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Determination Of Heavy Metal Contents From Dumpsites Within Ikot Ekpene, Akwa Ibom State, Nigeria Using Atomic Absorption Spectrophotometer

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--ABSTRACT--

The elemental composition of lead, iron, cadmium, zinc and copper in the top soil samples (0-15cm) from some selected dumpsites and 100m away from the dumpsites within Ikot Ekpene town in Akwa Ibom State, Nigeria, have been measured and determined using Atomic Absorption Spectrophotometer. At dumpsites, the concentrations of lead, iron, cadmium, zinc and copper ranged from 9.466 to 18.83 mg/kg, 18.06 to 23.47 mg/kg, 0.10 to 0.42 mg/kg, 13.82 to 17.26 mg/kg and 6.68 to 11.04 mg/kg respectively, while at control sites (100m away from dumpsites) the concentrations ranged from 5.21-7.53 mg/kg, 8.24-11.72 mg/kg, 0.04-0.08 mg/kg, 6.32-8.15 mg/kg and 2.06-5.61 mg/kg respectively. The concentrations of metals in soils at the decomposed biodegradable wastes dumpsites were higher than those at the control sites. It was observed that the concentrations of these metals in some sampling points were below accepted limit while others were within the accepted limit. Thus, no marked deleterious effect on the soil resulting from excess amount of these metals was detected. Highlights on good maintenance and improvement in the quality of soil in this area have been suggested.

KEYWORDS: Dumpsites, Ikot Ekpene, Heavy metals, pollution.

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I. INTRODUCTION

People across the globe have been facing a number of health problems, some resulting in death caused by indiscriminate dumping of urban waste matter, industrial waste, mineral exploitation and harmful agricultural practices. Despite this proven fact, there is usually more emphasis on air and water since man and animal breath air and drink water directly. Hence, are vulnerable to the effect of pollution from these sources unlike soil and vegetation pollution whose effects are more indirect. Recently in Nigeria, several attempts have been made to waste avoidance, reduction, reuse and recovery (recycling, composting and energy recovery). Land fill and waste disposal sites are still the principal focus for ultimate disposal of residual wastes and incineration residues worldwide (Waite, 1995). Several schools of thought have attempted the definition of solid waste. According to Udoessien (2003), solid wastes are substances which are solid or semi-solid, discarded or unwanted at a given time and place. The Federal Environment Protection Agency (1995) as well gave her definition for solid waste stating that, solid wastes are useless, unwanted or discarded material that arise from man’s activities and cannot be discarded through the sewer pipe. But from the authors’ point of view, solid waste can be defined as solid or semi-solid matter that occurs in nature or created by man or animal activities which are useless and/or hazardous to the environment. Many works thus have indicated that the unplanned municipal waste disposal could pollute land, water and air, and this has attracted considerable attention from scholars, private organizations and government agencies over the years. Svete *et al*., (2001) investigated the partitioning of zinc, lead and cadmium in sediment from lead mining areas of mezica valley using the BCR (Community bureau of reference) three steps sequentially extraction procedure. The result indicating that zinc prevailed in the most sparingly solution fraction and is distributed between organic matter and sulphide. While a small proportion is found in the easily soluble fraction. Lead was distributed mainly between organic matter and sulphides whereas cadmium was predominantly associated with the most sparingly,fraction.

Equally, data from normalization procedure indicated that the anthropogenic input zinc, lead and cadmium correlated with the very high total metal concentration determinations, determined in the sediments. The investigation showed that the highest total zinc lead and cadmium concentration (16. 3, 9.3 and 0.13) mg/ka respectively were found in the sediment of galena rivalet arising from mining activities. Adekunle et al., (2003) studied that level of some hazardous trace metals and simulated blood lead levels from highway soils of South-Western Nigerian. The mean simulated blood levels were 23.29±3.55µ/dl, 22.64±2.64µ/dl and 19.88±2.62µg/dl for Lagos, Ibadan and Abeokuta respectively. The result suggested contamination of these soils up to 4, 14 and 97 times the maximum tolerance by lead, copper and cadmium respectively. According to Sutherland and Track (2003), the relationship between the sum of the three steps of the modified BCR (Community Bureau of Reference) protocol and liberated from single dilute hydrochloric acid (0.5M) leach for soil and road side deposited sediment samples and found good correlation with r2 >92% for sediment aluminum cobalt, copper, manganese, lead and zinc.

