Studies of the Concentration Levels of Heavy Metals in Vegetable (*Amaranthus caudatus*) Grown in Dumpsites within Lagos Metropolis, Nigeria.

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ABSTRACT

Samples of *Amaranthus caudatus* grown on some dump sites at different locations in the Lagos metropolis were analyzed for their heavy metal concentrations using atomic absorption spectrophotometer (AAS). The results obtained revealed that the metals are present in the following order of concentration Fe> Cu> Pb> Zn> Mn> Cd. The average values of the heavy metals obtained for vegetable samples at control sites are about 35% less than those at the dumpsite. The pH values of the soil samples at the dumpsites are also relatively higher than the control. Most of the metals in the dumpsites have impacted the soil environment but copper concentrations were found to be much higher than normal range in the mineral soil environment. The hazardous effects of those metals on plants and humans have been discussed based on the results obtained from the national and international standards as well as the available literature.

(Keywords: *Amaranthus caudatus*, dumpsite, Lagos metropolis, heavy metals, vegetables)

INTRODUCTION

Heavy metals are of considerable environmental concern due to their toxicity and accumulative behaviors (Purves, 1985). Their uptake by plants from soil is largely determined by their presence in the environment based on their chemical specification, soil particle and size, organic matter content, salinity, pH, etc. (Solomon and Forestener, 1984 and Knock et al., 1989). Although all trace elements are natural constituents of soil, the dumping of wastes on soil has been found to increase their heavy metal profile (Clarkson et al., 1983, Adeniyi et al., 1993, and Adeniyi, 1996) the effect of this is that their concentration may reach toxic levels (Singh and Narwal, 1984) resulting in increased health risk to humans through exposure pathways especially if plant materials are cultivated on such dumpsite soils and subsequently consumed.

Amaranthus caudatus is a common leafy vegetable and is locally called Tete. It is grown both in wet and dry seasons and harvested between 30-40 days after planting. Because of its nutritional importance and demand it is widely cultivated especially in the South-Western part of Nigeria. Its leaf contains high levels of vitamins A, calcium, and potassium, and its edible seeds are rich in protein (Gubben, 1997). However, due to decline in soil fertility, increased prices, and non-availability of fertilizers, other alternatives means are being employed to source for manure/compost. One such source at the local level is the use of dumpsites and animal manure areas. In the urban centers such as Lagos the cultivation of staple vegetables at dumpsites is common. Unlike in the local areas, the composite dumps in the urban centers such as Lagos metropolis are mostly wastes from residential, commercial, and industrial areas.

Lagos, the economic nerve center of Nigeria, has a problem of a growing population, industrial waste generation which is immensely diverse in nature, and an inherently urbanized lifestyle. This accounts for the magnitude of waste generated and the presence of different dumpsites across the metropolis. Plate (a) shows a typical dumpsite in Ojota, Lagos.

The objectives of this paper therefore was to investigate the concentration levels of heavy metals in *Amaranthus caudatus* grown in

dumpsite soils within Lagos metropolis and provide the necessary information of the consequences on the human life.

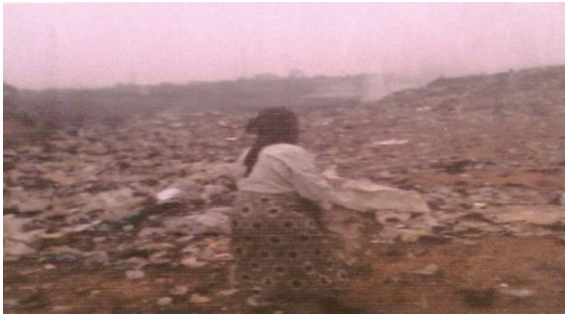

Plate A: Ojota Dumpsite.

MATERIALS AND METHODS

Sample Collection

Five dumpsites within the metropolis were selected for the study. They were identified dumpsites with the cultivation of the vegetables. The sites were taken across the length and breadth of Lagos and therefore may be representative of the practices in deferent areas in the metropolis. Figure 1 shows the locations where samples were collected including the control sites. At each dumpsite the edible leafs of different plants of *Amaranthus candatus* were collected to a depth of about 150 mm beneath the plant. A control site at a distance of 500m away from each dumpsite was chosen for comparative analysis of the leaf and soil samples.

Sample Preparation

Each sample of the vegetable leaf was washed thoroughly with water to remove soil and other particles on the leaf. Effort was made to ensure that the washing was done in the manner that is representative of local practices as possible and the samples were then left to dry at the room temperature. The dried samples were crushed and stored in labeled polythene bags prior to analysis. The soil samples were similarly air-dried, crushed, and sieved and were put in labeled polythene bags. The extracts from the leaf samples of *Amaranthus caudaus* were analyzed for heavy metals using Atomic Absorption Spectrophotometer (AAS) (Philips Model Pu 9100x).

