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Full Length Research Paper

Level of heavy metals in some edible plants collected from selected dumpsites in Ekiti State, Nigeria

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The study considered level of heavy metals in various sections of vegetables harvested from Atikankan, Aba–Egbira and Moshood road dumpsites in Ekiti State, Nigeria with a view to monitoring the pollutional status of these dumpsites. *Amaranthus cruentus* and *Talinum fruticosum* were the two vegetables used. Heavy metal concentrations varied among different plants. The concentration of heavy metals analyzed was found to range from Cd (Nd to 0.90µg/g), Pb (0.10 to 0.40µg/g), Mn (0.10 to 1.00µg/g), Zn (0.70 to 3.60µg/g), Fe (0.20 to 2.00µg/g), Cr (0.20 to 1.30µg/g), Cu (0 .20 to 2.50µg/g), Ni (0.20 to 2.10µg/g) and Co (0.20 to 1.40µg/g) respectively in all the dumpsites. Cd was not detected in the root of *Amaranthus creuntus* and leaf of *Talinum fruticosum* (Moshood road dumpsite). The extent of metal contamination in plants samples was greater in Atikankan than other dumpsites. However, concentration of Cd exceeds the *WHO/FAO* limits for human consumption in *Talinum fruticosum.*

Keyword: dumpsites, edible plants, heavy metals, selected

INTRODUCTION

In Nigeria, indiscriminate dumping of waste have become a common practice, most of the wastes dumps are located close to residential areas, markets, farms and road sides. The composition of waste dumps varies widely with many human activities located close to dumpsites (Olorunfemi and Odita, 1998). The general belief that wastes are sometimes hazardous to health cannot be over emphasized. The environmental problem posed by solid wastes ranges from health hazard, soil and water pollution, repulsive sight and offensive odour. These are worst experienced where waste are not properly disposed off or managed. Health risk due to heavy metal contamination of soil has been widely reported (Eriyamremu *et al*., 2005; Muchuweti *et al.,* 2006; Satarug *et al.,* 2000). Crops and vegetables grown in soils contaminated with heavy metals have greater accumulation of heavy metals than those grown in uncontaminated soil (Sharma *et al.,* 2006, 2007; Marshall *et al.,* 2007).

Amaranth species are cultivated and consumed as a leaf vegetable in many part of the world. In Nigeria, it is a common vegetable and goes with all Nigeria carbohydrate dishes. These species have extended period of germination, rapid growth, and high rate of seed production (Bensch et al., 2003). Also, this plant can survive in tough conditions. There are four species of *Amaranth* documented as cultivated vegetable in eastern Asia, *Amaranthus cruentus, Amaranthus blitum, Amaranthus dubius*, and *Amaranthus tricolor* (Costae, 2003). *Talinum fruticosum* (also known as *Talinum triangulare*) is commonly found as weed throughout Africa. It is not considered to be a serious weed because of its shallow rooting system. It is most frequently

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cultivated species in Africa.

Plants do not readily absorb large amount of heavy metals, and the amount they do absorb depends on the species and variety of plant, the chemical composition of the soil, the amount of heavy metal and the soil temperature. Intake of vegetables is an important path of heavy metal toxicity to human being. Dietary intake of heavy metals through contaminated vegetables may lead to various chronic diseases. Duruibe *et al.,* (2007) suggested that biotoxic effect of heavy metals depend upon the concentration and oxidation states of heavy metals, kind of sources and mode of deposition. Severe of Cadmium may result in pulmonary effects such as *emphysema*, *bronchiolitis* and *alveolitis.* Renal effect may also result due to subchronic inhalation of Cd (European Union, 2002). Lead toxicity causes reduction in haemoglobin synthesis, disturbance in functioning of kidney, joints, reproductive and cardiovascular systems and chronic damage to the central and peripheral nervous systems (Ogwuegbu and Muhanga, 2005).

