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Assessment of Soil Quality of Saje Dumpsite at Abeokuta, Nigeria

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Abstract

Globally, the major environmental problem associated with dumpsite is soil pollution. The objective of this study was to assess the effect of dumpsite on nearby residential soil quality. Soil samples were collected from Saje dumpsite in Abeokuta, at different locations. The physical and chemical properties of the soil analysed were Electrical Conductivity (EC), pH, Particle Size, Organic Carbon (OC), Total Nitrogen (TN), available phosphorus, Na, K, Ca, Mg, Pb, Cu, Cd, Cr and Zn using standard methods. Data were analysed using descriptive analysis and ANOVA at $\alpha_{0.05}$. The dumpsite soils were moderately alkaline with pH values ranging from 7.95 to 8.53 and OC ranging from 2.0 to 122 g kg-1. The respective range of concentration ($mgkg^{-1}$) for top and sub soils were: Zn (1150±230 to 2570±240 and 10900±190 to 6890±3090), Cu (159±12 to 322±130 and 139±98 to 237±67), Pb (87 ± 73 to 516 ± 210 and 105 ± 95 to 305 ± 16), Cr (13.9 ± 1.6 to 19.5 ± 1.5 and 10.4 ± 2.1 to 15.9 ± 3.9) and Cd (3.87±0.37 to 11.6±1.4 and 3.00±0.25 to 13.8±4.3 The parameters of soil higher than permissible limits of the WHO, EC and MAFF were in the order: Zn>Cu>Pb>Cr>Cd. This study revealed Zn as the highest measured metal in the soil with average concentrations. Lead (Pb) concentration decreased with increasing depth, while Cd showed the lowest values in all samples.

Keywords: Soil characteristics, Saje Dumpsite, Organic Carbon, Soil Quality, Zinc.

Introduction

In a developing country like Nigeria, open dump is the only available option for solid waste disposal in the cities. Consequently, soil and groundwater system can be polluted due to poorly designed disposal facilities, leakage from underground storage tanks and agricultural wastes and have been linked to soil and groundwater acidification and nitrification (Bacud et al., [1] as well as microbial contamination [2]. Farmers use soils obtained from dumpsites or planting of vegetables and food crops because of high cause of fertilizer. The disposal of waste generated by anthropogenic activities has been an environmental problem in many municipal areas in developing countries as they tend towards industrialization [2]. Human civilization activities and population are responsible for increase in waste generation in any human society [3]. Although solid waste can be wealth when properly managed, otherwise it become threat to life [4]. Amusan et al. [5] studied the characteristics of soils and crop uptake of heavy metal in municipal waste dumpsite in Nigeria and established that soil of municipal waste dumpsites are higher in heavy metal concentration and that crops growing on the dumpsites bio-accumulate considerably higher metal content than those on normal agricultural soils. The immediate use of dumpsites for cultivating vegetables and the on-farm use of compost sourced from the dumpsites is a frequent practice in urban and suburban centres in Nigeria [5, 6], while the study of Ademoroti[7] confirmed the positive linear correlation between heavy metals (Cd, Pb, and Ni) in the soil and vegetables grown on it. Bodur and Ergin [8] and Zonta et al. [9] also established high heavy metals affinity for organic matter and clay soils. Metals from dumpsite can also leach into groundwater and be transported to surface water. They can also bio accumulate in plants and

subsequently transferred to food chains. Heavy metals, even at low-levels can result into long-term cumulative health effects. Various studies have documented the impact of the constituents of solid waste from dumpsites. Marijian [10] documented high constituents of total hydrogen, total organic matter, humus, toxic elements such as Cu, Cd, Pb and Zn and other numerous compounds of natural origin and xenobiotic compounds in a landfill at Zagreb, Croatia.

