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RESEARCH ARTICLE

HEAVY METAL ASSESEMENT OF DUMPSITES SOIL IN ILORIN METROPOLIS, KWARA STATE

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ABSTRACT

Evaluations of some heavy metals were carried out at four different dumpsite within Ilorin metropolis and its environments using Atomic Absorption Spectrophotometer (AAS). The mean heavy metal concentrations of the dumpsites were found to follow the trend: Mn>Fe>Zn>Cd>Pb with concentrations 4234.53±0.038, 1525.55±0.873, 966.8±0.2151, 387.30±0.561, 40.87±0.21 (µg/g) respectively. High concentration of iron and manganese may be attributed to dumping of structural components of condemned automobile parts and building materials into the dumpsites. The degree of heavy metal contamination of the dumpsites was determined using geoaccumulation index. Out of all the metals determined only Pb was practically uncontaminated in all the dumpsites while Fe, Zn, Mn, and Cd show a status of practically unpolluted to moderately polluted in all the dumpsites. The results for Coefficient of variation of the metals show that Pb had unsteady distribution pattern while Cd, Fe and Zn had moderately uneven distribution pattern and Mn was the most evenly distributed of heavy metals in the dumpsites.

INTRODUCTION

Dumpsite is a place where waste materials are disposed and is one of the oldest methods of waste treatment (Abdul-Salam *et al.,* 2011). The disposal of wastes to dumpsites is the most common method of waste management and remains so in many places around the world (Adedara *et al.,* 2014). Most dumpsites are located within the vicinity of living communities and wetland (Ibrahim *et al.,* 2013). The wastes on dumpsite contain toxic metals, which are of great concern and pose dangers to the people in contact with the contaminated soil and plants. The chemical composition of the solid waste materials often lead to changes in soil physical and chemical characteristic due to contamination(Logan,1992). The excessive input of un-separated municipal household waste may lead to changes in soil physicochemical properties that have serious impact on biophysical and chemical soil functions, which may lead to accumulation of nitrates and heavy metals in soil and ground water (Anikwe and Nwobodo, 2002). Continuous disposal of municipal wastes in soil and plants may increase heavy metals concentration. Heavy metals may have harmful effects on soil, crops and human health (Smith *et al.,* 1996). No strong relationship between concentrations of heavy metals in soil and plants because it depends on many factors such as soil metal, bioavailability, and plant growth and metal distribution to plant part (Vousta *et al.,* 1996).

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The dumpsites are not basement prepared for selective adsorption of toxic substances hence; it is susceptible to the discharge of pollutants to nearby water and to the air through leachates and dumpsites gases respectively (Abuduls-Salam, 2011). Industrialization, population growth and unplanned urbanization have partially or completely turned our environment to dumpsites (Alimba *et al.,* 2006). Poor urban planning, lack of enforcement of relevant laws and acts on waste disposal and lack of organized landfill sites add to the existence of dumpsites within living areas in developing nations. This result in the discharge of domestic sewage and refuse into the environment untreated (Abduls-Salam, 2011).

The surface runoff and leachates from dumpsites are sources of fresh water contamination. The general belief that wastes are sometimes hazardous to health cannot be over-emphasized. Un-control hazardous waste disposal leads to environmental pollution or contamination which consequently cause threat to health and may eventually leads to death. Exposure to multiple chemical combinations in population living near waste dumpsites has led to series of human health disorder (Palmer *et al*. 2005).

Common problem emanating from abandoned dumpsites is the emergency of leachates caused by biochemical breakdown of organic or decomposable portion of the wastes and the percolation of rain water through the wastes (Adedara *et al*. 2015). Leachates are liquids effluents produced by the decomposition of wastes or by interaction of wastes with rain water.

Leachates coming from unrestrained dumpsites are often a good source of pollution for ground water and surface water (Adedara *et al.,* 2015). Study has showed that the physiochemical characteristics including total alkalinity, total acidity, total hardness, Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) as well as the concentrations of copper, lead, cadmium, arsenic, cobalt, chromium and mercury were higher than acceptable limits by international regulatory authorities, the toxic chemicals such as heavy metals that are present in the liquid coming out of decomposing dumpsite could be assimilated by aquatic species, pass through the food chain and bio-accumulate upon long-term exposure (Adedara *et al*., 2013).

Heavy metals are natural components of the environment; they are present in rocks, soil, plants and animals, bond in organic and inorganic molecules or bound to particles in air (Tan and Wong, 2000). Different definitions have been used to explain heavy metals. Some are based on density or atomic weight while some on chemical properties or toxicity. Recently heavy metal is used as general term for those metals and metalloid with potential human and environmental toxicity (Samara and Richard, 2009). Heavy metals are persistent in the environment because they are non-biodegradable and non-thermo degradable and readily accumulate to toxic levels. Heavy metals can accumulate in the soil at toxic levels due to long term application of waste water (Bohn *et al*., 1985). The relative high levels of toxic heavy metals such as cadmium, cobalt, lead, copper and iron in contaminated ground water has been attributed to the uncontrolled disposal of lead batteries and spent petroleum products (Adedara *et al*., 2014). The ground water sources within 2km radius of a dumpsite have been reported to be contaminated by heavy metals which has largely associated with dispersion of chemical constituents from leachate produced at the dumpsite (Adeyemi *et al.,* 2010). Monitoring the contamination of soil using heavy metals as indicator is of great concern due to their influence on ground water, surface water and also on plants, animals and humans (Sadhana, 2014). In the present study, evaluation of Soil contamination by heavy metals from dumpsites in Ilorin metropolis was carried out using Geo accumulation Index (I-geo Index).

