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ASSESSMENTS OF PHYSICOCHEMICAL PROPERTIES AND HEAVY METALS CONTENT IN SOILS FROM SELECTED SOLID WASTE DUMPSITES IN KADUNA METROPOLIS, KADUNA STATE, NIGERIA

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ABSTRACT
Representative samples of the solid wastes were collected from three dumpsites in Kaduna metropolis respectively using standard sampling methods. Control samples were obtained at about 200m from the dumpsites. Physical and chemical properties of these samples were assessed after extraction. Classical and Atomic Absorption Spectrophotometric methods were used for the analysis. Results obtained were subjected to statistical analysis for the range, mean & standard deviation. The results indicates that Fe has the highest concentration of 4935.0 mg/kg and the least was Ni with 28.1mg/kg. Likewise, the contamination status of metals shows that, Pb has the status of 5.0 as the highest while Cr has 0.5 as the least. The results of the physicochemical parameters obtained were within the permissible limits specified by Food and Agricultural Organization (FAO) for micro and macro nutrients, while the heavy metals content were above the limits specified by World Health Organization (WHO) and FAO for soils.

Keywords: Physicochemical, Heavy metal, Solid waste, Dumpsites, Contamination, Micronutrient and macronutrient

INTRODUCTION

Solid wastes which are normally referred to as ' Garbage or trash' mostly contains papers, metal scraps, glasses, batteries, electronic appliances, plastics and motor oil, and when undergoing decomposition or oxidation, they release different elements of various concentration (Eneja and Lemoha, 2012: Cupta and Agrawel, 2014). At a require amount, some of these elements are essential for plants and animals growth, but, at a higher or lower concentration: these elements affect the metabolic activities of the plants and animals. Although, some metals like Cd, Pb, Cr and Ni even at a small amount, they are toxic to both plants and animals (Salam, 2010).

Sometimes farmers on the quest of searching for soil that is rich on manure, parked up composts from solid waste dumpsites to their farms or use the solid waste dumpsites as farm land. This might be detrimental to our health when transferred to us through food chain. However, this depend on the composition of the solid wastes at the dumpsite.

Amadi and Nwankwoala, (2013) observed that, sites previously utilized as dumpsites are often converted to farmland without any treatment", plants grown in such soil take up toxicants, which accumulate in plants tissues, pose health risk when transferred into the food chain.

Research conducted on physicochemical properties and heavy metal contents from the soil within some solid waste dumpsites in other countries and Nigeria, shows that, solid wastes affect the soil properties within the solid waste dumpsites (Amadi and Nwankwoala, 2013). Eneja and Lemoha, (2012) observed that, the properties and heavy metals concentration of soil within the solid waste dumpsites varies, and this, depend on the composition or characterization of the solid wastes and the peculiarities of the neighborhood activities".

As a result of these observations, the properties of soil and amount of heavy metals from the soil of any solid waste dumpsite cannot be accurately predicted and thus, it become very necessary to obtain information from these dumpsites. Therefore, the aim of this study is to assess physicochemical properties and heavy metal contents of the soil within the selected solid waste dumpsites in Kaduna metropolis of Kaduna State, Nigeria.

MATERIALS AND METHODS

Sampling Sites

The samples were collected from three dumpsites within Kaduna metropolis in Kaduna State, Nigeria. The control samples were collected at about 200m away from the dumpsites. Kaduna is the state capital of Kaduna state in north-western Nigeria, It is a trade Centre and a major transportation areas with its rail and road junction. It's located at Latitude: 10^0 31' 36'' 33.5484N and Longitude: $7^0$25'46.2144''E (www.latlong.net >country>Nigeria>cities, 2019).

Sample Collection and Sample Preparation

Soil samples were collected from different parts of the selected dumpsites, with the aid of a stainless steel sampler. The quadrate crate sampling method was used (Anake, *et al.,* 2009). The samples were pooled together and homogenized to obtain the composite samples. The control samples were also, collected from uncontaminated areas away from the dumpsites. The samples were placed into appropriately labeled polyethene bags and taken to the laboratory for preparation and analysis (Anake, *et al.,* 2009: Tandom, 1999).

