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Levels of Heavy Metals (Cd, Pb and Zn) in a Selected Solid Waste Dumps Sites Environment in Abakaliki Urban

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Abstract: Soil samples collected from various waste dumps in Abakaliki urban were analysed from four heavy metals. Cadmium (Cd), mercury (Hg), lead (Pb) and zinc (Zn). The samples sites include Rice mill, Mechanic village and Spera-in Deo junction all within Abakaliki metropolis. The levels of heavy metals in the soil samples were determine using Atomic Absorption Spectrometer (Perkin – Elmer Model 306). The results (in mg/kg) revealed the range: (2.19±0.03 – 4.36±0.04) for Hg; (0.05±0.01 – 1.19±0.01) for Cd; (0.05±0.01 – 2.19±0.02) for Pb and (2.00±0.02 – 14.11±0.11) for Zn. The levels of heavy metals generally decreased from topsoil > mid-soil > subsoil which suggests that the source of pollution is anthropogenic. None of the heavy metal concentration exceeded the WHO standard of U.S.EPA (1993). However the heavy metal load was found to be highest in soil samples from rice mill waste dump which reflects the prevalent economic activities in the area. Regular evaluation of soil is expedient in environmental monitoring.

Key words: Heavy metals · Solid waste · Dumps sites and Abakaliki

INTRODUCTION

According to CODEX Alimentarius Commission [1], every 1000 Kg of a normal soil contains at least 200 g chromium, 80 g nickel, 16 g lead, 0.5 g mercury and 0.2 g cadmium theoretically. Hence it may not be easy to assign a definite cause for increasing metal content of a soil sample without recourse to the background level of the metal. However, urbanization always results in introduction of heavy metals in the environment based on man's activities. Sources of trace metals to the environment includes: natural (weathering of rocks, volcanic ash etc) and anthropogenic sources. Anthropogenic sources of heavy metals in agricultural soils include mining, smelting, waste disposal, urban effluent, vehicle exhausts, sewage sludge, pesticides and fertilizers application. Heavy metals such as cadmium, magnesium, lead and arsenic are regarded as environmental pollutants because they have hazardous effects on the environment. Previous studies of heavy metals within an ecosystem have showed many urban areas, utilization of metallic materials and industrialised cities contain high concentration of their pollutant [2-4]. The term pollution is used to describe an undesirable state of the environment. Pollution is the modification of the environment by the release of toxic materials which are harmful to human life. It can also be defined as the natural or induced undesirable changes in the quality of a substance which renders it dangerous to human activity [5]. The defects of toxic element in the soil depend on their concentration and degree of toxicity. Some of these heavy metals are essential, while some adversely affect human beings on consumption. Finally, the effect resulting from the accumulation of toxic element is bound to occur anywhere such element are found in levels exceeding the natural concentration of these elements in soil or plant [4, 6]. The aim of this study is to determining the concentration of those heavy metals (Cd, Hg, Pb, Zn) in soil of waste dump site in Abakaliki Urban.

Study Area: Abakaliki, the Capital City of Ebonyi State of Nigeria is located at latitudes 6°19'N, 6° 21'N and longitudes 8°05'E, 8°07'E (Microsoft Encarta, 2007), [22]. The study area, Abakaliki, is in the mid of the South Eastern, Nigeria (latitudes 4°20' and 7°00'N and longitudes 5°25' and 9°35'). The prevailing climate conditions are high rainfall, high temperatures, high atmospheric humidity and precipitation usually exceeding evapotranspiration for more than half the year. The vegetation types are mangrove and freshwater swamp communities, rainforest, forest/savannah mosaic and derived savannah zone. The farming system prevailing in the region is dominated by yam, root crops and plantain, in addition to oil palm.

