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Heavy Metals Concentration in Dumpsites at Gwagwalada, Abuja: Implications on Sustainable Environmental Management

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ABSTRACT

Agricultural soil quality deterioration resulting from increase in the level of heavy metals is becoming more and more pronounced, thus raising the question of safety status of human health and environment. Heavy metals affect the quality and production of crops and influence atmospheric and water quality. These contamination are important and of concern because of increasing demand for food safety. Heavy metals in two layers (0-15cm and 15-30cm) of four different sites of waste dumps and the control taken from 50 meters away from the dump sites were studied in Gwagwalada area of Abuja in Federal capital territory of Nigeria. The samples were air-dried and digested with concentrated HNO_3 and $HClO_4$ acids; Cu, Pb, Fe, Mo and Zn were determined using an Atomic Absorption Spectrophotometer model Sp 2900. The results showed that the heavy metals were found in the surface soil and the heavy metal levels for the soils follow this trend Fe > Zn > Cu> Mo > Pb. The concentrations of Fe, Zn and Pb were highest in abattoir dumpsite (509.7, 83.8 and 1.5 mg/kg respectively). Cu and Mo were highest in Kuje road dumpsite with (24.1 and 5.5 mg/kg). The study revealed that although the concentrations of the heavy metals were lower than the established limits, they were higher than the control soils. The relatively low average content of the metals investigated in this study present insignificant exposure risks. This does not ruled out the possibility of increase in concentration of these metals with time, since the extent of heavy metal pollution varies with age. The study therefore recommends that dumping of the wastes should stop or more accumulations will constitute a major health risk to the people around these areas.

INTRODUCTION

Heavy or toxic metals are common environmental pollutant and are released into the soils from natural or anthropogenic sources. The main natural sources of metals in soil are weathering of parent material and soil erosion (Yoon, *et al*., 2007) while the anthropogenic sources are associated mainly with industrial activities such as metal finishing, paint pigment, traffic emission and other human activities such as industrial production, leather tanning, battery manufacturing, mining, agriculture and transportation. Also urban and municipal waste, water sludge depositions and use of pesticides and phosphate fertilizers all release a high amount of heavy metals to the biosphere. (Omar, 2004; Boularbah *et al*., 2006). They are also called trace elements which are detrimental to human health.

The disposal of domestic, commercial and industrial garbage in the environment is a problem that continues to grow with human civilization and no method so far is completely safe (Ogu and Ogwo, 2014). The non free flowing or sticky nature of this waste gives rise to the accumulations of solid wastes on some habitable parts of the earth surface. In Nigeria today, urban centers are experiencing an increased rate of environmental deterioration with refuse dumped along drainage channels. The composition of these dumps varies from site and depends on the peculiarity of the neighbourhood. Most cities are faced with waste management problems; this is due to improper solid waste handling and disposal system within the society. It is estimated that between a third and half of waste generated in urban areas goes uncollected (Adefemi and Awokunmi, 2009). Some metals like lead, mercury, chromium, arsenic are introduced into the environment by use of chemicals like pesticides, herbicides and fertilizers (Frink,1993) while lead and related metals found on roadside soils, vegetation and nearby surfaces are discharged from automobiles (Onianwa, 2001).

Soils are the major sinks for heavy metals released into the environment by aforementioned anthropogenic activities and unlike organic contaminants which are oxidized to carbon (iv) oxide by microbial action, most metals do not undergo microbial or chemical degradation. The total concentration of heavy metals in soil persist for a long time after their introduction thereby bringing changes in their chemical forms (speciation) and their bioavailability are however influenced (Adriano, 1986). This study was aimed at assessing the accumulation of heavy metals in selected dumpsite areas in Gwagwalada, Abuja

MATERIALS AND METHODS

Study Area

The study was carried out in Gwagwalada, a University town located in Gwagwalada Area Council of Abuja, Federal capital territory of Nigeria. It lies on longitude 07^{o} 10$^{'}$E and latitude 08^{o} 59$^{'}$ N. The town is densely populated, with industrial, agricultural and economic activities on the increase. Metropolitan services such as automobile activities, manufacturing businesses, food vending and others are prominent in the town. Four soil sites were selected to represent the geographical area of the town.

Site Description

Site 1 is situated at mechanic workshop along Kuje road, Gwagwalada. Resident building and some factories are around the area. Wastes commonly dumped at this site include; domestic wastes (leftovers of food, fruit peels, wood ash, tree leaves, wood trunks and non-biodegradable wastes (empty cans, polybags, broken bottles, plastic materials/ cans, motor tyres, metal scraps from mechanic workshops, spent engine oil etc). Site 2 (control) is at an unpolluted land around the student hostel of the University of Abuja in Gwagwalada. Site 3 is within the premises of Gwagwalada market. Wastes deposited include, domestic wastes, rotten fruits, fruit peels, animal wastes, polybags, plastic. Site 4 is situated in an abattoir in Gwagwalada. Animal wastes, bones, dried blood, few domestic waste, wood ash and plastic cans are dumped around this area.

Soil Sampling

Soil samples were collected at two depths 0-15cm, 15-30cm and 50meters away from each site to serve as the control using soil auger. The sampled soils were placed in well labelled polythene bags and taken to the laboratory for analysis. The soil samples were air dried, ground, passed through a 2mm sieve and stored in labelled plastic cans for analysis. The samples were digested according to method described by Ademoroti (1996). The digested samples were analyzed for the metals and read using Atomic Absorption Spectrophotometer Pye Unican model Sp-2900.

