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Environmental Impact of Heavy Metal Contaminants and Micronutrients in Soil Samples of Metal Dumpsites in Abeokuta, OgunState, Nigeria.

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Abstract: *Soil samplesin metal dumpsites in Abeokuta metropolis was assessed for possible availability, concentration of heavy metals, micronutrients and theireffects. The soil samples were collected from three (3) different dumpsites, analyzed using AAS and the data subjected to statistical analysis of variance.Metals were detected in all the sampling sites. Sodium content determined are 0.24 ± 0.03, 0.23 ± 0.04and 0.94 ± 0.05 mg/kg in soil samples found in metal dumpsites of Sabo, Lafenwa and Ojere respectively. Potassium content determined are 0.44 ± 0.04, 0.38 ± 0.03and 0.23 ± 0.02 mg/kg, Manganese content determined are 1.30 ± 0.20, 1.45 ± 0.15 and 0.80 ± 0.00 mg/kg, Chromium content determined are 1.15 ± 0.15, 1.15 ± 0.15 and 0.24 ± 0.02 mg/kg, Cadmium content determined are1.35 ± 0.15, 0.90 ± 0.10 and 0.75 ±0.05 mg/kg. Concentration of Nickel was highest in Lafenwametal dumpsite with a value of 1.88 ± 0.00mg/kg while Zinc showed a high concentration of 2.00 ± 0.00, 2.95 ± 0.77 and 1.20 ± 0.00mg/kg in all soil samples and Calcium has 4.13 ± 0.18, 4.25 ± 0.35 and 1.81 ± 0.09mg/kg respectively.Copper has the highest concentration as 4.30 ± 0.42, 8.80 ± 0.28 and 2.55± 0.35 mg/kg respectively. The concentrations of Magnesium in the soil sample are 1.65 ± 0.08,1.70± 0.14 and 7.30 ± 0.04mg/kg and that of Iron are 1.55 ± 0.21, 1.60 ± 0.28 and 0.90 ± 0.14mg/kg while Cobalt concentration were 1.73 ± 0.42, 2.17 ± 0.14 and 0.02 ± 0.00mg/kg.It is evident that the soil from dump sites of Abeokuta contained low concentration of heavy metals compared to other studies. However, the continuous use of this area as a metal dumpsite may lead to heavy metal build up in soils to undesirable level, coupled with automobile mechanic activity which could increase the risk of serious environmental pollution in the nearest future.*

Keywords: *Environmental Impact,Heavy Metal Contaminants, Metal Dumpsites,Micronutrients, Soil Contamination.*

I. Introduction

The Impact of solid waste on health and environment has been an issue of global concern over the years [1, 2]. Solid wastes are sources of environmental pollution through introduction of chemical substance above their threshold limit into the environment. Reports have shown that solid waste adds additional heavy metals into the surrounding soil and groundwater [3, 4].

Soil is a natural reservoir of metals whose concentration are associated with several factors such as biological and biogeochemical cycling, parent material and mineralogy, soil age, organic matter, soil pH, redox concentration and microbial activities[5, 6].

However large amounts of these heavy metals are released into soil as a result of increased anthropogenic activities such as agricultural practices, industrial activities, energy consumption and waste disposal methods, thus leading to the contamination of the soils[7, 8]. These Data on the contamination and subsequent pollution of the environment by toxic heavy metals has become an issue of global concern due to their widespread sources, distribution and multiple effects on the ecosystem [9, 10].The pollution of the environment with heavy metals has become a world-wide problem during recent years because they are non-biogradable and toxic to flora and fauna in the ecosystem [11, 12].

Heavy metals have a density of 6.0g/cm^3 or more (much higher than the average particle density of soils which is 2.65g/cm^3) and occur naturally in rocks but concentrations are frequently elevated as a result of contamination. The most important heavy metals with regard to potential hazards and occurrence in contaminated soils are: Arsenic (As),Cadmium (Cd), Chromium (Cr),Mercury (Hg), Lead(Pb) and Zinc(Zn). The sources of heavy metal pollutants are metal mining and smelting, metallurgical industries and other metal using industries, waste disposal, corrosion of metal in use, agriculture, forestry and fossil fuel combustion. Agriculture in the pollutant areas faces major problems due to heavy metal transfer into crops and subsequently into the food chain [13].Heavy metals are natural components of the Earth's crust. They cannot be degraded or destroyed; to a small extent they enter our bodies via food, drinking water and air. As a trace element, some heavy metals (e.g. Copper, Selenium and Zinc) are essential to maintain the metabolism of the human body;however, at higher concentration they contained poison. Heavy metals poisoning could result, for instance from drinking contaminated watere.g. lead pipes, high ambient air concentrations near emission sources.