Methods of determination of physicochemical properties

Soil particle size (Clay, Silt and Sand), pH, and Electric Conductivity (EC) were determined using Hydrometer method, pH meter using soil to water ratio solution of (w/v) 1:2 after calibration

with buffer and digital conductivity using soil to water suspension (ratio w/v 1:2) respectively (Gee and Bauder, 1986: Blakemore, *et al.,* 1987). While, Walkley and Black rapid titration, Kjeldahl distillation and Bray and Kurz-1 and Olsen methods were used to determine Organic Carbon & Organic Matter, Total Nitrogen and Available phosphorous respectively (Malgwi, 2013).
Cation Exchange Capacity (CEC) was determination using soil extract of Ammonium acetate from which the K and Na were determined by Flame Photometer and Atomic Absorption Spectrophotometer (AAS) was used to determine Mg and Ca (Bamidele, *et al.,* 2014: www.midweastlab.com, 2018).
Metals were extracted by digestion using standard acid digestion method (Official Method of Analysis of Analytical Chemistry 15th Ed 960:30, 1990). The heavy metals concentration were determined with Atomic Absorption Spectrophotometer (AAS) Pg990.

All samples were analyzed in the maximum analytical replication measurement in triplicate. Glass wares were properly cleaned, the reagents used were of analytical grade and double distilled water was used throughout the studies. The standard solutions were prepares according to the specified guides (Pye Unicom Atomic Absorption data book, 1979). The assurance program were further conducted by carrying out % recovery study and blank analysis. The results of digestion of metals and precision showed that, the recoveries of metals varies from 84.61%-96.83% and the precisions were less than 10%. All the analysis were done at federal ministry of agriculture soil complex laboratory, Kaduna, Nigeria.

RESULTS AND DISCUSSION

Table1: Physicochemical properties of soil from solid waste dumpsites and control

Properties	Dumpsite		Control	
	Range	Mean ±SD	Range	Mean ± SD
pH	7.5-8.3	7.9±0.5	6.7-6.9	6.7±0.2
EC: dSm^{-1}	1.8-3.9	2.3±1.3	0.1-0.2	0.2±0.0
Sand %	82.9-88.8	86.2±3.0	76.6-80.6	78.9±2.1
Silt "	10.8-15.0	12.8±2.1	16.3-19.3	18.0±1.4
Clay "	0.4-2.1	1.1±0.9	0.1-6.1	3.1±2.5
OC "	2.3-3.7	3.1±0.7	1.0-1.6	1.1±0.1
TN "	0.2-0.4	0.3±0.1	0.1-0.1	0.1±0.0
AP "	0.7-1.6	1.0±0.5	0.2-0.6	0.5±0.2
Na Meq/100g	2.6-3.2	3.0±0.4	2.7-2.8	2.7±1.3
K "	0.4-1.1	0.7±0.4	0.3-0.3	0.3±0.0
Mg "	0.4-0.4	0.4±0.0	0.3-0.3	0.3±0.0
Ca "	1.8-2.3	2.1±0.2	0.2-0.6	0.4±0.2
CEC "	5.2-6.8	6.2±0.9	3.5-3.9	3.6±0.2

NB: OC= Organic Carbon, OM=Organic Matter, TN=Total Nitrogen, AP=Available Phosphorous, CEC= Cation Exchange Capacity

Table 2: Heavy metals content in soil from solid waste dumpsites and control

Metals		Dumpsite		Control	
		Range	Mean ±SD	Range	Mean ±SD
Fe	mg/kg	3470.0-5741.0	4935.0±1271.0	4755.0-5500.0	5167.0±311.9
Cu	"	104.9-358.4	245.7±34.1	1.2-272.2	80.1±188.5
Mn	"	208.6-485.3	345.4±138.7	81.4-815.4	267.9±351.1
Zn	"	662.2-4585.5	2097.0±2215.0	301.8-849.4	520.6±235.2
Cr	"	25.0-105.3	56.8±37.0	0-210.6	105.3±121.6
Ni	"	19.0-39.9	28.1±10.7	0-34.7	19.9±17.2
Pb	"	366.4-613.0	531.6±90.4	101.2-126.0	107.4±17.2

Key: Fe-Iron, Zn-Zinc, Mn-Manganese, Cr-Chromium, Cu-Copper, Ni-Nickel, Pb-Lead.

