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DETERMINATION OF SOME HEAVY METALS IN SOME SELECTED SOILS FROM DUMPSITES IN UYO AND ITS ENVIRONMENT

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Abstract: *Heavy metals are trace metals which are detrimental to both animals and human in term of health. Soil samples collected from the dumpsites located in Uyo, Akwa Ibom State were analyzed for Arsenic (As), Zinc (Zn), Nickel (Ni), Mercury (Hg), Lead (Pb), Copper (Cu), Iron (Fe), Cadmium (Cd), Chromium (Cr), and Manganese (Mn). using Atomic Absorption Spectrometer. six (6) sample points of 0M, 1M and 2M (depth) were studied. The results revealed that Arsenic (As), Zinc (Zn), Nickel (Ni), Mercury (Hg), Copper (Cu), Cadmium (Cd) and Chromium (Cr) all have values greater than the permissible limit of heavy metal in soil by WHO, except that in sample (C) 2M dept the Cu value of four (4) points are less than that of the standard. However, it was observed that a minimal reduction in concentration of each metal along the surface of the dumpsite occurred. Based on the Federal Environmental Protection Agency and Land Disposal Restriction Standard Regulation, this metal could have adverse effect on human health, stream and agricultural activities of people around the dumpsite.*

Keywords: *Waste, Heavy Metals, Chemical, Soil, Animal, Human, Health.*

INTRODUCTION

Heavy metals are defined according to soil chemistry as special group of elements that exert toxic effect on plant upon their high concentration in the soil (Vodyanitskii, 2016). Heavy metals are trace metals which are detrimental to both animals and human in term of health. According to Maigari *et al*., (2016), heavy metal or toxic metals are trace metals which are detrimental to human health and having a density of at least five times that of water. These have been found in certain environment including water reservoirs such as wells, boreholes, rivers, dams, streams and lakes, soils including wastes dumps farm lands as well as air in the atmosphere. Because of health risk associated with heavy metals, it had called for its study along the years. Heavy metals are among the common contaminants found in dumpsite soil, and when this contaminated soil is used for agricultural purposes, they may lead to the accumulation of heavy metals either by physical or chemical interaction between the contaminated soil and the cultivated crop plant (Anhwange and Asamave, 2012). Heavy metals have become a major source of global problem because they pose a multi-dimensional negative effect on living organisms (Uwah et., al 2011). Heavy metals, sometimes referred to as trace elements are found in soil, water, air, food, dust, plants and animals. They are elements of the periodic table mostly found to exist as transition metals otherwise called d-block elements. The most prevalent group of elements in the soil is the transition metals, otherwise called heavy metals. Examples include copper (Cu), iron (Fe), manganese (Mn), zinc (Zn), mercury (Hg), arsenic (As), lead (Pb), nickel (Ni), etc. (Asemave and Anhwange. 2012). Dumpsite is a designated place for dumping of refuse (solid waste) while places that accumulates high amount of solid waste are refers to as refuse dumps (Awokunmi, et al., 2010). The usual pollutant from dumpsites are heavy metals and hence the contamination of cultivated crops with dumpsites soil is of greater concern for all humans (Anhwange, 2012).

Due to over increasing population growth and industrialization in our world today, there has been increase accumulation of both domestic as well as industrial wastes. Because there are no effective waste disposal methods, this had led to the accumulation of waste dumps all over and around our residential areas as industrial based environments. Agricultural waste is also a factor that contributes to the number of waste dumps seen in our world today. It should be noted that the menace of waste dumps as they affect our environments cannot be over emphasized. These waste dumps cause environmental pollution by affecting our air, water bodies as well as soil. This peculiar when the air blows across them, when rain washes them away to various water bodies, when rain washes them away to soil in other areas and when man in search of manure and fertile soil deposits them in his farm lands in other of cultivate crops. The risk that arises in soil highly contaminated with heavy metals is primarily from the mobility (i.e. transportation) to water sources and bioavailability of chemicals. (Adriano et al. 2002).

Heavy metals contamination is a major problem of the environment especially in growing cities and developing world, primarily due to uncontrolled pollution levels driven by causative agents such as industrial growth, increase agricultural activities, etc. (Maigari *et al.*, 2016).

Some of these metals are essential to life for normal body functions. For examples, cobalt, copper, Iron, manganese, molybdenum and zinc are needed at low levels as catalysts for enzyme activities. Adepoju et al., (2009). However, excess exposure to these heavy metals can result in toxicity. (Adepoju and Alabi 2005). They further stressed that heavy metals can cause serious health effect with varied symptoms depending on the nature and the quantity of the metal ingested.