According to Adekunle et al., (2003), the amount and distribution of heavy metals are known to influence properties such as surface. Specific surface are swelling and aggregate formation, transformation of nutrients and so on. Ebong et al., (2008) further gave their contributions stating that modern technologies have brought about a rapid increase in world population, industrialization and urbanization. These have in turn caused a corresponding increase in the domestic and industrial wastes generated, but the improper management of these waste results in environmental pollution problems. Amusan et al., (2005) showed that heavy metal content from 0.1cm to 15cm top soil from dumpsites reveals that lead 63.88 is 19.86µgg-1 , cadmium 17.00 is 5.70µgg-1 , cobalt 36.00 is 16.75µgg-1 and zinc 102.11 is 26.7µgg-1 . This study is aimed at determining the concentration of some heavy metals in soil samples from five dumpsites and five control sites, observe the relationship between the concentration of the heavy metal in the soil sample at dumpsite and soil sample 100m away (control site) without taking into account the physicochemical parameters of waste and the concentration of the waste before dumping, within Ikot-Ekpene metropolis in Akwa-Ibom State, Nigeria.

II. STUDY AREA

History streamlines the fact that Ikot-Ekpene Local Government Area (L.G.A) is the first L.G.A in Nigeria as a nation. Ikot-Ekpene L.G.A has been a fast growing urban centre in Akwa Ibom State. It is presently, divided into eleven (11) political zones. Areas within these zones have been chosen for this study. Apart from being a booming business centre in the state, it is also a pivotal town linking Akwa-Ibom State with Abia, Imo, Cross River and Rivers States. As a result of her situation matrix and her local craft industry which attracts foreigners, Ikot-Ekpene L.G.A is nicknamed “Raffia City” of Nigeria. The population of Ikot Ekpene L.G.A is over 110,000 and would continue to increase leading to environmental nuisance via solid waste disposal of various dimensions. Ikot-Ekpene is within the mainland part of Akwa Ibom State. Its topography is basically plain except that a sloppy terrain which ends in a ravine (Nkap ravine) at one end of the Local Government Area. The area lacks functional drainage system in most part especially areas like Umuahia road, Kent Street and others of which when it rains heavily are flooded. Due to improper disposal of solid waste, part of the area is faced with the problem of indiscriminate dumping of wastes on the streets and road which is not advisable for a healthy living. The area is located within the broad vegetation of lowland forest and the sub region of the tropical high forest. The vegetation is however affected by activities like agriculture, construction, and urbanization. Ikot-Ekpene Local Government Area is principally influenced by two air masses: the tropical continental air mass (CT) and the tropical maritime air (MT). These two air masses are in constant conflict with one another hence, the inter-tropical discontinuity (ITD) (Eddy et al., 2006).

Source: Microsoft (2008) Map showing location of study area (Ikot Ekpene L.G.A)

III. MATERIALS AND METHODS

Sample Collection

Soil samples were randomly collected 15cm depth (Nyangababo and Hamya, 1986) from five (5) different dumpsites within Ikot-Ekpene metropolis. Areas of dumpsites include:

i) Umobot Street
ii) Ukam Street
iii) Kent avenue
iv) GRA and
v) Udua Adan Market

Control samples were also collected 100m away from each dumpsites using augar (Eddy et al., 2006). The samples were poured into polythene bag properly labeled and transported to the laboratory for analysis.

Sample Preparation

The sample was air-dried for twelve days (Ebong et al., 2008) grinded, sieved with a 2mm mesh sieve, and a total of 30. 06g of sample was obtained which was stored in a small plastic container properly labeled before the analysis. The concentrations of iron (Fe), lead (Pb), Zinc (Zn), Nickel (Ni), Cadmium (Cd) and copper (Cu) in the digested soil samples were determined using Atomic Absorption Spectrophotometer Unicam 939/959 model following the methods described by Ebong et al.,(2008).

IV. RESULTS AND DISCUSSION

Results

The concentrations of lead, iron, cadmium, zinc and copper in soils at five dumpsites and 100m way from the dumpsite of the study area were analytically treated as shown in Table 3. The field results were presented thus: mean ± standard deviation. Concentration of heavy metals (mg/kg) in soil samples from the five dumpsites and the five control sites (100m away) are presented in Table 1 and 2 respectively. Bar charts showed the percentage composition of the heavy metals from the dumpsites and the control sites respectively are presented in fig 1 & 2

Table 1: summary of heavy metal concentration (mg/kg DW) in soil samples from the five dumpsites within the study area.