Soils may become contaminated by the accumulation of heavy metals and metalloids through emissions from the rapidly expanding industrial areas, disposal of high metal wastes, leaded gasoline and paints, land application of fertilizers, animal manures, sewage sludge, pesticides, wastewater irrigation, coal combustion residues, spillage of petrol chemicals and atmospheric deposition [(13)]. Soil are the major sinks for heavy metals released into the environment by a fine mentioned 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[(1)]. Heavy metals contamination of soil may pose risks and hazards to humans and the ecosystem through: direct ingestion or contact with contaminated soil, the food chain (soil- plant- human or soil-plant- animal- human).

The aim of this study is to determinethe possible heavy metal contaminationand micronutrients in the soil sample found in metal dumpsites and the effect of each element on the environment.

II. Materials And Method

2.1 SAMPLE COLLECTION

The soil samples were collected from three (3) different dumpsites in Abeokuta, (Sabo, Lafenwa and Ojere). The soil samples were taken from the surface down to 20cm depth of the ground to get a composite sample. They were put in three different sample bags and well labeled before taken to the laboratory for analysis.

2.2 CHEMICAL ANALYSIS

2g each of the samples were measured into a digestion tube, one tablet of selenium catalyst was placed inside the tube, 10 cm^3 of concentrated perchloric acid and 10 cm^3 of concentrated Nitric acid inratio 1:1 was added to the tube, placed inside a digestion block, and slowly digested. The digest was washed into 100 cm^3 volumetric flask and made-up with distilled water.The washed samples were then read with an Atomic Absorption Spectrophotometer (AAS) using their respective lamp and wavelengths.
Calculations were done using the formula below:
Meter reading x Slope x Dilution factor (Preer and Roser 1999).

III. Result And Discussion

Table 1 shows the result of the concentration of heavy metals and trace elements found in the soil samples. Metals were detected in all the sampling sites. Sodium contents determined were 0.24 ± 0.04, 0.23 ± 0.05 and 0.94 ± 0.50 mg/kg in soil samples found in metal dumpsites of Sabo, Lafenwa and Ojere respectively. Sodium concentrations in these dumpsites were within the WHO guideline [(14)].This might be due to the texture of the soil which might not likely contain high levels of clay and organic matter that can develop problems with high sodium levels that are not considerable for both plants and animals [(15)].High concentration of sodium in soil is said to have detrimental effects on plants as it causes ionic toxicity and imbalance in the Na^+/K^+,Na^+/Ca^{2+}, Na^+/Mg^{2+} and may cause salt injury to plants. Physiologically, it also helps osmo-regulations, heat expansion and may act as potassium constituent[(16)].

Potassium contents determined were 0.44 ± 0.04, 0.38 ± 0.38 and 0.23 ± 0.23 mg/kg in soil samples found in the metal dumpsite respectively and were within the WHO guideline [(14)]. Potassium is an essential nutrient for plant growth and low potassium concentration might be due to the competition with calcium and magnesium on the sites with relevance to the cation exchange and this affect the plant growth[(15)]. Potassium is an enzyme activator that increasesphotosynthesis, its availability and leaching has become a limiting factor for crop production[(16)].

Manganese content determined are 1.30 ± 0.20, 1.45 ±0.15 and 0.80 ±0.00 mg/kg in soil samples found in metal dumpsites respectively. These concentrations are a little high at sabo and lafenwa dumpsites compared to the soil sample in ojere dumpsite, though these concentrations are still within the international agricultural soil limits. Concentrations found in sabo and lafenwa dumpsites might be due to a high soil pH while the low concentration of manganese in soil sample found in ojere could be due to the alkalinity of the soil and this can affect the plant growth and swellingof cell wall, weathering of leaves and brown spots on leaves[(16)].

Chromium content determined are 1.15 ± 0.15, 1.15 ± 0.15 and 0.24 ± 0.20 mg/kg in soil samples found in the metal dumpsites respectively. The concentrations of chromium in these dumpsites arestill within the permissible limits of the international agricultural soil limits and the US EPA as well as NYS DEC guidelines for clean ups for both residential and unrestricted use. This result might be due to dumping of electroplated metals. Chromium is required for carbohydrate and lipid metabolism and the utilization of amino acids. Its biological function is also closely associated with that of insulin and most chromium stimulated reaction depends on insulin. However, excessive amount can cause toxicity [(15)].

Cadmium content determined are1.35 ± 0.15, 0.90 ± 0.10 and 0.75 ± 0.05 mg/kg in soil samples found in the metal dumpsites respectively. The concentrations of cadmium are very high in these soil samples found in metal dumpsites of Sabo, Lafenwa and Ojere yet, within the soil screening level for US EPA but higher than the limits for both international agricultural soil limits and NYS DEC unrestricted use. These high concentrations of cadmium might be caused by the dumping of substance like cadmium batteries and electroplated metals. It causes phyto-toxicity risk of cultivating edible hyper-accumulator plants. Cadmium has its toxicity linked with reproduction problem because it affects sperm and reduce birth weight and it is a potential carcinogen and seems to be a causal factor in cardiovascular disease and hypertension (15).