Arsenic the high concentrations of arsenic are toxic and therefore non-essential to plants. Irrigation water contaminated with arsenic can increase arsenic concentrations in the soils, thereby reducing agricultural production, reducing crop quality and eventually leading to great economic loss, (WHO 2008).

Chromium can cause a lot of problems; it can cause cardiac problems, metabolic dysfunctions and diabetes. Symptoms of chromium toxicity in plants, comprises decrease of germination, reduction of growth, inhibition of enzymatic activities, impairment of photosynthesis and oxidative imbalance (Shad et al., 2008).

Nickel is used mainly in the production of stainless steel and nickel alloys. However, increased concentrations have many health effects. Example, it tends to accumulate in the kidney, causing its damage. Its steady exposure can cause cancer of the lungs and nasal sinus. Nickel fumes are respiratory irritants and cause pneumanities chronic bronchitis, allergic reactions and skin rash (Shad et al., 2008).

MATERIALS AND METHOD

Sample Collection Technique

Uyo town was demarcated into six (6) major areas for this study. The samples were taking from these six (6) locations to identify the following heavy metals: Arsenic (As), Zinc (Zn), Nickel (Ni), Mercury (Hg), Lead (Pb), Copper (Cu), Iron (Fe), Cadmium (Cd), Chromium (Cr), and Manganese (Mn). The soil samples from the study area were collected around a particular refuse dumpsite. The dumpsite was clear both North, South, East, West and Middle of the dumpsites, up to 2M depth by the use of machete for digging; trowel for fetching and the meter rule for the measurement. The samples were mix and put into the clear polythene bottles/bags, and was taking to the laboratory for digestion and analysis.

Sample Digestion Method

The conventional aqua regia (i.e solution of HCl and HNO_3 in the ratio of 3:1) digestion was employed. A well-mixed sample of 2g was digested in 24ml of aqua regia on a hot plate for 5minutes in a fume cupboard. After evaporation to near dryness, the sample was dilute with 20ml of distilled water and was transfer into a 100ml volumetric flask after filtering through Whatman No 1 filter paper. The extract was taking for subsequent analysis of heavy metals (Chen and Ma, 2001).

Method of Sample Analysis

Metal determination in soil extract digestion was carried out using Atomic Absorption Spectrophotometer (AAS). The thermometer was used for the determination of temperature. The pH meter was used for the determination of pH.

Statistical Analysis

The results of different concentrations obtained from different samples using Atomic Absorption Spectrophotometer (AAS) was used to analyze the data using SPSS version 2.1.

Results and Discussion

The results from the Atomic Absorption Spectrometer showing the amount of each metal in (mg/kg) are shown in Tables 1 to 3. The metals analysed were copper (Cu), iron (Fe^2) manganese (Mn), cadmium (Cd), Lead (Pb), zinc (Zn), chromium (Cr), arsenic (As), mercury (Hg) and nickel (Ni). Table 1 shows the results of the studied metals at surface level. The ten metals studied were copper (Cu), iron (Fe^2) manganese (Mn), cadmium (Cd), Lead (Pb), zinc (Zn), chromium (Cr), arsenic (As), mercury (Hg) and nickel (Ni). at surface level and various depths. These metals were chosen due to low industrial activities in Minna town. Majorly, municipal solid waste mainly domestic waste dominates the dumpsite. It is for this reason that the selected metals were considered, as they are associated with municipal solid waste.

Table 6 sample A (surface level with respect to dept)

Sample	Cu	Fe	Mn	Cd	Pb	Zn	Cr	As	Hg	Ni
1	68	5.54	11.60	0.82	8.78	210	167	12	220	30
2	38	5.10	9.00	0.82	3.62	235	157	14	200	29
3	45	3.78	5.40	0.73	4.68	225	155	11	215	32
4	37	4.67	7.00	1.0	5.29	195	145	15	205	30
5	40	3.73	6.80	0.9	6.26	205	160	13	202	28
6	42	2.27	6.30	1.4	2.7	191	143	14	195	25
x	39	425.5	200	0.8	85	50	100	20	270	35

Table 7 sample B (1M in dept)

