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HEAVY METAL CONTENT OF SOIL SAMPLES FROM TWO MAJOR DUMPSITES IN MINNA

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Abstract
This study investigates the concentrations of some heavy metals in two major dumpsites in Minna located at Kpakungu and Gidan Kwanu road both along Minna –Bida road in Niger state. Soil samples from the dumpsites were collected and prepared using standard analytical procedures and analytical grade reagents were used for digestion. A flame type atomic absorption spectrophotometer (AAS) was used for the analysis of the heavy metal (Zn, Cu, Pb, Cd, As, Ni, Cr, Mn and Fe) content of the samples. The result of the analysis of the samples from Kpakungu gave the following mean concentrations: Zn, 9.28mg/kg; Cu, 2.08mg/kg; Pb, 17mg/kg; Ni, 21mg/kg; Mn, 3.07 mg/kg; Fe, 19.76 mg/kg. The mean concentrations for samples from Gidan Kwanu are: Zn, 23.21mg/kg; Cu, 4.57mg/kg; Pb, 12mg/kg; Ni, 52mg/kg; Cr, 72.90 mg/kg; Mn, 19.64 mg/kg; Fe, 47.29 mg/kg .These results showed that the concentrations of the metals are comparatively higher for samples from Gidan Kwanu road dumpsite than that from Kpakungu dumpsite with the exception of As which had higher concentration at Kpakungu dumpsite. The concentrations of Cadmium at both sites were below detection. The result obtained was attributed to the refuse constituent and their quantity in each site, since Gidan-Kwano was a larger dump site and enjoy more patron than Kpangungu. The concentrations of the investigated metals in the two sites were found to be within their natural range in soil and could be said to pose no immediate toxic threat to man through the environment or the crop that might be planted on the soil collected from these sites. Recommendations on the proper handling of wastes to reduce possible toxic metal loads at dumpsites have also been highlighted.

Keywords: Dumpsite, soil, Pollution, heavy metals

Introduction

Refuse generation, dumping and management have become a serious environmental problem in many urban areas in Nigeria. The volume of waste generated in many of these urban areas has been on the increase in recent times. Many human factors such as: technology, industrialization, agricultural practices, transportation, education, construction trade, commerce, nutrition, and most importantly population increase are directly responsible for increase in refuse generation in any human society. Nigeria's population has increase greatly over the years; this consequently has led to the increase in the human practices responsible for waste generation. Although solid waste can be an asset when properly managed, it poses the greatest threat to life amongst all the classes of waste since, it has the potential of polluting the terrestrial, aquatic and aerial environments (Bishop, 2000). The Nigerian Government at all levels through their agencies (like the Federal Environmental Protection Agency-FEPA, ministry of environment and environmental sanitation authorities) has invested much in waste management and enforcement of sanitation laws but little has been achieved so far. Furthermore, the erratic growth of housing units in the urban cities, has made monitoring and management of waste difficult (Ojeshiria, 1999). These have led to indiscriminate dumping of waste at every nook and cranny of major cities in Nigeria. The influx of fairly used computers, cars and other similar products from other countries has combine to worsen the situation.

Nigeria is fast becoming a dumping ground for technological waste especially used computers and cars from the USA, Japan and Germany, rechargeable lamps and electronics toys from china etc. It is a known fact that some of these products contain hazardous metals such as lead, mercury, nickel, and cadmium from car and rechargeable lamp batteries, and copper, zinc etc from electroplated parts of cars. The

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indiscriminate dumping of damaged parts of these imported and other similar locally produced materials in different forms can perturb the distribution and concentration of these metals in the environment.

There are many refuse dump scattered across Minna town, the content of which are mainly domestic waste. Two major dump sites are located along Minna -Bida road. One is at Kpakungu area and the other is at Gidan kwanu road (Gbaganu). The two dump sites witness daily influx of refuse from around the town. While Kpakungu is a densely populated area Gbaganu is sparsely populated but has large span of farmland. Like many cities in Nigeria, separation of hazardous waste is not practiced in Minna. As a result, heavy metal present in waste accumulates in the environment. Slow leaching of these metals during degradation process can result in underground water contamination. Since leaches are one of the potential sources of ground water pollution (Odukoya et al., 2000), heavy metal content in dump site can serve as indicator for potential underground water pollution. Furthermore; it is a general practice, for farmers in search of soil rich in organic manure to obtain soil from dumpsite for planting (especially vegetables). Research (Ademoroti, 1990) has confirmed that there is a linear correlation between Cd, Pb, and Ni content in the soil and vegetables grown in them. This work attempts to quantify the concentration of some heavy metals (Zn, Cu, Pb, Cd, As, Ni, Cr, Mn and Fe) in the soil of two major public dump sites in Minna. The objective is to ascertain the suitability of such soil for agricultural purpose. The data obtained in this work could serve as a base line data for heavy metals concentrations in the studied sites which until now to the best of our knowledge is not available.