Dumpsite	Lead	Iron	Cadmium	Zinc	Copper
Kent Street	17.05	21.24	1.42	14.84	9.10
Udua Adan Market	18.83	23.47	0.11	17.76	8.31
Umobot Street	13.48	20.37	0.12	15.31	11.04
Ukam street	9.46	18.06	0.10	13.82	6.68
GRA	16.46	20.00	0.09	16.35	8.15

Table 2: Heavy metal Concentration (mg/kg) DW in Soil Sample from the five control Sites within the Study Area

Control Site	Lead	Iron	Cadmium	Zinc	Copper
Kent Street	5.22	8.27	0.08	6.52	4.04
Udua Adan Market	6.25	11.72	0.06	6.35	5.61
Umobot street	7.53	10.86	0.08	7.57	5.01
Ukam Street	5.21	8.94	0.05	6.32	2.06
GRA	7.02	8.24	0.04	8.15	3.02

Table 5: Analytically Treated Information of Heavy Metal Concentration (Mg/Kg DW) in Soil Samples from Five Dumpsites and Five Control Sites Respectively Within the Study Area

Sample Site	Pb	Fe	Cd	Zi	Cu
Kent Street	17.05±4.10	21.24±7.35	0.42±0.01	14.84±6.33	9.10±1.64
Control	5.22±0.55	8.27±1.06	0.08±0.02	6.52±0.45	4.01±0.43
Udua Adan	18.83±7.10	23.47±8.44	0.11±0.02	17.26±7.20	8.13±2.19
Control	6.25±1.13	11.72±3.57	0.06±0.01	6.35±1.05	5.61±1.04
Umodot Street	13.48±5.30	20.37±6.42	0.12±0.03	15.31±4.77	11.04±5.60
Control	7.53±0.81	10.86±1.22	0.06±0.02	7.57±0.54	5.01±0.36
Ukam Street	9.46±2.37	18.06±5.85	0.10±0.01	13.82±6.11	6.68±0.73
Control	5.21±0.55	8.94±1.24	0.05±0.01	6.32±0.71	2.06±0.04
GRA	16.46±3.28	20.00±7.25	0.09±0.02	16.35±5.28	8.15±0.74
Control	7.02±1.26	8.24±0.87	0.04±0.01	8.15±1.01	3.02±0.45
A M (D)	15.05	20.63	0.17	15.12	8.62
AM (C)	6.25	9.61	0.06	6.98	3.94
SD(C)	1.05	1.59	0.02	1.83	1.44
SD(D)	3.67	1.97	0.14	1.41	1.61
Min. (D)	9.46	18.06	0.10	13.82	6.68
Min. (C)	5.21	8.24	0.04	6.32	2.06
Max. (D)	18.83	23.47	0.42	17.26	11.04
Max. (C)	7.53	11.72	0.08	8.15	5.61
Range (D)	9.37	5.41	0.32	3.44	4.36
Range (C)	2.32	3.48	0.04	1.83	3.55
CV (%) (D) 24	24	95	83	9	19
CV (%) (C) 17	17	17	25	12	37

AM = Arithmetic Mean; SD = Standard Deviation; Min = Minimum; Max = Maximum; CV = Coefficient of variation; (C) = Control Site and (D) = Dumpsite

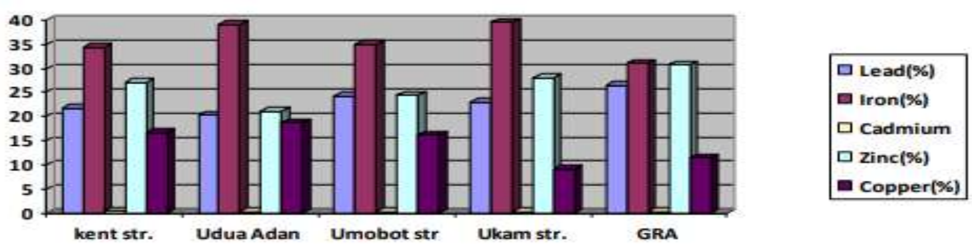

Fig. 1:
Bar chart showing the percentage composition of Heavy Metal Concentrations in soil samples from the five dumpsites within the study Area

