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Content of Heavy Metals in *Lumbricus Terrestris* and Associated Soils in Dump Sites

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ABSTRACT: Metals concentrations in *Lumbricus Terrestris* and soil samples from the dumpsites located in Zaria metropolis, Nigeria were measured spectrophotometrically. Mean metal content in dumpsite soils were: 25.95 - 75.17, 8.33 - 382.94, 124.84 - 206.96, 34.24 - 666.67 and 111.11 - 488.10mg/kg for Cd, Cu, Mn, Pb and Zn respectively. While the concentration ranges recorded in *L. Terrestris* samples were; Cd, 0.55 - 8.13mg/kg; Zn, 105.82 - 380.95mg/kg; Cu, 0.66 to 10.25mg/kg; Pb, 5.01 to 265.40mg/kg and Mn, 1.26 to 10.23mg/kg respectively. The ratios of these metals accumulation in L. Terrestris were less than unity for all metals except for Zn. The order of bioaccumulation of the metals followed the trend; Zn>Pb>Cu>Cd = Mn. Since birds and domestic fowls fed on insects and *L. Terrestris*, transfer of these metals across the food chain are most probable with resultant health problems.

Key words: Heavy metals, Dumpsite, *Lumbricus Terrestries*, Soils, Zaria, Nigeria

INTRODUCTION

The term "heavy metals" refers to any metallic element that has a relatively high density and is toxic or poisonous even at how concentration (Lenntech, 2004, Duruibe *et al*., 2007). Heavy metals concentrations in soil are associated with biological and geochemical cycles and are influenced by anthropogenic activities such as agricultural practices, industrial activities and waste disposal methods (Ndiokwere and Ezehe, 1990; Zauyah, *et al*., 2004; Usman, *et al*., 2002; Eja *et al*., 2003; Ebong, *et al*., 2007; Saeedi and Amini, 2007). Dumpsite contains different kinds and concentrations of heavy metals, depending on the age, contents and locations (Udosen, *et al*., 1990: Odukoya, *et al*., 2000; Ebong, *et al*., 2007). In recent times, it has been reported that heavy metals from waste dumpsites can accumulate and persist in soils at an environmentally hazardous levels (Alloway and Ayres, 1997; Amusan *et al*., 2005; Ebong, *et al*., 2007).

Zaria metropolis is located at latitude 11º 3'N and longitude 07º 40'N and is presently one of the most important cities in Northern Nigeria. As at 2007 Census, it had a population of 1,018,827 (TWG, 2007). Like many cities in Nigeria, Zaria faces problems of environmental sanitation such as improper disposal of refuse near residential areas; poor refuse collection and handling etc. For example, it is a common feature to find huge refuse dumpsites within residential areas and along some minor and major roads.

According to Ireland (1983) and Bamgbose et al. (2000), earthworms can accumulate in their tissues heavy metals in contaminated and non-contaminated environments. That use of earthworms as bio-indicators of soil pollutions was shown by Morgan and Morgan (1988a, 1988b) and Stafford and McGrath (1986), who reported significant positive correlation between the earthworms and total soil Cu, Pb and Zn concentrations from various metal contaminated sites. Edward and Lofty (1977) reviewed that earthworms consume a significant amount of dirt and in this process help in enriching the soil and improving growing condition for plants. Dumpsite

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provides suitable environments for earthworm's activity, by increasing the degree of mixing with soil micro flora, facilitating enzyme activity (Bamgbose, *et al*., 2000) and increasing the overall decomposition of organic matter (Hamilton and Dindal, 1989).This study reports the levels of heavy metals (Cu, Cd, Mn, Pb and Zn) in soils and *Lumbricus Terrestris* (Earthworms) with a view of examining the bioaccumulation by *L. Terrestris* as a result of their feeding on leaf crumbs and particles within the vicinity of dumpsites.

MATERIALS & METHODS

Soils and Lumbricus Terrestris from dumpsites were collected from four main settlements in Zaria metropolis as shown in (fig. 1). These dumpsites are; Basawa (B), Railway station (R), Ali Basawa (AB), NTC, Babban gwani (G), Galadiman (GL), Anguwan Karfe (AK), Alkali Jae (J), Hajiya (H) and Dandutse (D) dumpsites.Soils collected 10m away from H dumpsite was chosen as control. The areas used for sampling in each location were divided into four quadrants (Nuonamo *et al*., 2002). Earthworms (Lumbricus Terretris) samples were collected by digging into the soil within the quadrant placed in samples bottles and labeled. Soils samples were collected from each site with the aid an auger at 0-15cm profile. The soil samples were placed in polythene bags, labeled and taken to the laboratory for analysis together with the L. Terrestris samples.

