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An Investigative screening of heavy metal contamination of *Amaranthus spp* grown along Ibi river-bank,Taraba State, Nigeria

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Abstract

Agricultural activities around river bank are popular practice in most riverine areas in Nigeria. Vegetables are the commonest agricultural commodity that are grown around the river bank and are averagely the most consumed food product in Nigeria. An investigative screening of metallic contamination of *Amaranthus spp* grown in three farms around river Ibi bank showed a level of metallic deposition: Cadmium (Cd), (2.25±0.63, 3.28±0.55, 2.51±0.03) ppm; Lead (Pb), (1.83±0.51, 0.54±0.03, 1.06±0.13) ppm; Mercury (Hg), (0.53±0.01, 1.03±0.01, 0.66±0.01) ppm; Arsenic (As), (0.50±0.72, 0.51±0.06, 0.62±0.15) ppm and Chromium (Cr), (4.26±0.51, 2.66±0.22, 1.75±0.38) ppm. Descending order of the mean concentrations of the trace metals detected from analyzed sample of *Amaranthus spp* from the three locations are as follows; Farm A: Cr>Cd>As>Pb>Hg, Farm B: Cd>Cr>Hg>Pb>As, Farm C: Cd>Cr>Pb>Hg>As. *Amaranthus spp* cultivated along Ibi river bank has shown a reasonable amount of deposition of heavy metals, therefore, are not totally safe. The metallic content in *Amaranthus spp* sample collected in farms along Ibi river bank ranges; 0.50±0.72 to 4.26±0.51 in sample A, 0.51±0.06 to 3.28±0.55 in sample B and 0.62±0.15 to 2.51±0.03 in sample C. The metallic deposition detected from analyzed *Amaranthus spp* showed values that are above the World Health Organization set permissible limit (Pb-0.3ppm; Cd-0.2 ppm; As-0.5ppm; Hg-0.5ppm; Cr-0.5ppm). Bioaccumulation of these metallic substances in the human system as a result of long-term consumption of the vegetables poses a deleterious health effect. This study aimed at ascertaining the food safety of agricultural products cultivated around Ibi river bank.

Keywords: *Amaranthus spp*, Arsenic (As), Cadmium (Cd), Chromium (Cr), Ibi river, Lead (Pb), Mercury (Hg)

1. Introduction

River Ibi which is the gateway between Taraba state in north-eatern, Nigeria and neighboring states such as; Plateau, Nasarawa and the Federal capital territory of Nigeria is a hub for diverse economic activities. Human activities; use of chemicals for Fishing, engine propelling boats crossing, vehicular and animals crossing, etc poses a great threat of metallic contamination of the water and vegetation around the riverbank. Environmental contamination by metallic compounds has become a major concern due to their ability to bioaccumulate in the environment and biological systems (Onyekwere *et al*., 2021). Chemical residues have an impact on human health because they pollute the environment and contaminate food. Chemicals can travel through the various mediums; air, and water into biological systems (plants, animals, humans) (Emmanuel *et al*., 2021; Moses *et al*., 2021).

Toxicity of heavy metals refers to the negative consequences of excessive exposure or ingestion of levels that exceed the daily recommended limits. When heavy metals get absorbed by the biological system and bioaccumulate in tissues, they become poisonous (Sobha *et al*., 2007). Toxicity of heavy metals refers to the negative consequences of excessive exposure or ingestion of levels that exceed the permissible daily intake. Each metal has different ways of expressing toxicity. Symptoms like gastrointestinal disorders, diarrhoea, stomatitis, tremor, hemoglobinuria, ataxia, paralysis, and vomiting are attributed to poisoning by the likes of cadmium, lead, arsenic, mercury, zinc, copper, and aluminum (Jaishankar *et a*l., 2014).

