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Level of Heavy Metals Uptake on Vegetables Planted on Poultry Droppings Dumpsite

E. O. Adefila, C.T. Onwordi and I. A. Ogunwande [*]

Department of Chemistry, Lagos State University, P.M.B. 0001, LASU Post Office, Ojo, Lagos, Nigeria

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Abstract

Levels of cadmium, zinc, lead and chromium were determined in the roots, stems and leaves of *Amaranthus vridis and Talinum triangulare* planted on poultry dumpsite located in Ojo Local Government Area, Lagos, Nigeria. The vegetables were harvested from various distances (10m, 80m & 140m) from the dumpsites. The metal contents in the various plant parts were determined by means of Atomic Absorption Spectrophotometer. The results indicated a reduction in heavy metals uptakes in samples collected from distance nearest (10m) to the point of the poultry dropping dumpsite compared with samples collected from far distance (140m). Metals tested seemed to be least accumulated at the edible parts of both plants (0.22-98.20mg/kg).The highest mean concentrations (1.17± 0.1-86.48± 20.7) of all the metals investigated were found in samples collected from locations (140m) further away from the point source. Zn was consistently high (50.67-102.98mg/kg) in all the samples followed by Pb (2.27-7.21mg/kg),Cr (0.64-4.45mg/kg) and Cd (0.62-2.74mg/kg). Statistical comparison test at 95% confidence interval indicated significant difference between the levels of metals contents in most samples collected at the point nearest to the dumpsite to that far away from the dumpsite.

Keywords: Vegetables, *Amaranthus viridis* , *Talinum triangulare*, heavy metals, Poultry droppings.

Introduction

Heavy metals, such as cadmium, copper, lead, chromium and mercury, are important environmental pollutants, particularly in areas with high anthropogenic pressure. Their presence in the atmosphere, soil and water, even in traces, can cause serious problems to all organisms. Heavy metal accumulation in soils is of concern in agricultural production due to the adverse effects on food quality, crop growth [1-3]and environmental health. The mobilization of heavy metals into the biosphere by human activity has become an important process in the geochemical cycling of these metals. This is acutely evident in urban areas where various stationary and mobile sources release large quantities of heavy metals into the atmosphere and soil, exceeding the natural emission rates[4-5]. Heavy metal bioaccumulation in the food chain can be especially highly dangerous to human health. These metals enter the human body mainly through two routes namely: inhalation and ingestion, and with ingestion being the main route of exposure to these elements in human population. Heavy metals intake by human populations through the food chain has been reported in many countries with this problem receiving increasing attention from the public as well as governmental agencies, particularly in developing countries like Nigeria

Vegetables constitute essential diet components by contributing protein, vitamins, iron, calcium and other nutrients, which are usually in short supply[6] . They also act as buffering agents for acidic substances produced during the digestion process. However, they contain both essential and toxic elements over a wide range of concentrations. Metal accumulation in vegetables may pose a direct threat to human health[7][8]. Chinese cabbage (*Brassica chinensis* L. cv. Zao-Shu 5), winter greens (*B. rosularis* var. Tsen et Lee cv. Shang-Hai-Qing), pakchoi (*Brassica chinensis* L.) and celery (*Apiumg graveolens* L. var. dulce DC) are some crops, which were assessed for heavy metal toxicity. Vegetables take up metals by absorbing them from contaminated soils, as well as from deposits on different parts of the vegetables exposed to the air from polluted environments[9] .It has been reported that nearly half of the mean ingestion of lead, cadmium and mercury through food is due to plant origin (fruit, vegetables and cereals). Moreover, some population groups seem to be more exposed, especially vegetarians, since they absorb more frequently 'tolerable daily doses'.

Heavy metals may enter the human body through inhalation of dust, direct ingestion of soil, and consumption of food plants grown in metal-contaminated soil[10],[11],[12]. However, predicting exposure to potentially toxic metals from consumption of food crops is more complicated because uptake of metals by plants depends on soil properties and plant physiologic factors.
Lead is a toxic element that can be harmful to plants, although plants usually show ability to accumulate large amounts of lead without visible changes in their appearance or yield. In many plants, Pb accumulation can exceed several hundred times the threshold of maximum level permissible for human[13]. The introduction of Pb into the food chain may affect human health, and thus, studies concerning Pb accumulation in vegetables have increasing importance[14]. Although a maximum Pb limit for human health has been established for edible parts of crops (0.2 mg/kg)[15] (Chinese Department of Preventive Medicine, 1994), soil Pb thresholds for producing safe vegetables are not available.

The Knowledge of Zn toxicity in humans is minimal and the most important information reported is its interference with Cu metabolism[16],[17]. The symptoms that an acute oral Zn dose may provoke include: tachycardia, vascular shock, dyspeptic nausea, vomiting, diarrhea, pancreatictis and damage of hepatic parenchyma[18]. Although maximum Zn tolerance for human health has been established for edible parts of crops (20 mg/kg) [19](Chinese Department of Preventive Medicine, 1995), soil Zn threshold for producing safe vegetables is not available.
Food contamination by heavy metals depends both on their mobility in the soil and their bioavailability. Though some of the mobility and bioavailability factors are easy to measure,

determination of the food risk contamination is tricky. The aim of the present paper is to review concisely the leacheate effects of poultry droppings and bioaccumulation of heavy metals in vegetables for potential dietary toxicity.