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Fig. 1: Map of Nigeria Showing the Study Area (Abakaliki)

Rice mill houses hundred of milling engines, operators, loaders, transporters, petroleum station, traders, etc. It majorly attracts thousands of people daily who parboil and mill rice while women are seen carrying bags of rice husk, the waste product of rice mill for further utilization of rice husk. Rice mill is characterized many kinds of pollutions such as sound pollution coming from old engines, air pollution by gases emitting from rice milling engines and vehicular movement and land pollution from discharge of waste of rice mill. In addition, agronomic activity such as farming is another vital component of the rice mill. Hence the use of fertilizers by the farmer in the area, the combustion of leaded gasoline by motor vehicle and other power generating plants introduce a lot of pollutant that contaminate the environment.

Mechanic Village is located 1500 m from the central part of the town about 200 m to Rice Mill Industry. The mechanic village is characterized by beehive activities from 8.00 am in the morning to 6.00pm in the evening. A section known as Motor parts is where people buy and sell different parts of vehicles. The remaining section is occupied basically by the four major identifiable groups such as mechanics, welders, electricians and panel beaters. The mechanics and electricians focus on repairing the mechanical and electrical aspect of the vehicles respectively. The welders and panel fix damaged parts of vehicle and weld metals together. All these activities result to introduction of metals into the environment due to poor waste management [21].

Spera in Deo junction is one of the busiest parts of Abakaliki town. It is located at a junction where three major roads meet *viz*: Afikpo Road, Enugu Road and Ogoja road. The junction has the highest density of petroleum station, vehicle movements and local markets. Anthropogenic activities are very high and numerous residential buildings are concentrated around the junction.

MATERIALS AND METHODS

Sampling: Composite samples of soil were collected using pre-treated plastic spoon from 0-30cm, 30-60cm and 60-90cm representing the top, mid and sub soils. The samples were labelled appropriately and stored in treated polythene bag. The samples were ground, sieved and sun dried for 6 hours so as to remove the moisture present and to avoid interference during analysis. The grounded samples were sieved using a 2.0 mesh size sieve in order to remove large fragments of the sample and to separate the coarse grains from the metal rich fine grained soil samples.

Sample Digestion: 5g of the dried soil sample was weighed out using an electric balance (model mp 300) into a 25ml beaker and 10ml of aqua regia was added. The solution was heated in a hot plate at the temperature of 250°C and 10ml of de-ionized water was added and the solution was heated until a clear liquid was obtained. Then the solution was cooled and was filtered into measuring cylinder. The content of the measuring cylinder was made up to 25ml. The solution was finally transferred to a clean plastic container for AAS analysis.

RESULTS

The results in Table 1 indicated that levels of heavy metals in the three investigated waste dumps in Abakaliki showed that top soil had the greatest level, followed by mid soil and sub soil respectively. The results also indicated that all the levels of heavy metals recorded at Rice mill, Mechanic village and Spera in Deo were below the US EPA standard level. The results in figure showed that the level of zinc increased significantly in Rice mill when compared to the zinc levels at Mechanic village and Spera in deo respectively. Also the level of mercury increased at Rice mill but when compared to Mechanic village and Spera in deo its increase was not significant. Lead level was higher in Mechanic village but Rice mill recorded the least concentration of Cd.

DISCUSSION

The levels of heavy metals in the three investigated waste dumps generally decreased in the order: top soil > mid soil > sub soil which suggests that the source of the metal is anthropogenic in nature. Zinc and cadmium values were the highest and lowest concentration in the refuse dump soils, respectively. It was observed that none of the studied heavy metals exceeded the United States Environmental Protection Agency (U.S.EPA) standard for metals in sludge or waste soils. The highest pH value was observed in Spera in Doe waste (6.81) and the lowest was Mechanic Village (6.51). The pH values are known to affect the solubility and concentration of metals in the soil. Lead has low solubility at pH range of 5.5 - 7.5 which is normal for most mineral soils [23]. Generally at pH of 7.0, soils have higher availability of nutrient elements such as Mg, Ca, K, N and S, while metals such as Pb, Cu, Mn and Zn are less soluble and therefore less available at about this pH. Results obtained from confirm that industrialization leads to heavy metal loads in the soil in agreement with those obtained by Anyakora *et al.* [27]. The data generated from this work were comparable with those reported by Oti *et al.* [28].