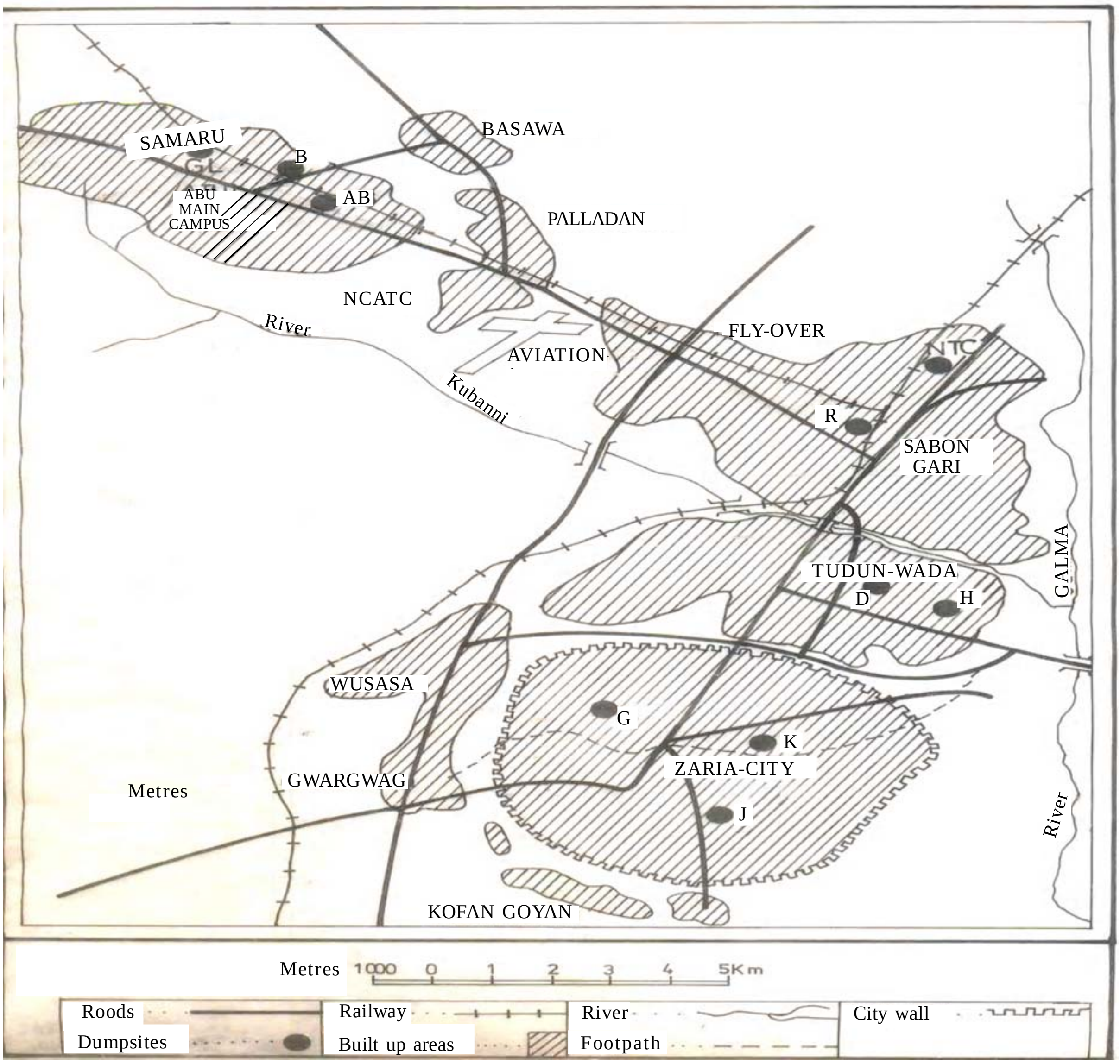

Fig. 1. Zaria metropolis showing dumpsite Source: Modified from Zaria Topographic map and field work 2006

Soils samples from each site were homogenized and air dried in a circulating air in the oven at 30^{0}C overnight and then passed through a 2mm sieve (Awofolu, 2005). The earthworms (*L. Terretris*) were also properly rinsed with distilled water so as to remove any attached soil particles on their bodies, they were then dried in the oven at 100^{0}C overnight, the dried samples, were carefully grinded and sieved using 2mm sieve (Awofolu, 2005). The sieved soils were placed in polythene bags prior to digestion.All chemicals used were of analytical grades and metals standard solutions were prepared from (1000mg/L) stock solutions of the metals. Glasswares were properly washed with liquids soap rinsed with water, soaked in dilute nitric acid overnight and then rinsed thoroughly with distilled water before used. Working standards were prepared from the stock solution of each metal and calibration curves of the standard were plotted. Good linearity of all calibration curves were obtained and used in the qualitative analysis. The same observation was made by Awofolu (2005).