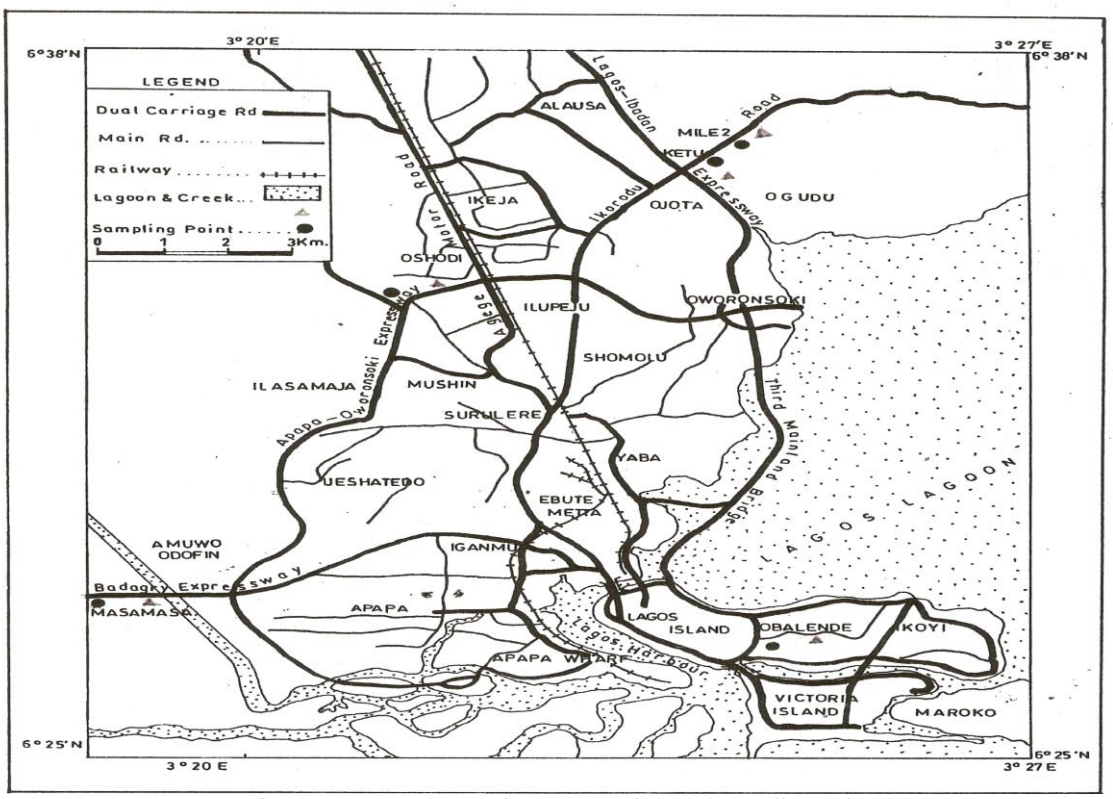

Figure 1: Locations where Samples were Collected.

The extraction procedure followed was in accordance to the Association of Official Analytical Chemist (1990). Each 2g of the crushed leaf was incinerated to white ash at 550°C for 2 hrs in a porcelain crucible. The ash was subsequently dissolved in 10mI of 5M HCI and evaporated to dryness. The samples were evaporated to dryness on a water-bath using a crucible for 15 min; thereafter the residue was reconstituted in 20 ml water and 10ml HCI in a 250ml flask and boiled and for 1 hr after which the mixture was allowed to cool at room temperature. The heavy metal analysis of the soil samples were analyzed using the methods reported by Allen et al. (1974) while the soil pH was determined using the methods described by Selema and Farrago (2000).

RESUL TS AND DISCUSSION

The heavy metal analysis of soil samples at control sites and dump site locations have been determined. Results of the soil samples obtained for the control soil and dump site soil are presented in Tables 1 (a) and (b), respectively. Equally the concentration of the metals obtained in *Amaranthus caudatus* for control site and dump sites are presented in Tables 2 (a) and (b), respectively. The results obtained for the different soil samples from the dump site show that they are highly contaminated with iron when compared with the control values. The mean concentration value of 2930 mg/kg was within the normal range of 10,000-100,000 mg/kg in mineral soil environment and 300-500,000 mg/kg reported for naturally occurring heavy metal concentrations for soil (USEPA, 1986). Cadmium was detected in all of the samples. The values ranged from 1.70 - 2.00 mg/kg with a mean of 1.90 mg/kg (Table 1b). This range of value is within normal range of 0.1 – 7 mg/kg (Bohn et at, 1979) and is well above' that range reported by (USEPA, 1986). The source of cadmium in the dump site soil may be due to the presence of discarded batteries, paint pigments, plastic, oils, and chemicals such as fungicide.