Sample	Cu	Fe	Mn	Cd	Pb	Zn	Cr	As	Hg	Ni
1	67	3.17	11.50	0.80	8.70	205	165	11	218	28
2	36	2.86	8.7018	0.80	3.58	230	154	13	208	27
3	43	2.43	5.30	0.71	4.60	220	152	10	212	30
4	34	3.15	6.90	0.9	5.20	190	140	14	200	27
5	37	2.56	6.70	0.8	6.20	202	156	12	217	25
6	39	2.37	6.10	1.2	2.5	188	140	12	192	22
x	39	425.5	200	0.8	85	50	100	20	270	35

Table 8 sample C (2M in dept)

Sample	Cu	Fe	Mn	Cd	Pb	Zn	Cr	As	Hg	Ni
1	64	3.14	11.00	0.78	8.68	202	162	10	216	26
2	32	2.84	8.20	0.77	3.54	226	150	12	206	25
3	40	2.40	5.00	0.68	4.56	216	148	09	210	28
4	30	3.12	6.50	0.85	5.14	188	138	13	208	25
5	33	2.52	6.30	0.78	6.14	200	152	11	215	23
6	36	2.32	6.00	1.0	2.2	186	138	11	190	20
x	39	425.5	200	0.8	85	50	100	20	270	35

The heavy metal content obtained from different soil depth and distance varied with different types of heavy mental constituent. (Table 1, 2 and 3). Results obtained showed that soils from dumpsite area were higher in heavy metal concentration on the surface than as one goes down the soil. The heavy metal concentration at 0m in dept of the soil sample (dumpsite) ranged between 37-68, 2.27-5.54, 5.40-11.60, 0.73-1.40, 2.7-8.78, 191-235, 143-167, 11-15, 195-220 and 25-32 for copper (Cu), iron (Fe^{2}) manganese (Mn), cadmium (Cd), Lead (Pb), zinc (Zn), chromium (Cr), arsenic (As), mercury (Hg) and nickel (Ni) mg/kg, respectively. Soils sample of the 1M dept showed ranged between 34-67, 2.37-3.17, 5.30-11.50, 0.71-1.20, 2.5-8.70, 190-230, 140-165, 11-14, 192-218 and 22-30 for copper (Cu), iron (Fe^{2+}) manganese (Mn), cadmium (Cd), Lead (Pb), zinc (Zn), chromium (Cr), arsenic (As), mercury (Hg) and nickel (Ni) mg/kg, respectively. While soils sample of the 2M dept showed ranged between 30-54, 2.32-3.14, 5.00-11.00, 0.68-1.0, 2.2-8.68, 186-226, 138-162, 9-12, 190-216 and 20-38 for copper (Cu), iron (Fe^{2+}) manganese (Mn), cadmium (Cd), Lead (Pb), zinc (Zn), chromium (Cr), arsenic (As), mercury (Hg) and nickel (Ni) mg/kg respectively. Soil samples analyzed for heavy metals at different depths indicated different concentration levels. Furthermore, results indicated concentration levels of heavy metals decreased with distance. The different range of heavy metal contamination in the different depth or distance of the soil samples is highly dependent on the chemical composition of the soil. The effect of perturbation depends on the buffering capacity, chemical characteristics and specific compound of the soil, and the soil organic matter. Heavy metal binding properties of these soil constituents differ with the charges of the soil material and the ionic valency (Agamuthu and Fauziah, 2010). Lead, iron and manganese concentrations of all the soils samples were found to be below the standard (WHO) soil quality standard which indicated not exceed 85, 425.5 and 200 mg/kg for agriculture purpose. Copper (Cu), cadmium (Cd), zinc (Zn), chromium (Cr), arsenic (As), mercury (Hg) and nickel (Ni) have quantities above the WHO standard.

Conclusion

The contents of garbage been generated from different parts of Uyo is essentially the same as reflected by the close range of values for the trace metals studied. The enrichment factor showed that Zn, Cd and Pb are essentially from anthropogenic source while Fe originates from natural and anthropogenic sources. There is a growing concern on the gradual build-up of toxic metals in the dumpsites as greater percentage is in the mobile fractions. These will become available to plants or groundwater over geological time scale where they are biomagnified. The information on the potentially available trace metals as opposed estimated total metals may be useful in designing remediation programmed for contaminated sites. It provides information on the relationship between contaminants and the environment. It is recommended that the government should consider a basement treatment for dumpsites before use. This will provide sorption surfaces for pollutant and prevent groundwater contamination.

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