About 3g of powder *Lumbricus Terrestris* (*L. Terrestries*) samples was weighed into 100mL beaker, spiked with (5ppm of Cd and Pb, 40mg/L, Cu, Mn and 50mg/L Zn standards). Concentrated nitric acid of about 2mL was added and heated to dryness on a hot plate. The digests was redissolved in 1mL concentrated nitric filtered and made up to 50mL with distilled water. Triplicate digestion was carried out together with blank. 5g of pre-digested soil samples was weighed into 100mL beaker and spiked with metal standards as above. 10mL concentrated nitric acid added. The mixture in the beaker was covered with a watch glass and refluxed for 45minutes. The watch glass was then removed and the content in the beaker evaporated to dryness. 5mL aqua-regia was added and the mixture was again evaporated to dryness after which 10mL 1M nitric acid was added and the suspension filtered. The filtrate was then diluted to volume with distilled water in a 50mL volumetric flask. Triplicate digestion of each sample was carried together with the blank.Heavy metals were determined in the soil and L. Terrestries following the methods described in above.

RESULTS & DISCUSSIONS

Table 1. showed the concentration of five heavy metals in soils collected from dumpsites. Cd content in the study area ranged from 25.95 - 75.17mg/kg while Cu and Mn ranged from 8.33 - 382.94mg/kg and 124.84 - 206.96mg/kg respectively. Other ranges of values are 34.24 - 666.67mg/kg for Pb and 111.11- 488.10mg/kg for Zn. While in the control area, 2.91mg/kg and 27.29mg/kg was found for Cd and Zn respectively.

The profile of average metal contents in the study areas were: Pb>Zn>Mn>Cu>Cd. Correlation analysis showed positive correlation for all the metals in the study area. Levels of these heavy metals were compared with values reported in literature. Cd concentrations in all study areas were above the standards (European Commission, 1986).

Table 1. Concentration (mg/kg) of some heavy metals of refuse waste soil in Dump sites

Sites	Mean±SD				
	Cd	Zn	Cu	Pb	Mn
H	43.69±0.21	369.05±9.52	382.94±7.20	565.15±13.89	155.81±1.36
G	58.76±2.06	30.9.52±8.25	8.33±1.57	275.76±6.94	196.17±2.05
K	47.38±0.74	258.73±5.50	14.68±1.82	35.15±9.46	192.33±1.36
J	75.17±0.41	111.11±7.27	37.50±1.19	472.73±7.87	241.44±1.50
AB	62.95±0.21	209.52±24.74	31.55±1.19	350.06±10.50	206.01±1.58
NTC	52.74±0.55	447.62±9.52	15.08±0.69	34.24±6.94	192.82±2.05
D	45.24±1.25	488.10±12.07	56.15±2.48	666.67±9.46	206.96±2.05
GL	59.64±0.71	290.48±9.52	124.40±0.60	216.67±5.25	154.17±2.05
R	25.95±0.21	228.57±16.10	88.29±0.69	422.12±5.25	124.84±0.36
B	55.60±1.03	277.78±16.72	74.17±1.19	481.82±13.64	418.61±0.39
SCTR	2.91±0.79	27.29±5.46	BDL	20.91±0.79	68.23±10.91

BDL: Below detection limits

The ranges obtained in this study were higher than those reported by Ebong et al. (2007). The results were also found higher than 1.85 - 8.65 and 42.05 - 60.85mg/kg reported for Cd and Pb respectively by Odukoya, et al. (2000). Mean values obtained in this study forTable 3 Transfer Ratio of Heavy metals from dumpsites soil - *L. Terrestries*

cadmium were all in conformity with those reported by Ma and Rao (1997). According to Udosen, et al. (1990), the high concentration of Cd may be attributed to anthropogenic sources such as spent batteries, paints and plastics being dumped in the dumpsites. Cu accumulation was noticeably higher only in H dumpsite soils while dumpsites H, G, D and NTC have accumulated Zn above other sampling sites.European commission (1986) sets limits of 300mg/kg for Pb. Pb accumulation was noticeably higher in J, AB, D, R and B dumpsite soils which may be attributed to their locations while levels of Mn observed were below the recommended limit.

Table 2. showed the values for metal contents recorded in *L. Terrestries* in both the study and control sites. Cd content in the *Lumbricus Terrestries* ranged from 0.55 - 8.13mgkg^{-1} while Zn ranged from 105.82 - 380.95mg/kg. The range for Cu and Pb were 0.66 - 10.25mg/kg and 5.01 - 265.40mg/kg respectively. Mn content ranged from 1.26 - 10.23mg/kg. The mean metal contents in the control area were: 3.79, 63.67, BDL, 1.52 and 11.75mg/kg for Cd, Zn, Cu, Pb and Mn. Zn has the highest value in the *L. Terrestries* samples for both control and the study areas. Pearson Correlation analysis showed positive correlation for all the metals except Cu, which was negatively correlated.