The study of Eddy et al. [11] at Ikot Ekpene examined the elemental composition of soils in selected dumpsites. The study measured high concentrations of heavy metals, exchangeable cations and N and P. The impact of municipal solid wastes on soil quality around Ado-Ekiti metropolis, Ekiti State, Nigeria was carried out by [12]. Results of the study documented high heavy metal contents for soils around the dumpsite, while and low heavy metal concentrations were observed for soils sampled at 20 m away from the dumpsite. Alloway [13] determined the levels of heavy metals (Zn, Cu, Cd and Fe) in the top soil of refuse dumpsite in Abeokuta and discovered higher concentrations of heavy metals in the soil of refuse dumpsites than control. These showed that dumpsites are major sources of environmental pollution.

With increase in population, there have been encroachments on lands in area very close to Saje dumpsite for residential purposes. Keeping in mind those farmlands for food crops were sited proximal to this dumpsite. Soil samples from the soil very close to the dumpsite needed to be tested to ascertain their physical and chemical properties especially the concentration of heavy metals found in these soils to evaluate the influence in soil with respect to municipal waste dumping and it effect to general public is paramount to this study. The objective of this study was to assess the effect of dumpsite on nearby residential soil quality.

Materials and methods

Study area

Saje dumpsite is located in Abeokuta North Local Government of Abeokuta, the capital of Ogun State, south-west Nigeria. Abeokuta covers an approximate area of about 40.63 km2. It lies between latitudes $70^{o}10^{1}$N and $70^{o}15^{1}$N and longitudes $30^{o}17^{1}$E and $30^{o}26^{1}$E [14]. The Saje dumpsite was established in 2006 which was previously a quarry site. In order to reclaim the site, the state government decided to use the quarry as dumpsite. The dumpsite is the only designated dumpsite used in Abeokuta metropolis and is about 4 ha (40000 meters square) in area. Saje dumpsite was formerly located in the outskirt of Abeokuta city, but has now been surrounded by residential houses due to increase in population of the metropolis.

The location coordinates of the dumpsite and soil samples were obtained with a hand held Global Positioning System (Garmin MAP 76CSx model made in Taipei County, Taiwan) with position accuracy of less than 3 m. Soil samples were taken at the dumpsites with a soil auger. Twenty (20) soil samples of triplicates (20 x 3) were collected at different spots of both the top soils and sub soils in the area, while additional two samples of same depth ranges were collected far away from the dumpsite, to serve as controls. The choice of the sampling points within the dumpsite was considered using the following criteria: location of farmlands, accessibility, and proximity to residential areas.

Sampling Design

Soil samples were collected at the dumpsites with a soil auger. A total of twenty-two (22) soil samples were collected in triplicates (20 x 3) between May and June 2017, Top soil samples were obtained at a depth between 0 – 15 cm while the sub soil samples were obtained within the range of 15 – 30 cm. The samples were put into polythene nylon and labelled for easy identification. The co-ordinates where the soil samples were taken were also recorded as shown in Figure 1.

The representative samples collected were prepared properly in order to have a homogenous sample to be used for analysis.

Each soil sample was properly exposed to air to reduce the moisture content of the soil samples. The soil samples were air dried for three days. After air drying, the soils were sieved with 2.0 mm sieve to remove the large particles that cannot pass through the sieve. Soil samples were then ground in mortal and finally sieved with 0.2 mm mesh. The powdered particles were properly packed with the use of a sterile spoon to avoid contamination of the samples and labelled properly for further analysis.