Materials and Method

Ten evenly distributed locations were identified at each dump site as sample collection points. At each point solid waste were removed at the surface. Soil sample (0-15cm deep) was then taken at each point following standard procedure (Udosen et al., 2006). The top layer (0-15cm) of the soil was employed in this research since earlier studies by Nyangababo and Hamya (1999), indicated the top soil layers as better indicators of metallic burdens. The soil samples were put in clean polythene bags and sealed to prevent contamination during transportation and taken to the laboratory. At the laboratory, care was taken to prevent contamination of the samples. The samples were collected before the raining season of the year 2009. This is due to the fact that research (Yahaya, et al. 2009) has shown that the concentrations of these metals in soil are higher in the dry season than in the rainy season. This could be due to absence of surface run-off and leaching. Each sample was air-dried for two weeks to remove its water content. Clods and crumbs were removed and mixed uniformly. The samples were crushed and sieved through a 2mm sieve to remove the stones and other remaining coarse particles. 1.2g of the sieved soil was transferred to a tube of 100ml capacity and 10ml of concentrated HF acid followed by 20ml of concentrated HNO_3 and HCl in the ratio 3:1. The solution was heated for 45minutes. 5ml of saturated boric acid was later added and heated for another 45minutes after which distilled water was added to fill the tube to mark. The mixture was allowed to cool and settle for 24hours. The digested sample was then analyzed for heavy metals by a flame type atomic absorption spectrometer (AAS) (Model200A/Buck scientific).

Results and Discussion

Heavy metal analysis of soil samples from two dumpsites in Minna was carried out. The mean heavy metal content of the soil taken from 0—15cm depth at both sites are shown in table 1.

Table 1.: mean heavy metal content of soil from Gidan Kwanu (G.K) and Kpakungu (K.P) road refuse dump in, Niger State.

Metal	Dump – sites	
	G.K (mg/kg)	K.P (mg/kg)
Zn	23.21	9.28
Cu	4.57	2.08
Pb	12.00	17.00
Cd	-	-
Ni	52.00	21.00
Mn	19.64	3.07
Fe	47.29	19.76

For Gidan Kwanu road refuse dump the mean concentration of lead and Arsenic are comparatively less than that obtained for the other metals. The concentration of cadmium was below detection level in samples from the two dumpsites. The ascending order of heavy metal content at Gidan Kwanu road refuse dump is Cu , Pb Mn, Zn, Fe, and Ni . The ascending order of the heavy metal content at Kpakungu road refuse dump are; Cu, Mn, Zn, Pb, Ni, and Fe.

A comparison of the mean concentrations of Fe, Pb, Zn, Ni, Cd and Cu in Table 1 with their corresponding normal range in natural soil: Fe,100-7000mg/kg; Pb,2-200 mg/kg; Zn, 10-300mg/kg; Ni, 10-1000 mg/kg; Cd, 2-200; and Cu, 2-100 mg/kg (Vacera et al., 1999), show that these concentrations are within their normal range. Cadmium mean concentrations in both dump-sites were below detection level (BDL). The mean concentrations of manganese at both sites were within the natural range in soils (20-100mg/kg) as given by Ademoroti (1990). Generally the mean concentrations of all the metals investigated are higher for samples from G.K than those from K.P with Pb as an exception. The difference in metal concentration between the two dump sites could simply be attributed to the nature, quality and quantity of waste deposited in the sites. G.K site is a bigger dumpsite and witnessed massive influx of refuse on a daily basis from different parts of the town. While K.P, though closer to the town and residential abodes, witness a lower refuse content. The refuse content of both dump sites are mostly domestic and agricultural in origin as there are no industries that could throw metallic rich waste in them in Minna. Although K.P has lower metal content than G.K, unfortunately it is the soil from G.K that has higher potential of been used as a rich soil for agricultural purpose because of its proximity to farm lands.

Further comparison between concentrations of metals at the two sites shows that the mean (and standard deviation) of metals at GK and KP is 26.45 (19.14) mg/kg and 12.03(8.39) mg/kg respectively. The difference between the two mean equals 14.42, at 95% confidence interval of this difference is from -4.5880 to 33.4280. The unpaired t-test result obtained by using GraphPad software (www.graphpad.com/quickcalcs/ttest2.cfm) is t = 1.6903, df =10 and the two tail p-value equals 0.1218. By conventional criteria, this difference is considered to be not statistically significant.

Conclusion and Recommendation

Heavy metal analysis of two major dump sites in Minna (Gidan-Kwanu and Kpakungu) was carried out. The mean concentrations of samples from the dumpsites are found to be within their normal concentrations in soils with higher concentrations in soils from Gidan-Kwanowhen compared to those from Kpakungu.The higher level of heavy metal concentration at Gidan Kwanu road refuse dump is thought to be as a result of the frequent and large amount of refuse dumped there.

This study highlights the potential accumulation of heavy metals in soils around our environment - dump-sites. Although, for now the heavy metal content of the dumpsites could be said to pose no significant threat directly or indirectly to man or the environment, but the continuous dumping of refuse especially those of heavy metal will eventually lead to an increase in the metallic burden of the dumpsites soils. Therefore sorting and recycling of wastes should be intensified to reduce the quantity of these toxic metals at dumpsites. There is also a need for the establishment of a statutory body that can legislate and enforce the environmental rules and regulations on the general public. Although, recycling and sorting of wastes before dumping can also help to reduce the metal load at dumpsite soils. Proper education and legislations on the handling of wastes in the society should be intensified to forestall wastes related problems along the food chain. Furthermore, modern wastes disposal facilities should be acquired by the authorities concerned and appropriate waste disposal sites chosen by experts to avoid indiscriminate dumping of wastes within our cities.

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