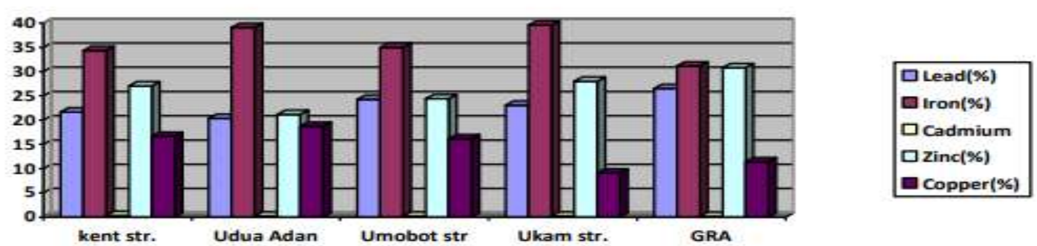

Fig. 2:
Bar chart showing the percentage composition of Heavy Metal Concentrations in soil samples from the five control sites of the study Area

V. DISCUSSION

The concentration of metals in soils at the decomposed biodegradable waste dumpsite and 100m away (control site) from dumpsite indicate that there is a relative increase in the concentration of heavy metal at dumpsites compared to those in soils 100m away (control site) from the dumpsite. This is in agreement with the results obtained from similar a study by Amusan et al., (2005). This could be attributed to the availability of metal containing wastes at dumpsite which are eventually leached into the underlying soils. The metals considered in this study include the metals which are micro-nutrient such as iron, zinc and copper and the nonessential/toxic heavy metal which are toxic to plant when present in the soil at concentrations above tolerance level. These elements are highly needed by plants for their normal growth. From the results obtained, the concentration of lead at dumpsites ranged from 9.46 mg/kg to 18.83mg/kg and for the control sites it ranged from 5.21 mg/kg to 7.53mg/kg showing that both the dumpsites and control sites had normal range of 2- 200mg/kg (Ebong et al., 2008). Comparing values at dumpsites with that at control sites, the higher concentration of lead at dumpsites could be attributed to the decomposition of lead containing waste. From similar work reported by Dara (1993), the major source of lead pollution is industrial source. Thus, any nearby industry that disposes lead as one of its wastes can also influence the concentration of lead in that environment.

According to Aluko et al., (2003), the mean concentration of lead in soil at Ibadan dumpsite also ranged from 1.34mg/g to 1.693mg/g. But since lead is a cumulative pollutant (Dara, 1993) the pollution of soil by lead remains a very serious problems that should be given much attention by environmental chemists in collaboration with government agencies. Also, effort should be made to educate the public on the health effect of this metal when injected in excess to the body. Such effects which includes: damage of the brain, kidney, miscarriage in pregnant women and damage of sperm production organ in male (Sabine and Wendy, 2009).

The standard and accepted level of iron in soil ranges between 100-700mg/kg (Ebong et al., 2008). From this study, at dumpsite Udua Adan Market recorded the highest level of iron (23.47mg/kg) while the dumpsites at Ukam Street recorded the least level of iron (18.06mg/kg). The five dumpsites analysed for iron ranged from (18.06 to 23.47) mg/kg which fell far below the accepted range of iron in soil. At the control site, the concentration also ranged between (8.24 and 11.72)mg/kg, which is much far below the accepted range of iron in soil. But iron records the higher concentration of the metals analysed. This indicates the importance of iron to humans. According to WHO (1984), the deficiency of iron in man can cause weak muscular coordination, vomiting, diarrhea and other serious health defects. Comparing this with the result obtained by Akaeze (2001), Elelenwo (of Rivers State) dumpsite had concentration of iron range between (10,300 and 31,000) ppm which falls within accepted level. But from studies carried out by Udeme (2001) for soil along Abak/Ikot Ekpene Road, in Uyo metropolis, Akwa-Ibom State Nigeria, using different methods at different sample location revealed results that are comparable to the one obtained in this study. Eddy et al., (2004) suggested that different sample location revealed results that are comparable to the one obtained in this study. Eddy et al., (2004) suggested that any pollution of the environment by iron cannot be conclusively linked to waste materials alone but other natural sources of iron must be taken into consideration. From the authors' point of view: despite the fact that iron is a micro nutrient, it should be properly monitored to maintain its concentration in the accepted range to avoid health defect caused by the deficiency or excess amount of it.