MATERIALS AND METHODS

Study Area

Ilorin is located between northern and southern Nigeria on latitude 8°3'N and longitude 4°35'E with approximation of 100sq.km land mass (Orire *et al*., 2013). The city comprises of Ilorin west, east and south with a population of 777,667(NPC, 2007). The major tribe is Yoruba with Hausa, Fulani and Nupe as minority (Orire *et al.*, 2013). Ilorin is known as Gateway city between northern and southern Nigeria (Muhammed, 2006). The major activities in city ranging from agriculture such as food crop to cloth weaving, leather work, tie and dye, mat making to modern business, Industrial and administrative activities.

Reagents and Glassware

Analytical grade reagents and distilled water were used throughout the study. The apparatus and glassware were washed with detergent and thoroughly rinsed with distilled water and oven drying.

Sampling and sample treatment

Soil samples were collected from four different dumpsites; Ganmo, Sango, Asadam and Airport, all within Ilorin Township. The Soil Samples were taken from the upper 20 cm (ploughing) of soil with a sharp edged plastic spatula into clean homogenization polyethylene bags sample container. Five Sampling spots were located in a site at an interval of five meters to each other which were then mixed thoroughly to obtain a representative sample of each sampling spots and this were taken to the laboratory for further treatment and analysis. The samples were air dried at room temperature and sieved with 2mm mesh size (Barth and Mason, 1984).

Digestion and Heavy Metal Analysis

0.25g of the oven dried soil samples were weighed into platinum crucibles. The digestion was carried out by mixture of 3cm^3 of conc. HNO_3, 2cm^3 of conc. HF and 1cm^3 of 40% H_2O_2 solution. The soil was digested on a sand bath at a temperature of 200 - 230^{0}C and the acid-mixture was evaporated to dryness. 20cm^3 of 0.25 M HNO_3 was added, warm for 10 minutes, transferred and filtered into 50cm^3 plastic container and filled to 50cm^3 volume with the 0.25MHNO_3 solution (Oduma,2014).The digested samples were subjected to Atomic Absorption Spectrophotometer (Model number; VAC 210) for total metal concentration in the Soil samples. The following metals were analyzed for Zn, Fe, Cd, Mn and Pbin (µg/g) of soil sample. Metals Concentrations were extrapolated from the standard Calibration curve.

Geo-Accumulation Index: represents a quantitative measurement of metal pollution in an environment (Asaah and Abimbola, 2005). Index of Geo-accumulation (Igeo) has been used widely to evaluate the degree of metal pollution in terrestrial, aquatic and marine environment (Tijjani and Omodera, 2009). The Igeo of a metal in a sample was calculated using equation one (Asaah and Abimbola, 2005; Mediola *et al*., 2008).

$$Igeo = \log_2 \left(\frac{C_n}{1.5B_n} \right) \frac{Sample}{Control} \quad \text{.............................. Equation 1.}$$

Where Cn is the concentration of the heavy metal in the sample and Bn is the concentration of the metal in the unpolluted sample. The correction factors 1.5, was used to minimize the effect of the possible variation in the background values which may be attributed to lithogenic variations in the sample (Mediola *et al.,* 2008). The degree of metal pollution is assessed in terms of Igeo as thus:

Igeo< 0 means unpolluted, (UP)
Igeo 0 < 1 means unpolluted to moderate polluted, (UP-MP)
Igeo 1 < 2 means moderately polluted, (MP)
Igeo 2<3 means moderately to strongly polluted, (MP-SP)
Igeo 3<4 means strongly polluted, (SP)
Igeo 4<5 means strongly to very strongly polluted, (SP-VSP)
Igeo> 5 means very strongly polluted, (VSP)

The background values of 20,3800,200,0.035 and 9mg/kg for unpolluted soils (Oyekunle *et al.,* 2011) for Zn, Fe, Cd, Mn and Pb respectively were used against the mean total heavy metals in the soils.

RESULTS AND DISCUSSION

Table 1 shows the mean concentration of the heavy metals (µg/g) in the soil samples obtained using Atomic Absorption Spectrophotometer. From the result obtained it can be seen that total mean concentration of Zn analysed in the dumpsites soil follow the trend, Zn: 382.79±0.121>318.07±0.015>317.98±0.159>292.04±0.029 µg/g for Sango, Airport, Asadam and Ganmo dumpsites respectively. Sango had the highest mean concentration of Zn of all the dumpsites. The mean concentration of Zn obtained in all the dumpsites in this study was higher than (44.5±4.1 -134±10.5) mg/kg obtained by (Olajire *et al.,* 2003) in an industrial soil. Higher concentration of Zn in Sango dumpsite might be attributed to anthropogenic activities where structural building materials were dumped in the dumpsite.