Table 3: Heavy metals contamination status in soil of solid waste dumpsites

Heavy metal	Mean concentration		Contamination status	Degree of contamination
	Dumpsite	Control		
Fe	4935.0	5167.0	1.0	Low
Cu	245.7	80.1	3.1	considerable
Mn	345.4	267.9	1.3	moderate
Zn	2097.0	520.0	4.0	considerable
Cr	56.8	105.3	0.5	Low
Ni	28.1	19.9	1.4	Moderate
Pb	531.6	107.4	5.0	Considerable

Key: Fe-Iron, Zn-Zinc, Mn-Manganese, Cr-Chromium, Cu-Copper, Ni-Nickel, Pb-Lead
Source: (El- Sayed, 2016)

In table 1 & 2, most of the physical and-chemical parameter as well as heavy metals content in the soil from the solid waste dumpsites were higher than the control, except silt, clay, Fe and Cr. The results in this study agreed with the results obtained by" Eneja, and Lemoha (2012) who stated that the solid waste dumps were responsible for the higher concentration of the physicochemical properties in the solid waste soil". The decomposition and mineralization of the biodegradable solid wastes in the solid waste dumpsites to the soil, might have been responsible for these higher concentration.
However, the lower concentration of some elements (N, P, Ni, Cr & Cd) in the dumpsites as observed in this study (table 1 & 2) might be due to higher contain of non-biodegradable wastes or poor drainage which might have inhibited the biodegradation of solid waste by microorganism (Ukpong, *et al.,* 2013). This was also observed by **"**Gautam, *et al.* (2009) that, only 47% of carbon solid wastes were biodegradable". Although, other soil properties like high pH, low % of clay and higher % of sand which decreases the binding sites of metals and also higher leaching rate from sandy soil might also be responsible for this low concentration(Anake, 2009: Bamidele, *et al.,* 2014).

The results of degree of contamination of the heavy metals using Contamination Factor CF (El – Sayed, 2016) indicates in table3: range from low to considerable, with their contamination status range from 0.5-5.0 Pb, Zn and Cu with status of 5.0, 4.0 and 3.1 respectively, had a degree of contamination to be considerable, while, Ni and Mn were moderately contaminated with the status of 1.4 and 1.3 respectively. Likewise, Fe and Cr status of contamination were, 1.0 and 0.5 respectively with low degree of contamination. The trend of contamination status of heavy metals from soil of solid waste dumpsites was; Pb > Zn > Cu > Ni > Mn > Fe > Cr.

The higher status of lead fellow by zinc and copper might have been attributed to refuse from the dumpsites which were mainly the alloys, plastic cables, used batteries, demolishing structures, and electric cables etc. The trend in contamination status of this study was in contrast with the trend, observed (Cd > Cr > Pb > Mn > N) by Getachew and Degefa, (2015). This variance might have been as a result of the different types of solid wastes found in dumpsites. Also, the differences in the location, age of the dumpsites and activities of the peoples within the dumpsites affect the physicochemical content of the soil within the dumpsite (Gautam, *et al.,* 2009).

Agricultural Implication of the physicochemical properties and heavy metal contents in soil from solid waste dumpsites

The trace elements (Fe, Cu, Zn & Mn), and macro (Ca, Mg, K) nutrients were quantitatively recorded in the soil from the dumpsites. The values of organic matter, available phosphorous, total nitrogen and cation exchange capacity were within the normal ranged in soil for agricultural purposes (Malgwi, 2013: FAO, 1990).

These elements are very essential for the proper growth of the plant and also good for animal metabolism. The values of the physicochemical properties and heavy metals contents were within the world compost standards but above the FAO/WHO & UNEPA soil standard for agricultural purposes (FAO, 1990: WHO' In DPR, 2002: UNEPA, 2006). This implies that the solid wastes from the dumpsites can be compost and be used for agricultural purposes, but the solid waste dumpsites might not be suitable to be used as farm land for cultivation of crops.

The higher percentage of sand and low values of silt and clay as recorded in table1, will lead to higher tendency of leaching of both essential minerals and toxic elements. This will increase the pollution index of the soil that might affect the community within the solid waste dumpsites.

Conclusion

Most of the parameters of the soil within the solid waste dumpsite were higher than the values recorded in the soil from control site and they varies within the solid waste dumpsites. The degree of contamination of the heavy metals were at the ranged of low to moderately contamination. The values of the soil parameters from solid waste dumpsites were within the world compost standard and rich with micro/macro nutrients

Therefore, the compost from the solid waste dumpsites could be used as manure/ compost for soils amendment. However, the heavy metal contents were above the world soil allowable limits and FAO/WHO standard for agricultural soil. Thus, dumpsites might not be suitable for farm land for cultivation of crops.

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