Cadmium is classified as a soft acid, preferentially complexing with sulfides (Moore, 1991). Its accepted range in soil as stated by Ebong et al., (2008) is (0.01-300) mg/kg. The result obtained showed that the cadmium level at dumpsite and control site, both fall below accepted range of the metal in soil. From the analytical result, it was found that the range of cadmium at dumpsite within the study area falls between (0.09 and 0.42)mg/kg and that of its control site falls between (0.04 to 0.08)mg/kg. Cadmium was listed by EPA (1991) as one of the 129 priority pollutants and among the 25 hazardous substances. Injection of high level of cadmium severely irritates the stomach leading to voting and diarrhea. Cadmium and its compound are known human carcinogens and smokers get exposed to significant amount of cadmium than non-smokers. Other effects associated with cadmium include damage of lungs, fragile bones and kidney disease (Sabine and Wendy, 2009). Thus, should be able to attract the attention of environmental chemists, Government agencies and other private bodies.

The concentration of zinc in soils was obtained to range between (13.82 and 17.26) mg/kg for dumpsites and (6.32 to 8.15) mg/kg for the control sites. It could be seen that this falls within the accepted standard for the dumpsites but slightly deviates for the control sites. Control sites for kent Street, Udua Adan market and Ukam Street were specifically found to fall out of the accepted range of zincs in soil which is (10-300)mg/kg. According to Odukoya et al., (2000), the range of zinc obtained from Abeokuta dumpsites was 100.80 to 226.00mg/kg, while its control sample range was found to be (51.25 to 71.43)mg/kg which falls within the accepted range. This variation could be attributed to the fact that categories of waste introduce to such dumpsites have high concentration of zinc. Also from the concentration of zinc in the two control sample soils can be high due to some environmental factors. This was confirmed by Dara (1993). Zinc is required in human nutrient for normal functioning of the body. The deficiency of zinc in man can lead to impaired growth, low energy balance and low protein intake. While excessive intake of zinc from plants can lead to vomiting, dehydration, electrolyte imbalance, abdominal pain, and lack of muscular co-ordination (Udosen, 2000)

The natural range of concentration of copper in soil is (2-100)mg/kg (Ebong et al., 2008). The concentration range between (6.68 and 11.4)mg/kg and (2.06 to 5.61)mg/kg for dumpsite and control site respectively of the study area. Both the dumpsites and control sites concentration of copper within the study area falls within the accepted standard range. There is no deleterious effect of copper resulting from its deficiency or excess amount. According to Dara (1993), the high concentration of copper at the dumpsite might be attributed to biodegradable waste introducing metallic copper into the soil. World Health Organization (1984) stated that, the injection of copper can lead to severe muscular irritation, nausea, vomiting, diarrhea, intestinal cramps, severe gastrointestinal irritation, and other dangerous health defects. For the general results obtainedfrom this study, the top layer (0-15cm depth) of the soil was employed in the research since earlier studies by Nyangababo and Hamya (1986) indicated the top soil layers as better indicators of metallic burdens.

VI. CONCLUSION

From this study, since none of the heavy metals analysed was higher than the accepted standard, there was no hazard associated with the high concentration of the metals analyzed but the concentrations of all the heavy metals analysed at dumpsites were higher than the values at the control sites which might not be unconnected with the rate or level of leaching in the soil. An evidence of this relative increase in concentrations of metals in soils at dumpsites compared to those 100m away from dumpsites shows that the concentration of heavy metal in soil at dumpsite is directly proportional to its concentration distance away from dumpsite provided porosity is constant. Thus dumpsites have a significant impact in the environment which could be positive or negative. This means that there should be a kind of measure taken in order to safely dispose of our refuse to prevent the general public from being exposed to unnecessary hazards. Hence, residential areas should be sited a reasonable distance away from dumpsite especially when the need for drilling bore hole for town water supply arises, environmental impact assessment is highly recommended. Effort should also be made to discourage the practice of cultivation at dumpsite soil(Ebong et al., 2008) since plants growing at dumpsite soil bioaccumulate considerably high heavy metal content than those in normal soil (Umoren, 2006) and the concentration of heavy metal on this soil can easily increase beyond tolerance level causing serious problems along the food chain. Thus the need to test for the physicochemical parameters of waste and the concentration of heavy metals in waste before dumping in a different study remains an outstanding area which should be focused on.

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