Although Zn is an essential micronutrient, it can become harmful especially to humans at excessive levels. Even at low concentrations, Hg, Cd and Pb are toxic and they reduce biomass production through the deterioration of soil fertility. For instance, Cadmium was found to be toxic to plants at low pH and relatively low concentration in plants. In solution, some metals exhibit synergism such as Ni/Zn, Cu/Cd, Cd/Zn and Cu/Zn present a more hazardous effect than the individual metals [24]. Heavy metals in the soil are absorbed through the plants roots with soil water that dissolved the pollutants and may either cause harm to the plants or pass through the food chain to harm humans. The toxicological effect of heavy metals, especially Pb, Cd and Hg has been documented and they include gastro-enteritis, inhibition of haemoglobin formation, sterility, miscarriage, growth retardation, central nervous system disorder, kidney dysfunction, hypertension and mental retardation [25, 26].

CONCLUSION

The soil samples from all the investigated waste dumps can support agronomic activities since none of the studied heavy metals exceeded the U.S. EPA and the pH were found to be within the range of 6.51 – 6.92. However continuous disposal of waste will eventually lead to accumulation toxic metals in the soil which will adversely affect the plants and ultimately man and other member of the food chain. The results revealed that metal load in the soil from waste dumps reflect the prevalent economic activities in the area.

Table 1 presents the mean concentrations of heavy metals in the soil samples of different waste dumps in Abakaliki and Figure 1 shows the bar chart of the top soil of the investigated waste dumps.

Table 1: Mean concentration (mg/Kg) of Heavy metals in Samples of Waste Dump Soil in Abakaliki (n=3)

Sampling Points		Metal Concentration (mg/Kg) Hg	Cd	Pb	Zn	Mean pH
Rice Mill	Top Soil	4.36±0.04	0.22±0.01	1.11±0.01	14.11±0.11	6.81±0.72
	Mid Soil	3.78±0.04	0.15±0.01	1.05±0.01	8.54±0.06	
	Sub Soil	3.15±0.03	1.11±0.01	0.11±0.01	4.61±0.04	
Mechanic Village	Top Soil	2.99±0.03	1.19±0.01	2.19±0.02	4.34±0.04	6.51±0.22
	Mid Soil	2.66±0.03	0.08±0.01	2.08±0.02	3.09±0.03	
	Sub Soil	2.19±0.03	0.03±0.01	1.03±0.01	5.00±0.05	
Spera in Doe	Top Soil	3.17±0.03	0.96±0.01	0.96±0.01	2.45±0.02	6.92±0.02
	Mid Soil	2.31±0.02	0.54±0.01	0.64±0.01	2.00±0.02	
	Sub Soil	2.50±0.02	0.05±0.01	0.05±0.01	2.98±0.03	
U.S.EPA	(1993)	840	85	420	7500	

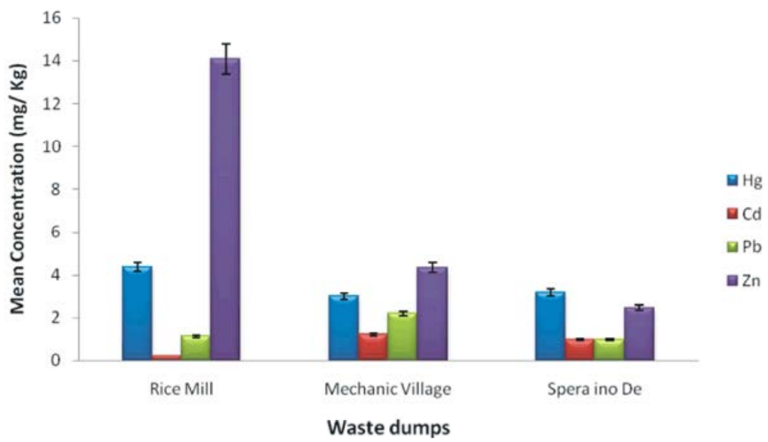

Fig. 1: Mean Concentration of Heavy metals (mg/Kg) in the Topsoil of Selected Waste dumps in Abakaliki

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