Materials and Methods

Sample collection and treatment

The *Amaranthus viridis (Green Vegetable) and Talinum triangulare (Water leaf)* were obtained from two different cultivated farmlands located near poultry dumpsites in Ojo L.G.A., Lagos State, Nigeria. The vegetables were randomly collected from each site at various distances (10m, 80m, and 140m) away from point source of the poultry droppings dumpsites. The samples were collected between the month of March and June, 2007, into separate Cleaned polythene bag and labeled accordingly with respect to site and distance. The collected samples were thoroughly mixed, separated into different pats of Roots, Stem and leave , washed with deioned water and allowed to dry in moisture extraction oven at 105^oC. The oven dried sample was ground into fine powder using pestle and mortar, and sieved through a 2.0 mm mesh sieve to obtain a dried powdered sample that was used for all the analyses.

Metals analysis

The metals cadmium, zinc, lead and chromium were determined according to the method of [20]with some modifications. 2.0 g of each of the processed samples was weighed and subjected to dry ashing in a well-cleaned porcelain crucible at 550^0C in a muffle furnace. The resultant ash was dissolved in 5.0 mL of aqua regia HNO_3/HCL (1:3) and heated gently on a hot plate until the brown fumes disappeared. To the remaining material in each crucible, 5.0 mL of de-ionized water was added and heated until a colourless solution was obtained. The sample solution in each crucible was transferred into a standard volumetric flask by filtration through Whatman No.42 filter paper and the volume was made to the mark with de-ionized water. A blank determination was also carried out. This solution was used for metal analysis in an air-acetylene flame (Perkin-Elmer model A-200, atomic absorption spectrophotometer)

Appropriate quality assurance procedures and precautions were carried out to ensure reliability of the results.

Results and Discussion

The results of this study could be found in Figs. 1, 2 and 3. A broad overview of the results of heavy metals concentration in the different plants revealed that the concentrations in different parts of the vegetables show large variations from distance to distance even within the same spot in the field. This is probably due to variable deposition processes, leaching rates and surface runoff[21]. . A cursory look at the distribution of heavy metals in the different plant parts as shown in figs 1 &2 for *A. viridis and T. triangulare* respectively showed that in most cases the highest concentration of the heavy metals accumulated is evident at the root part for all distances studied. This is similar to report of[22-23]. This is probably due to the slow rate of the metals from the roots to the shoot as a result of soil-plants root-microbes interaction such that the heavy metals accumulated at the root part get concentrated with time. The toxic metals tested seemed to be least accumulated at the edible parts of *A. viridis and T. triangulare* plants at all distance studied; from the distance nearest (10m) to the point source of leacheates (0.56-41.99 and 0.38-47.39mg/kg), followed by the 80m (0.97-98.20 and 0.22-47.85 mg/kg) and then the 140m distance (1.56- 50.47 and 1.12-62.34mg/kg) respectively.

Fig 3 revealed that in most cases *A. viridis and T. triangulare* collected from locations nearest (10m) to the point sources of poultry droppings leacheate featured lowest mean concentrations (1.11-57.62 and 0.62-50.67mg/kg) of metals investigated, followed by those collected from 80m (1.56-67.20 and 1.21-102.98 mg/kg), and then samples from 140m away from poultry droppings (1.78-52.68 and 1.17-86.48 mg/kg) respectively. Generally, Zn was consistently high in all the samples (50.67-102.98 mg/kg), followed by Pb (2.27-7.21mg/kg), Cr (0.64-4.54 mg/kg) and then Cd (0.62-2.74mg/kg).This results are in agreement with the studied of [24][25] which is as a result of effect of leacheate of heavy metals in the soil.

It is evidences from the study that Cd and Zn is accumulated more in *T. triangulare* were similar to result earlier obtained by[24] while Pb and Cr accumulated more in *A. viridis* similar to work the reported by[22][23][26] , that the uptake of heavy metals by vegetable depends on the plant species and varieties.

The heavy metals analysed mainly Pb and Zn exceeded the maximum limit of 0.2mg/kg and 20mg/kg as reported by (Chinese Department of Preventive Medicine, 1994&1995 [15][19] respectively. Cd level in the vegetables analysed is below the WHO[27] standard for Cadmium level in food, WHO has established in provisional tolerable weekly intake (PTWI) for cadmium at 7 µg/kg of body weight. This PTWI weekly value corresponds to a daily tolerable intake level of 70 µg of cadmium for the average 70-kg man and 60 µg of cadmium per day for the average 60-kg woman. Estimates from various countries showed that the dietary intake for Pb in adults is between 54mg per day[28] and 412mg per day[29] and that for Cd is between 10 and 30mg per day[30].For Zn, the estimated daily intake is from 1 to 3mg[31].