The study was conducted to assess the levels of heavy metals in various sections of vegetables collected from different dumpsites with a view to monitor the pollutional status of these dumpsites. This will generate baseline data for environmental awareness.

MATERIAL AND METHODS

Site description

The study sites were located at Ado and Ikere- Ekiti local government areas of Ekiti state, Nigeria. Samples of plant were collected from Atikankan, Aba-Egbira (Ado-Ekiti) and Moshood road (Ikere-Ekiti) dumpsites. The climate of both communities are generally mild, maximum, temperature occurring in July to September generally range from 143.7mm to 257.8mm while the average rainfall is 103.73mm and average temperature 21^0 C. The levels of waste in these dumpsites have increased over time since the creation of the state in 1996.

Sampling

Plants samples were collected from the dumpsites in April, 201l. Fresh plants material was separated from the soil, washed and cleaned with distil water in order to remove adhering soil particles and dust. The choice of plant species collected was based on the availability of the plant at the point of collection. Five plants samples were randomly collected from the three dumpsites. Control plant samples were also collected from different environment. Samples identification was done at plant science herbarium, Ekiti State University, Ado – Ekiti.

Sample analysis

The plants were separated into various parts namely leaves, stems and root after which they were air dried before oven dried at 70ºc to constant weight. The dried tissues were ground with porcelain mortal and pestle into powders, sieved to 2mm size and transferred to polythene bags for further analysis. The plant samples were ashed. 2g of the ashed samples of plant was digested in 15ml of HNO_3 at 80ºc until a transparent solution was obtained. The solution was then filtered through whatman number 42 filter paper into 100ml volumetric flask and made to mark with distilled water. The concentration of Pb, Cd, Mn, Zn, Fe ,Cr ,Ni, Cu and Co in the filtrate were determined using atomic absorption spectrophotometer (Perkin Elmer Model 306)

Data Analysis

The data collected were replicates of three determinations and were analysed statistically by calculating the mean, standard deviation, coefficient of variation and t- test.

Transfer factor was calculated to determine heavy metals accumulation in edible part of *Talinum fructicosum* and *Amaranthus cruentus* according to Zu *et al.* (2004)

$$TF = \frac{\text{Concentration of metal in shoot}}{\text{Concentration of metal in root}}$$

RESULTS AND DISCUSSION

Tables 1a and 1b presents the concentration of heavy metals (µg/g) in *Amaranthus cruentus* and *Talinum fructicosum* in Aba-Egbira. The mean concentrations (µg/g) in *Amaranthus cruentus* of Pb (0.27), Cd (1.67), Mn (0.23) , Zn (3.17), Fe (1.60), Cr (1.17) , Cu (1.87) ,Ni (1.73) ,Co (0.93) while *Talinum fructicosum* Pb (0.23), Cd (0.70), Mn (0.20) , Zn (2.03), Fe (0.93), Cr (0.90) , Cu (0.73) ,Ni (0.97.) ,Co (0.83). In all of the samples, Zinc has the highest mean concentration, similar result was reported by Amusan *et al*. (2005), while studying the characteristic of heavy metals intake by crops cultivated on dumpsites. All the heavy metals showed TF > 1 in *Amaranthus cruentus* and *Talinum fructicosum* from Aba – Egbira except Cu and Ni. TF value of Cd was the highest in Aba -Egbira when compared with other metals (Table 1a and 1b). The values obtained for roots, stems and leaves were closely spread with the values of CV% ranged from 0- 46.4.