Amaranthus spp, is a vegetable which is an example of a herbaceous plant or piece of a plant that is eaten whole or in part, raw or cooked (Zahid *et al*., 2016), usually with an entree or as a salad but not as a dessert. Farming of *Amaranthus spp* by the river bank is common in Nigeria, most especially on river Ibi. The agrochemicals and engine exhaust polluted water serve as the major source of water to the Agricultural crops around the riverbank. Hence, there is a higher likelihood of the crops being contaminated by heavy metals. Therefore, this research aimed at carrying out thorough investigation of the degree of heavy metal contamination in *Amaranthus spp* grown along Ibi riverbank.

2. Research methodology

2.1. Sample collection

Fresh samples of Amaranthus spp was collected from three different farms at Ibi river-bank. The Amaranthus spp specimens were then packed into well-sealed polythenes with proper identification to avoid mix up of the samples. It was then transported to Biochemistry Laboratory section of Bwacha Central Laboratory, Federal University Wukari, Taraba State, Nigeria to analyzed for As, Cd, Pb, Hg, and Cr.

2.2. Sample preparation for analysis

The collected samples were washed clean. The dried washed clean samples were crushed in a porcelain mortar with a pestle to smaller fragments for analyzing heavy metals content. Heavy Metal Analysis.

2.3. Determination of heavy metals

The analysis of As, Cd, Pb, Hg, and Cr was carried out by milling each sample, and then dried at 105OC. One gram of the sample was placed into 300ml beaker and boiled at 230oC with 15ml of nitric acid (HNO3, 69%) and 25ml of perchloric acid (HClO4, 58%), it was allowed to digest. Then the digested solution was filtered into a volumetric flask and the volume was increased up to 50ml. Then the metal concentrations was determined by UNICAM 939 Atomic absorption spectrophotometer AAS (Mehmet, 2008; Litlejohn *et al*., 2006).

3. Data analysis

The data was analyzed statistically by employing the aid of Statistical Package for Social Sciences (SPSS) statistical software (version 23). One way anova was used to analyzed the data. The Means and standard deviations were calculated.

4. Results and discussions

Table 1: Result of heavy metal content of *Amaranthus spp* from farm A at Ibi river bank, Taraba State, Nigeria

Parameter	Concentration (ppm)
As	0.50±0.72
Cd	2.25±0.63
Pb	1.83±0.51
Hg	0.53±0.01
Cr	4.26±0.51

Results are expressed in mean±standard deviation of triplicate determination

Table 1 result showed the metallic contamination in *Amaranthus spp* samples in the order Cr>Cd>As>Pb>Hg with Cr, Cd and Pb significantly high in values more than 1.0 while As and Hg slightly lower than 1.0.

Table 2: Result of heavy metal content of *Amaranthus spp* from farm B at Ibi river bank, Taraba State, Nigeria

Parameter	Concentration (ppm)
As	0.51±0.06
Cd	3.28±0.55
Pb	0.54±0.03
Hg	1.03±0.01
Cr	2.66±0.22

Results are expressed in mean±standard deviation of triplicate determination

Table 2 result showed metallic contamination in *Amaranthus spp* samples in the order Cd>Cr>Hg>Pb>As with Cd, Cr and Hg significantly high in values more than 1.0 while As and Pb slightly lower than 1.0.

Table 3: Result of heavy metal content of *Amaranthus spp* from farm C at Ibi river bank, Taraba State, Nigeria

Parameter	Concentration (ppm)
As	0.62±0.15
Cd	2.51±0.03
Pb	1.06±0.13
Hg	0.66±0.01
Cr	1.75±0.38

Results are expressed in mean±standard deviation of triplicate determination

Table 3 result showed metallic contamination in *Amaranthus spp* samples in the order Cd>Cr>Pb>Hg>As with Cd, Cr and Pb significantly high in values more than 1.0 while As and Hg slightly lower than 1.0.

Table 4: Result of heavy metals content of *Amaranthus spp* samples collected from farms located at Ibi river bank.