There are generally, statistically significant difference (95% confidence level) of Cd, Pb and Cr in *A.viridis* between 10m and 140m as shown in Table 1 while Cd, Zn and Pb show a significant difference in *T.triangulare* between 10m and140m.This suggests that the further the samples collected from the point source of poultry droppings dumpsites, the more the chances of uptake of the analyzed heavy metals in the analyzed vegetables .As shown in the table, there is no statistical difference between 10m and 80m for both vegetables analyzed. However *A.Viridis* and *T. triangulare* shows no statistical difference between 10m and 140m for Zn and Cr respectively.

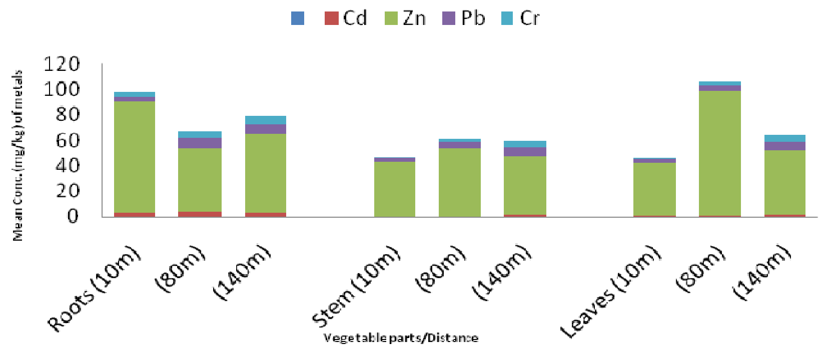

Fig. 1 Mean Conc.(mg/kg) of metals in different parts of Amaranthus viridis

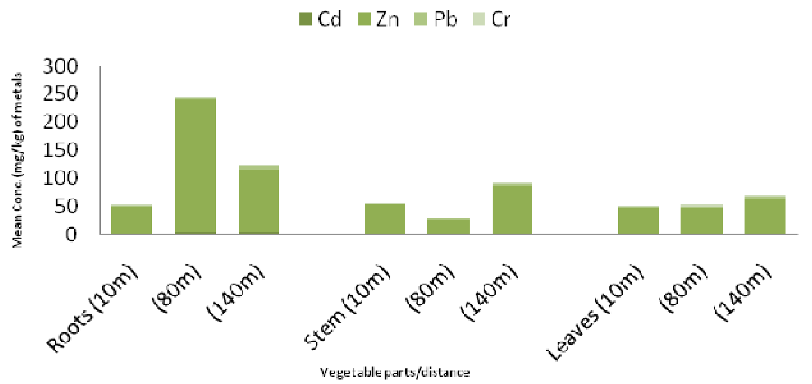

Fig. 2 Mean Conc.(mg/kg) of metals in different parts of Talinum triangulare

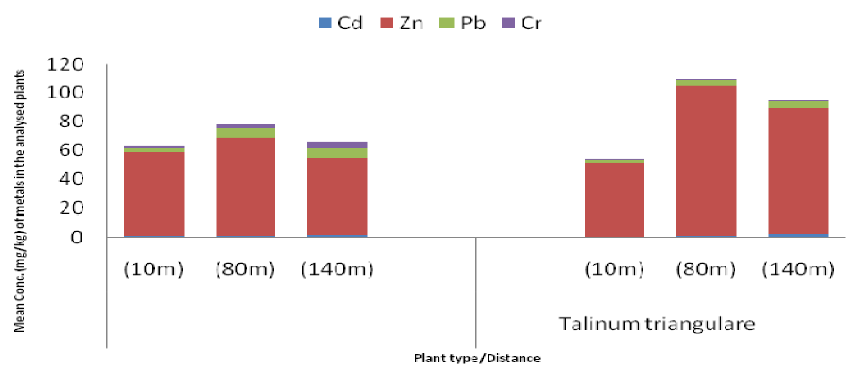

Fig.3 Mean Conc.(mg/kg) of metals in the analysed plants

Table 1: t Test (95% confidence level) of mean of metal contents

Sources of Variation	Cd	Zn	Pb	Cr
Amaranthus viridis 10m-80m	1.58(2.78)	0.02(2.78)	1.94(2.78)	0.84(2.78)
Amaranthus viridis 10m-140m	3.09(2.78)	0.07(2.78)	8.36(2.78)	3.55(2.78)
Talinum triangulare 10m-80m	0.87(2.78)	0.79(2.78)	1.54(2.78)	0.60(2.78)
Talinum triangulare 10m-140m	4.33(2.78)	2.94(2.78)	4.40(2.78)	1.18(2.78)

Figures in parentheses are the t tabulated values.

Conclusion

The metal contents mainly Zn and Pb exceeded the standard stated while the rest metals analyzed (Cr and Cd) are still within the limit. It is worthy to note that the metals analyzed are least in the edible parts of the analyzed vegetable. More so is evident that metals are more accumulated from vegetables planted a far distance from the poultry dropping site. The effect is as a result of interaction of soil-plant roots-microbes due to organic amendment play important role in regulating the metal movement from soil to plant.

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