- Pierzynski, G.M., Sims, J. T. and Vance, F. 2000. *Soils and Environmental Quality*. 2nd Ed CRC Press. LLC 243.
- Remarathna, H. M. P. L. P., Ettiarachchi, G. M. H., & Ndraratne, S. P. I. (2011). Trace Metal Concentration in Crops and Soils Collected from Intensively Cultivated Areas of Sri Lanka, (March), 230–240.
- Smical, A., Hotea, V., Oros, V., Juhasz, J., and Pop, E. (2008). Studies on Transfer and Bioaccumulation of Heavy Metals from Soil into Lettuce. *7(5):609–615.*
- Wangboje, O. M., and Ekundayo, O. T. (2013). Assessment of heavy metals in surface water of, the Ikpoba reservoir, Benin city, Nigeria. *32(1):61–66.*