Statistical Analysis

Data collected were subjected to Analysis of Variance (ANOVA). Significant means were separated with Duncan Multiple Range Test (DMRT).

RESULTS

From the Table 1, the concentration of Fe was highest followed by Zn, Cu, Mo and the least of the heavy metals concentration was Pb in that order. When compared with the control the heavy metal concentrations were higher in all the dumpsites. The Table also indicated higher depositions of heavy metals are found at the surface soils (0-15cm).

Table 1: Concentration of some heavy metals in refuse dump locations in Gwagwalada Area Council as affected by soil depth

	Cu	Pb	Fe	Zn	Mo
	($mgkg^{-1}$)				
0-15 (cm)	$22.6+0.07^{a}$	$1.3+0.05^{a}$	$427+0.02^{a}$	$70.6+0.06^{a}$	$4.8+0.08^{a}$
15-30 (cm)	$21.0+0.07^{b}$	$0.7+0.05^{c}$	$424.9+0.02^{b}$	$67.5+0.06^{b}$	$4.5+0.08^{b}$
Control	$21.1+0.07^{b}$	$1.1+0.05^{b}$	$345.5+0.02^{c}$	$66.2+0.06^{c}$	$4.5+0.08^{b}$

Table 2 indicates the concentration of some heavy metals in three refuse dump sites compared with the control site, the highest concentration was that of Fe (509.07+0.03 $mgkg^{-1}$) which was highest in the abattoir dump site while the least concentration of Fe was found in the student hostel dumpsite (223.2+0.03$mgkg^{-1}$).

Table 2: Concentration of some heavy metals in refuse dump locations in Gwagwalada Area Council as affected by locations

	Cu	Pb	Fe	Zn	Mo
	($mgkg^{-1}$)				
Market	$20.6+0.06^{c}$	$1.1+0.01^{b}$	$486.9+0.03^{b}$	$82.2+0.07^{b}$	$4.8+0.09^{b}$
Abattoir	$21.2+0.06^{b}$	$1.5+0.01^{a}$	$509.07+0.03^{a}$	$83.8+0.07^{a}$	$3.4+0.09^{d}$
Kuje road	$24.1+0.06^{a}$	$1.1+0.01^{c}$	$377.8+0.03^{c}$	$51.9+0.07^{d}$	$5.5+0.09^{a}$
Control	$20.2+0.06^{d}$	$0.5+0.01^{d}$	$223.2+0.03^{d}$	$54.6+0.07^{c}$	$4.7+0.09^{c}$

The concentration of Zn (83.8+0.07$mgkg^{-1}$) followed with highest concentration in the abattoir dumpsite and the least is in Kuje dumpsite (51.9+0.07$mgkg^{-1}$). Cu concentration (24.1+0.06$mgkg^{-1}$) was more in Kuje dumpsite with the least in the control (20.2+0.06$mgkg^{-1}$). Pb was more concentrated (1.5+0.01$mgkg^{-1}$) in abattoir site than all the others while Mo (5.5+0.09$mgkg^{-1}$) was found more in Kuje road than the abattoir dumpsite (3.4+0.09$mgkg^{-1}$). However, the values for the heavy metals were below the critical values (WHO standard).

DISCUSSION

The concentration of the heavy metals was more on the surface soils than in the sub-soils, this above finding that accumulations of heavy metals are concentrated at the soil-surface than the sub-surface is supported by Amadi *et al*. (2012); Ololade I. (2014) who reported in their findings that soils showed remarkably high levels of metals such as copper, iron and zinc decreasing with depth. Also Anikwe and Nwobodo, (2002) reported that surface soils are better indicators for metallic burdens. Moses (2006) also reported that addition of heavy metals to soil resulted to their accumulation in top soil.

The highest concentration of copper in Kuje dumpsite may be attributed to improper disposal of waste lubricants and automobile wastes since it is very close to mechanic workshops. Copper is used as additives to petrol and various lubricants and released during combustion, spillage, crankshaft wear and engine body damage (Alloway B. J. 1996). Electrical and electronic parts such as copper pipes and alloy from vehicle scraps littered for a long time on the soil gradually rust and leach into the soil causing phytotoxicity (Nwachukwu *et al.,* 2010). Dara S. S. (1993) also reported that a biodegradable waste can introduce metallic copper into the soil.

Impacts on Man and the Environment

From the study, it was established that soils in the dump sites are higher in heavy metals than in non-dump sites. Therefore to minimize heavy metals load of soil in dumpsites following waste decomposition there should be an enabling statutory regulation on waste management in the country. An enabling act advising and enforcing the non- use of refuse dump sites for farming is also desirable since the waste pose greater health hazards such as nervous disorder, kidney and liver impairments, increased blood pressure, cancer, reproductive defect and stress (WHO, 1996).

CONCLUSION

The present study emphasizes the need to continue to monitor concentrations of toxic metals such as Pb, Zn, Fe, Cu and Mo in dump sites in order to detect their toxicity on time. There should be proper harnessing and recycling of waste materials. However, their use as manures for gardens requires proper treatment to remove toxic levels of heavy metals accumulation in plants which may subsequently be hazardous to human health when consumed. Proper monitoring and remediation plan should be put in place to reduce the chances of ground water pollution by leaching contaminants.

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