Most of the results showed TF > 1 for different metals. It is easy for plants species with TF > 1 to translocate metals from roots to shoots than those which restrict metals in their root. Variations in transfer factor among different vegetables may be attributed to differences in

Table 1a. Concentration of heavy metals (µg/g) in *Amaranthus cruentus* collected from Aba-Egbira dumpsite

Heavy metals	Root	Stem	Leaves	T.F	Mean	S.D	CV%
Cd	0.10	0.20	0.20	4.00	1.67	0.05	2.99
Pb	0.30	0.20	0.20	1.67	0.27	0.05	18.5
Mn	0.30	0.20	0.20	1.33	0.23	0.05	21.7
Zn	3.60	3.00	2.90	1.64	3.17	0.30	9.46
Fe	2.00	0.90	1.90	1.40	1.60	0.50	31.3
Cr	1.30	0.90	1.90	2.15	1.17	0.13	11.1
Cu	2.50	1.10	1.20	0.92	1.87	0.58	31.0
Ni	2.00	1.30	1.90	1.60	1.73	0.31	17.9
Co	1.00	0.40	1.40	1.80	0.93	0.41	44.1

Table 1b. Concentration of heavy metals (µg/g) in *Talinum fructicosum* collected from Aba- Egbira dumpsite

Heavy metals	Root	Stem	Leaves	T.F	Mean	S.D	CV%
Cd	0.40	0.80	0.90	4.25	0.70	0.22	31.4
Pb	0.20	0.20	0.30	2.50	0.23	0.55	21.7
Mn	0.20	0.20	0.20	2.00	0.20	0.00	0
Zn	2.40	1.80	1.90	1.54	2.03	0.26	12.8
Fe	1.00	0.80	1.00	1.80	0.93	0.09	9.68
Cr	1.00	0.90	0.80	1.70	0.90	0.08	8.89
Cu	0.30	1.00	0.90	6.33	0.73	0.31	42.5
Ni	1.50	1.00	0.40	0.93	0.97	0.45	46.4
Co	0.70	0.90	0.90	2.57	0.83	0.09	10.8

Table 2. Concentration of heavy metals (µg/g) in *Amaranthus cruentus* collected from Atikankan dumpsite

Heavy metals	Root	Stem	Leaves	T.F	Mean	S.D	CV%
Cd	ND	0.10	0.20	0.00	0.10	0.08	80
Pb	1.00	0.20	0.10	0.30	0.43	0.40	93.0
Mn	1.00	0.30	0.10	0.40	0.47	0.39	82.97
Zn	3.00	3.30	2.70	2.00	3.00	0.25	8.33
Fe	1.30	1.80	1.10	2.23	1.40	0.29	20.7
Cr	0.90	1.00	0.90	2.11	0.93	0.05	5.38
Cu	1.00	2.10	1.70	3.80	1.60	0.46	28.8
Ni	1.10	2.10	0.80	2.64	1.33	0.60	45.1
Co	0.80	1.00	0.80	2.25	0.87	0.09	10.3

the concentration of metals in soil and differences in element uptake by different vegetables (Cui *et al*., 2004).

The concentration (µg/g) of heavy metals in *Talinum fructicosum* from Atikankan dumpsite is shown Table 2. The concentration of heavy metals examined ranged from ND- 3.30 µg/g, reaching minimum and maximum values in Cd and Zn respectively. Cd was not detected in the root of *Talinum fructicosum.* The mean concentration of Zn in shoots was significantly higher in *Talinum fructicosum* compared with other heavy metals (Table 2).Cu showed the highest translocation factor of 3.80. This high metal accumulation may be attributed to well develop detoxification mechanism based on sequestration of heavy metals ions in vacuoles, by binding them on appropriate ligands such as organic acids, proteins and peptides in the presence of enzymes

Table 3a. Concentration of heavy metals (µg/g) in *Amaranthus cruentus* collected from Moshood road dumpsite

Heavy metals	Root	Stem	Leaves	T.F	Mean	S.D	CV%
Cd	0.20	0.20	0.10	1.58	0.88	0.79	89.8
Pb	0.40	0.10	0.10	0.50	0.20	0.41	205
Mn	0.10	0.10	0.20	3.00	0.13	0.05	38.5
Zn	1.80	1.90	2.90	2.67	2.20	0.50	22.7
Fe	1.00	0.90	1.80	2.70	1.23	0.40	32.5
Cr	0.90	0.40	1.00	1.56	0.77	0.26	33.8
Cu	0.90	0.40	1.90	2.56	1.07	0.62	57.9
Ni	0.50	0.70	1.60	4.60	0.93	0.48	51.6
Co	0.50	0.10	0.90	2.00	0.50	0.33	66.0