>964.20±0.006>720.03±0.010µg/g for Asadam, Ganmo, Airport and Sango respectively. Asadam dumpsites had the highest concentration of Mn of all the dumpsites. This might be attributed to disposal of industrial waste from roof manufacturing industries very close to the site where manganese might be one of main component of the alloy. The result in this study was lower compared to value obtained by (Oyekumle *et al.,* ?) 2411.77± 968.50µg/g but higher than 51.45±15.10 by (ogunfowokan, *et al.,* 2003) in the soil sediment. Lead was detected only in sango dumpsite of all the dumpsites and the mean concentration was 40.87±0.21µg/g. The result obtained in this study was high compared to 85.54±5.91µg/g obtained in major road dust by (Ogunfowokan, *et al*., 2003). The situation not to detect Pb in other dumpsites might be attributed to less lead containing materials that were dumped in these sites.

Table 1. Shows the mean concentration of the heavy metals (µg/g) in the soil samples

SITES	METALS				
	Zn	Fe	Cd	Mn	Pb
AIRPORT	318.07±0.015	214.22±0.012	28.13±0.006	964.20±0.006	ND
SANGO	382.79±0.121	413.42±0.578	230.17±0.015	720.03±0.010	40.87±0.21
GANMO	292.04±0.029	316.85±0.046	80.60±0.006	1140.11±0.012	ND
ASADAM	317.98±0.159	581.06±0.237	48.40±0.534	1410.19±0.010	ND
Mean± S.D	966.8±0.2151	1525.55±0.873	387.30±0.561	4234.53±0.038	40.87±0.21
CV	0.022	0.057	0.145	0.00001	0.514

ND: Not Detected

Table 2. Shows the Geo-Accumulation Index (Geo-I) values (µg/g) for the dumpsites

ELEMENTS	SITES			
	AIRPORT	SANGO	GANMO	ASADAM
Zn	0.554(PU-MP)	0.580(PU-MP)	0.551(PU-MP)	0.559(PU-MP)
Fe	0.354(PU-MP)	0.392(PU-MP)	0.380(PU-MP)	0.420(PU-MP)
Cd	0.842(PU-MP)	0.045(PU-MP)	0.045(PU-MP)	0.032(PU-MP)
Mn	0.563(PU-MP)	0.638(PU-MP)	0.426(PU-MP)	0.703(PU-MP)
Pb	ND (PU)	0.000(PU)	ND(PU)	ND(PU)

ND: Not Detected, PU: Practically Unpolluted and MP: Moderately Polluted.

The total mean concentration of Fe analysed in this study follow the trend, 581.06±0.237>413.42±0.578>316.85±0.046>214.22±0.012µg/g for Asadam, Sango, Ganmo and Airport respectively. Asadam had the highest Fe mean concentration and Airport had the least of all the dumpsites. Generally, Fe concentrations in all the dumpsites was high, this might attributed to anthropogenic activities such as disposal of structural components of building materials, condemned automobile parts which are made up of iron into the dumpsites.

The result obtained in this study was lower compared to the result obtained in three dumpsites soil analysed by (Anikwe and Nwobodo, 2002) (423.00±4.9, 437.50±5.2 and 430.30±4.1)mg/kg. Cadmium mean concentration in this study follow the trend, 230.17±0.015 >80.60±0.006 >48.40±0.534>28.13±0.006µg/g for Sango, Ganmo, Asadam and airport respectively. Sango had the highest mean concentrations of all the dumpsites which may be attributed to disposal of condemned automobile parts and car tyre. Cadmium as additives present in lubricating oil as well as about 20-90µg/g of Cd has reported in car tyres as contamination during vulcanization process (Jaradat and Momani, 1999). Manganese mean concentration in this study follow the trend, 1410.19±0.010> 1140.11±0.012

Sampling season may enhance the level of concentration of heavy metals in the soil, a situation in which there is no rain to wash the surface heavy metal into the subsoil. Coefficient of Variation (CV): This is a stastical instruments used to interpret the temporal and spatial distribution as well as variability of pollutants in an environmental matrix. The CV values of the heavy metals in the dumpsites soil samples follow the trend, Pb (0.514)>Cd (0.145)>Fe (0.057)> Zn (0.022)>Mn (0.00001) µg/g. The results show that Pb had unsteady distribution pattern while Cd, Fe and Zn had moderately uneven distribution pattern and Mn was the most evenly distributed of heavy metals in the dumpsites. Table 2 shows the results for Geoaccumulation Index (I-geo) in the dumpsites soil. The calculated Geo-Accumulation Index results obtained for Pb in all the sites based on contamination classification above shows that the dumpsite soil was practically unpolluted (PU) while all other sites show a status of practically unpolluted to moderately polluted for all the metals.

Conclusion

This research shows that iron and manganese had highest accumulation within Ilorin metropolis dumpsites. However, none of these dumpsites were seriously polluted by these metals Zn, Fe, Pb, Cd and Zn as at the time of this research.

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