The highest positive correlation was observed for Zn (0.456) while the least positive correlation was shown by Pb (0.057). The mean metal contents in control soils were lower than those of the dumpsite soils for Pb, Cu and Zn while reverse was the case for Cd and Mn which may be attributed to the chemical changes that may occur in the guts of earthworms and hence render various metals more bioavailable to plants. Furthermore, mineralization of the dead earthworms releases accumulated heavy metals back to the environment (Morgan and Morgan, 1988a). This trend was also in conformity with the work of Weigman (1991), who reported higher levels of metals in worms analysed from more polluted soils. He stated that irrespective of the degree of pollution, the ratio of metal in earthworms to soil samples is less than unity with the exception of Cd.The transfer ratios (Bioaccumulation factor) of Cd, Cu, Pb and Mn were all less than unity in all the dumpsites studied while it was higher than unity for Zn in R, J and AB dumpsites as shown in (Table 3).On comparative basis, the concentration of Zinc was the highest (105.82 to 380.45mg/kg) while cadmium had least concentration (0.55 to 8.13mg/kg) in the *L. Terrestries* sample analyzed.

Table 2. Concentration (mg/kg) of some heavy metals in *Lumbricus terrestris* in Dump sites

Sites	Mean±SD				
	Cd	Zn	Cu	Pb	Mn
H	0.55±0.08	267.20±4.58	1.01±0.03	20.02±8.67	5.68±1.14
G	8.13±0.42	105.82±22.91	4.96±1.98	32.53±8.68	10.23±1.14
K	1.98±0.09	134.92±15.87	2.65±1.52	5.01±1.79	1.26±0.21
J	3.97±1.72	193.12±4.07	1.65±0.57	10.01±1.53	19.33±2.27
AB	1.59±0.09	314.81±12.12	3.97±0.99	265.40±11.88	3.41±1.14
NTC	2.98±0.06	380.95±23.81	0.66±0.57	11.88±2.47	18.95±2.86
D	3.17±0.09	314.81±24.25	1.65±1.52	30.03±7.51	11.37±2.27
GL	3.17±0.50	179.89±16.52	10.25±2.29	32.53±8.67	2.65±1.74
R	1.79±0.09	277.78±5.82	4.96±1.98	12.51±8.67	10.23±2.27
B	1.59±0.34	222.22±23.97	4.63±2.50	42.54±18.89	7.69±2.27
SCTR	3.79±1.74	63.67±18.19	ND	1.52±0.66	11.75±1.74

BDL: Below detection limits

Table 3. Transfer Ratio of Heavy metals from dumpsites soil - *L. Terrestries*

Dumpsites	Cd	Zn	Cu	Pb	Mn
H	0.01	0.72	0.00	0.04	0.04
G	0.14	0.34	0.6	0.12	0.05
K	0.04	0.52	0.18	0.14	0.01
J	0.05	1.74	0.04	0.02	0.08
AB	0.03	1.50	0.13	0.76	0.02
NTC	0.06	0.85	0.04	0.35	0.10
D	0.07	0.64	0.03	0.05	0.05
GL	0.05	0.62	0.08	0.15	0.02
R	0.07	1.22	0.06	0.03	0.08
B	0.03	0.80	0.06	0.09	0.02
Ctr	4.16	2.33	NIL	1.67	0.12

In separate studies by Awofolu (2005) and Bamgbose, et al. (2000) Zn being the highest followed by Lead. Cd had the least concentration. Generally, levels for all the metals analyzed in dumpsite soil samples were higher than those in *L. Terrestries* samples; this was not unexpected since soil has been described as reservoir of pollutants where they concentrate according to the level of pollution (Onyari *et al*., 2003). Detection of these heavy metals in invertebrates samples called for sustained monitoring since birds and domestic fowls feed on insects and earthworms. Transfer of metals across the food chain and their accumulation are most probable with resultant health problems.

CONCLUSION

This study confirms that earthworms accumulated some amount of heavy metals from dumpsite soils and levels of these metals accumulated in the earthworms tissues were less than unity for Cd, Cu, Pb and Mn while the ratio was higher than unity for Zn metal in R, L and AB dumpsites. Based on the transfer ratio, the accumulation of the analyzed metals followed the trend: Zn>Pb>Cu>Cd = Mn. The results show that possible contamination by metals is possible as result of indiscriminate deposition of used metals. Also the use of dumpsite as manure should be stopped to prevent possible transfer of toxic metals into the food chain.

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