Sample	As (ppm)	Cd (ppm)	Pb (ppm)	Hg (ppm)	Cr (ppm)
A	0.50 ± 0.72^{a}	2.25 ± 0.63^{a}	1.83 ± 0.51^{a}	0.53 ± 0.01^{a}	4.26 ± 0.51^{a}
B	0.51 ± 0.06^{b}	3.28 ± 0.55^{a}	0.54 ± 0.03^{a}	1.03 ± 0.01^{ab}	2.66 ± 0.22^{a}
C	0.62 ± 0.15^{b}	2.51 ± 0.03^{b}	1.06 ± 0.13^{b}	0.66 ± 0.01^{b}	1.75 ± 0.38^{a}

*Values are expressed in mean ± standard deviation. The different superscripts in each column are significantly different at $p < 0.05$.

Previous researches have reported the contamination of agricultural products by heavy metals, Orisakwe *et al*. (2012) reported lead contamination of rice, also Otitoju *et al*., (2014) reported high metallic (lead and mercury) contamination in samples of pumpkin leaves collected from a construction site in Uyo, Nigeria. Amaranthus spp were collected from three selected farms along Ibi river bank. The metallic content in Amaranthus spp sample collected in farms along Ibi river bank ranges; 0.50±0.72 to 4.26±0.51 in sample A, 0.51±0.06 to 3.28±0.55 in sample B and 0.62±0.15 to 2.51±0.03 in sample C. The amount of Arsenic (As) content is higher in Sample C (0.62±0.15ppm), sample B contains 0.51±0.06ppm Arsenic and sample A (0.50±0.72ppm) having the least amount. There was no significant difference between sample B and C but there is a notable significance difference between sample A with sample B and C. Cadmium is relatively deposited more in sample B (3.28±0.55ppm), with sample C (2.51±0.03ppm) and sample A (2.25±0.63ppm). Sample A and B have no significance difference between them but show a wide range of significance of difference with sample C. Lead (Pb) is deposited more in sample A (1.83±0.51ppm) and sample B Pb content is 0.54±0.03 which are both significantly different from sample C (0.54±0.03ppm). Although the values of heavy metals deposition on the Amaranthus spp are below permissible levels but can bioaccumulate (Amos-Tautua *et al*., 2013).

Sample B which contains 1.03±0.01ppm of Mercury (Hg) is higher compared to sample (0.66±0.01ppm of Hg) and sample A (0.53±0.01ppm) with the least amount of mercury deposition, the result is in conformation with research carried out by Otitoju *et al*. (2014) on rice cultivated by the roadside. There was no significant difference of mercury deposition in sample A and B, and also between sample B and C. Sample A and C show much significant difference. Chromium deposition is higher in sample A (4.26±0.51ppm), with sample B having deposition of Chromium to be 2.66±0.22ppm, while sample C is having the least amount of Chromium deposition which is 1.75±0.38ppm. There was no significant difference in the amount of Chromium deposition among sample A, B and C.

Metallic deposition of sample A is in the descending order Cr>Cd>As>Pb>Hg, this result correlate with the research findings by Amos-Tautua *et al*., 2013. There was no significant difference in the quantity of heavy metals deposition in sample A. Cadium (Cd) is most deposited in sample B compare to other heavy metals. The order of metallic content in Sample B is Cd>Cr>Hg>Pb>As. There was no significant difference in the amount of Cd, Pb, Hg and Cr deposition in sample B, but are significantly different to the amount of As deposition. Also, deposition of As and Hg in sample B shows no significant difference. Sample C metallic deposition follows the order; Cd>Cr>Pb>Hg>As. Cr showed a significant difference with other heavy metals; Pb, As, Hg and Cd. No significant difference in the quantity of Pb, As, Hg, and Cd deposition in sample C.

5. Conclusion

Toxicity capability and possible bioaccumulation of heavy metals makes them deleterious to both human and environmental health. The human activities in water ways; vehicular, petrol engine boat, fishing using chemicals, laundry and other domestic activities has left the water highly polluted by chemical substances. Consequently, the polluted water runs over the land surface around the riverbank. Agricultural practices around river bank result to uptake of such injurious substances by crops. This study has proven that raising crops around river-bank with high economical activities is prone to heavy metal contaminants.

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