Table 3b. Concentration of heavy metals (µg/g) in *Talinum fructicosum* collected from Moshood road dumpsite

Heavy metals	Root	Stem	Leaves	T.F	Mean	S.D	CV%
Cd	0.20	0.40	ND	2.00	0.20	0.16	80.0
Pb	0.10	0.10	0.10	2.00	0.10	0.00	0.00
Mn	0.10	0.10	0.10	2.00	0.10	0.00	0.00
Zn	0.70	1.20	1.80	4.29	1.23	0.45	36.6
Fe	0.20	0.50	1.50	10.0	0.73	0.56	7.67
Cr	1.00	0.20	1.00	1.20	0.73	0.38	52.1
Cu	1.00	0.20	0.30	0.50	0.50	0.36	72.0
Ni	1.00	0.20	1.50	1.70	0.90	0.54	60
Co	1.00	0.20	0.70	0.90	0.63	0.33	52.4

that can function at high level of metals (Cui *et al.,* 2007) and metal exclusion strategies of plant species (Ghosh and Singh, 2005).

Tables 3a and 3b presents the mean concentration of heavy metals in *Amaranthus cruentus* and *Talinum fructicosum* in Moshood road. The mean concentrations (µg/g) in *Amaranthus cruentus* of Pb (0.20), Cd (0.88), Mn (0.13) , Zn (2.20), Fe (1.23), Cr (0.77) , Cu (1.07) ,Ni (0.93) ,Co (0.50) while *Talinum fructicosum* Pb (0.10), Cd (0.20), Mn (0.10) , Zn (1.23), Fe (0.73), Cr (0.73) , Cu (0.50) ,Ni (0.90) ,Co (0.63). Ni and Zn had TF values greater than one in *Talinum fructicusom* and *Amaranthus cruentus* at Moshood road dumpsite, which showed that were translocated from roots to shoots. TF greater than 1 indicate a very efficient ability to transport metals from roots to shoots, most likely due to efficient metal transporter systems (Zhao *et al*., 2002) and probably sequestration of metals in leaf vacuoles apoplast (Lasta *et al*., 2000).

The values obtained for roots, stems and leaves were averagely wide spread with value of CV% ranged from 0.00- 205 in Moshood road, although the variation recorded for Pb was exceptionally high in *Amaranthus cruentus* which could be due to low transfer factor.

In general, the results showed variations in metals accumulation. Accumulation of selected metals varied greatly among plants species and uptake of element by a plant is primarily dependent on plants species, its inherent controls, and the soil quality (Chunilall *et al*., 2005).

Lastly, it was found that the levels of Cd were higher in *Amaranthus Cruentus* and *Talinum fructicosum* in Aba-Egbira dumpsites when compared to the safe limits set by (WHO/FAO, 2007).The levels of heavy metals contamination in plants were compared with each site and control area using t-test. The statistical results showed that there were significant difference ($P<0.05$) between mean metal concentration in the studied area compared with control sample, this further attested to the fact that these heavy metals were from anthropogenic sources.

CONCLUSION

The study revealed the potential use of *Amaranthus cruentus* and *Talinum fructicosum* as candidate plants for environmetals monitoring. The results showed that these plants were highly contaminated with heavy metals. In Atikankan and Aba – Egbira Co were actively transported to the leaves of *Amaranthus cruentus* where they were accumulated. Results also showed that *Amaranthus cruentus* and *Talinum fructicosum* have an unusual ability not only to accumulate heavy metals in its roots but also translocate it to the edible parts. Consumption of these vegetables with elevated levels of heavy metals may cause related health disorders. Thus regular monitoring of heavy metal concentration in the environment, most importantly dumpsites is necessary.

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