Concentration of Nickel is highest (though within the maximum permissible level) in Lafenwa dumpsite with a value of 1.88 ± 0.00 mg/kg and this could be due to the alkaline stabilization process of the soil**.** The concentration of Nickel is low in Ojere. Nickel high quantities can cause cancer, respiratory failure, birth defects, allergies and heart failure (15)

Zinc shows a high concentration of 2.00 ± 0.00, 2.95 ± 0.77, and 1.20 ± 0.00 mg/kg in the soil samples respectively, while Calcium has 4.13 ± 0.18, 4.25 ± 0.35, 1.81 ± 0.09 mg/kg respectively in the same soil samples. The soil samples were found to contain calcium at a low concentration which can be regarded as deficient as the deficiency symptoms occur generally at 500mg/kg. Increasing sodium salt may lead to precipitation of calcium salts with carbornates or bicarbonates. Physiologically calcium is important in plants nutrients as it regulates the growth(16)

The result showed that Copper has the highest concentration as 4.30 ± 0.42, 8.80 ± 0.28, and 2.55 ± 0.35 mg/kg in the samples of the metal dumpsite respectively compared to other metals. It is evident that the high concentration is caused by the nature of the materials dumped at the dumpsites which is dominated by electroplated metals. In copper rich soils, only a limited number of plants have the chance of survival as high concentrations have serious effect on plants(16).

The concentration of Magnesium in the soil sample of the dumpsites are 1.65 ± 0.08,1.70 ± 0.14 and 7.30 ± 0.04 mg/kg respectively while that of Iron were 1.55 ± 0.21, 1.60 ± 0.28, 0.90 ± 0.14 mg/kg and cobalt concentration were 1.73 ± 0.42, 2.17 ± 0.14 and 0.02 ± 0.00 mg/kg. Magnesiumplays an important role in plant growth and metabolism, it regulates the ATP enzymes, carbon dioxide fixation, cellular pH control, chlorophyll content and other functions of development(16).

However, the concentration of cobalt in the soil could be as a result of automobile exhaust fumes as well as dry cell batteries, sewage effluents, run off of waste and atmospheric depositions which could cause its bio accumulation in the soil(15).

Environmental conditions in soil, which includes change over time, resulting from the degradation of the organic waste or soil solution composition, natural weathering processes are responsible for metal mobility. The extent of vertical contamination is intimately related to the soil solution and surface chemistry of the soil matrix with reference to the metal and waste matrix.

IV. Conclusion

In this present study, it is evident that the soil from metal dumpsites of Abeokuta contains low concentration of heavy metals as compared to other studies. However the continuous use of this area as a dumpsite may lead to heavy metals build up in soils to undesirable level, especially due to automobile mechanic activity which could increase the risk of serious environmental pollution in the nearest future. Government should enforce that solid waste must be carefully incinerated using special facilities that are designed to prevent contamination of the soil since burning can result in emission of hazardous entity such as heavy metals.

Table 1:Mean Values Of Metal And Micro Nutrient Content Inmetal Dumpsite Soils

	LOCATIONS		
PARAMETERS	SABO mg/kg	LAFENWA mg/kg	OJERE mg/kg
SODIUM	0.24±0.04	0.23±0.05	0.94±0.05
POTASSIUM	0.44±0.04	0.38±0.03	0.23±0.02
MANGANESE	1.30±0.20	1.45±0.15	0.80±0.00
CHROMIUM	1.15±0.15	1.15±0.15	0.24±0.02
CADMIUM	1.35±0.15	1.40±0.10	0.75±0.05
NICKEL	0.61±0.07	1.88±0.00	0.04±0.01
CALCIUM	4.13±0.18	4.25±0.35	1.81±0.09
IRON	1.55±0.21	1.60±0.28	0.90±0.14
ZINC	2.00±0.00	2.95±0.77	1.20±0.00
COPPER	4.30±0.42	8.80±0.28	2.55±0.35
COBALT	1.73±0.04	2.17±0.14	0.02±0.00
MAGNESIUM	1.65±0.08	1.70±0.14	0.73±0.04

Table 2 International Agricultural Soil Standards

S/N	PARAMETER	UNITS	PERMISSIBLE LIMITS
1	P	mg/kg	>7
2	K	mg/kg	>80
3	Cu	mg/kg	100
4	Hg	mg/kg	1.0
5	Cd	mg/kg	1.0
6	Cr	mg/kg	100
7	As	mg/kg	30
8	Pb	mg/kg	500
9	Fe	mg/kg	NGVS
10	Mn	mg/kg	500
11	Ni	mg/kg	20
12	Zn	mg/kg	250

Source:alloway (1990)[17] NGVS: No guideline value set

Table 3:

LEVELS OF HEAVY METALS IN SOIL USED TO GUIDE CLEAN UP AND LAND USE DECISIONS mg/kg			
	US EPA	NYS DEC	
	Soil level requiring clean up	Unrestricted use	Residential use
Copper	-	270	270
Cadmium	70	0.43	0.86
Chromium	230	11	22
Nickel	1600	72	140
Lead	400	200	400
Zinc	23600	1100	2200

USEPA (2002)

NYS DEC (2007) Values based on human health risk

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