Cadmium is very hazardous and at certain concentrations, it is toxic to humans and other living organisms especially when present in the aqueous medium (Bryan, 1984; WHO, 1984). The cadmium wastes should therefore not be discharged into the environment.

The copper in the soil samples with a mean concentration of 230 mglkg is above the normal range 2-100 mg/kg (Bohn et at., 1979) in the mineral soil environment and is significantly above the data obtained for the control samples. Copper is very toxic to most plants, and highly toxic to mammals (Udosen, 1994). Copper concentration levels above normal range are highly dangerous and pose health risks to the environment.

The concentration of lead in the soil samples ranged from 58-115 mg/kg with a mean of 93.3 mg/kg (Table 1). This is below the formal range (2-200 mg/kg) (Bohnet et aI., 1979; Kabata, Benqias, and Pendias, 2001) in the mineral soil environment indicating that the soil is not polluted by lead and therefore not hazardous to the food chain and biological life due to lead contamination.

The levels of zinc found in the soil samples were within the normal range 10-300 mg/kg (Bohn et aI., 1979; USEPA, 1986, Steinbam and Breen, 1999) in the mineral soil environment. Zinc constitutes an essential element (micronutrient), but it is toxic to crop plants especially vegetables at the level of 400 mg/kg in the soil (Abreu et aI., 1998).

The concentrations of manganese in soil samples varied between 4.85 and 34.6mg/kg with a mean of 20.7mg/kg (Table 1b). This range values are below the normal range 200-2000 mg/kg (Bohn et aI., 1979) for the mineral soil but its presence influences soil biochemistry. Manganese in soil functions like iron and is also an essential trace element (micronutrient).

From Tables 1 (b) and 2 (b) there are apparent indications of the effects of dumps on the values of metals as compared to their values in Tables 1(a) and 2(a). This trend is also in agreement with the observations of Adeniyi (1996), Harrison and Chirgawi (1989), Bojakowska and Kochany (1985), and Sigh and Arwal (1984).

CONCLUSION

The heavy metal concentration level in dumpsites and *Amaranthus caudatus* grown on such soil have being determined. Results of our measurements reveals the presence of concentration of heavy metals when compared to

Table 1(a): The Concentration Levels (mg/kg) of Heavy Metals in Soil Samples at Different Control Locations.

Locations	Fe	Cd	Cn	Pb	Zn	Mn
A	10.4	0.23	21.8	18.9	29.7	3.78
B	11.4	0.28	26.6	56.8	23.9	2.98
C	14.6	0.25	26.6	48.1	25.9	16.3
D	25.4	0.26	21.2	31.6	21.1	5.12
E	20.1	0.27	24.9	25.3	24.6	21.0

Table 1(b): The Concentration Levels (mg/kg) of Heavy Metals in Soils Samples' at Different Dump Site Locations.

Locations	Fe	Cd	Cn	Pb	Zn	Mn
A	1360	1.97	234	115	41.3	16.3
B	1340	2.00	261	111	33.2	4.85
C	4640	1.70	242	88.4	39.1	22.6
D	3720	1.85	205	94.7	34.9	25.6
E	3570	2.00	209	58.4	43.1	34.6
Mean	2930	1.90	230	93.3	38.3	20.8
USEPA	300 -500000	0.1-1.0	7-80	12-25	10	300
Normal range in mineral soil environment	10000 - 100000	0.1-7.0	2-100	2-200	10- 200	200-300

Table 2(a): The Concentration Levels (mg/kg) of Heavy Metals in *Amaranthus caudatus* on Control Sites at Different Locations.

Locations	Fe	Cd	Cu	Pb	Zn	Mn
A	4.78	0.51	3.72	8.53	32.5	2.72
B	4.64	0.12	3.35	8.80	2.28	2.61
C	4.29	0.13	3.73	9.50	20.6	1.65
D	4.07	0.14	3.80	9.53	18.4	3.20
E	2.36	0.14	3.30	9.0	2.36	3.75

Table 2(b): The Concentration Levels (mg/kg) of Heavy Metals in *Amaranthus caudatus* on Dumpsites Soil at Different Locations.

Locations	Fe	Cd	Cu	Pb	Zn	Mn
A	7.50	1.46	209	80.5	35.9	11.2
B	6.75	1.28	199	145	37.9	3.79
C	7.85	1.20	207	68.7	31.9	4.32
D	21.8	1.65	205	75.8	19.6	3.75
E	14.6	1.71	171	68.7	14.6	2.52

those of the control and much higher concentration of copper above the normal range in most samples. This is seen to pose possible health hazards to members of the public who consume vegetables cultivated on such dumpsites within Lagos metropolis. In light of this development, the relevant authorities through the inspectorate and monitoring agencies in the state should endeavor to sensitize the populace on the hazardous implication of using dumpsites as a cheaper avenue for cultivation of vegetables for domestic consumption.

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