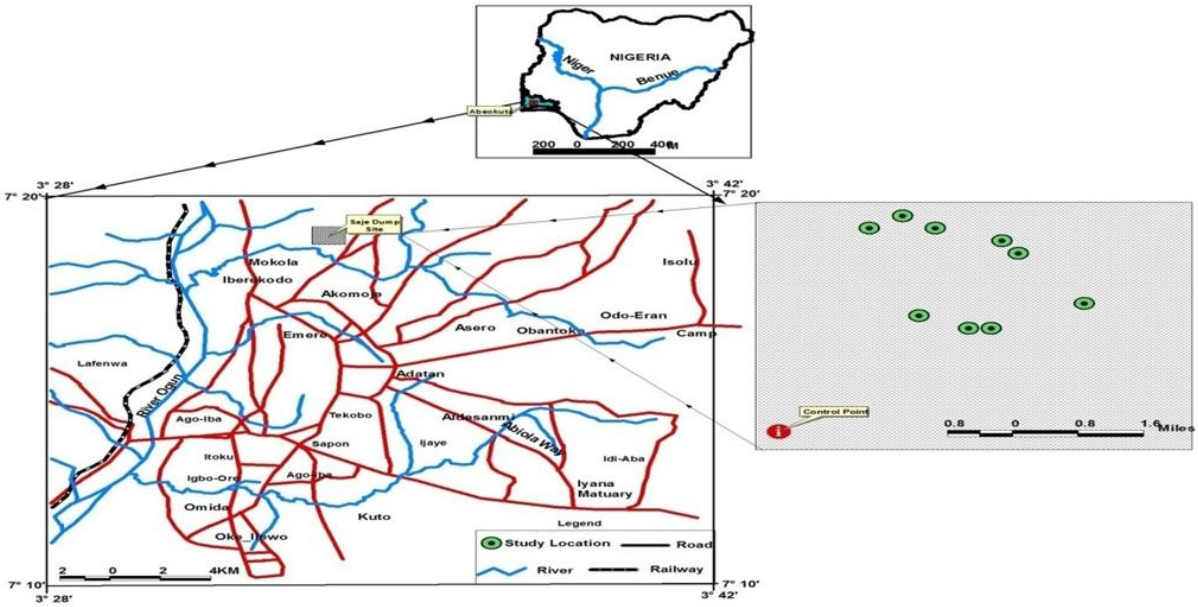

Figure 1: Map showing Study Location with sampling points

Sample Analysis

The samples were analyzed for different physical and chemical parametres. pH, Temperature and Electrical conductivity were analysed in-situ with a hand held multipurpose meter.

Determination of soil particle size (Hydrometer)

The particle size analysis was carried out using hydrometer. This involves weighing 50 g of air-dried soil samples into a clean beaker [15]. The soil samples in each beaker were saturated with distilled water and an appropriate amount of Calgon and allowed to stay for 24 hours. The dispersed soil samples were transferred into a 1000 ml measuring cylinder and made up to mark with distilled water. The cylinder was shaken vigorously, after 40 seconds as indicated by a stop watch, soil hydrometer was inserted and the readings were taken.

Determination of soil organic carbon (Walkey-Black method)

Organic carbon was determined using Walkey-Black method described in Taiwo et al. [15]. This involves weighing 1 g soil sample into cleaned 250 ml conical flasks followed by adition of 10 ml $K_2Cr_2O_7$ and 20 ml concentrated H_2SO_4. The mixture was allowed to cool for 30 minutes. Then, 100 ml of distilled water was added and titrated against ferrous ammonium sulphate solution

Determination of exchangeable bases (K, Na, Ca and Mg)

A 5g of air-dried soil sample was extracted for exchangeable bases following extraction with 1 M ammonium acetate solution. Details are presented in[15]. The soil extract was then analysed for K and Nausing a flame photometer (Jenway PFP 7, UK), while Ca and Mg were analysed using Atomic Absorption Spectrophotometer (Buck Scientific, 200, Connecticut, USA).

Determination of Total Nitrogen (Kjeldahl method)

The total Nitrogen concentration was determined by the calorimetric method involving digestion of 1 g of soil sample with H_2SO_4 and HNO_3. The content was transferred into a macro-Kjeldahl flask and heated in a fume cupboard for 40 minutes. The digest was measured with a UV-visible spectrophotometer (Jenway model 6405, UK) at 665nm.

Determination of available soil Phosphorus (Bray 1 method)

Bray 1 method was used to determine phosphorus content of the soil. The method entails weighing 5 g of soil samples into a clean 100 ml beaker and 25 ml Bray 1 solution was added, stirred and filtered. Following this, Bray 1 and 1-5 mg phosphorus standards, KH_2PO_4 were introduced, while 5 drops of Ammonium Molybdate was introduced and mixed. The extract was read with UV-visible spectrophotometer (Jenway model 6405, UK) at 660 nm.

Analysis of heavy metals in soil

Metals in soil were analysed using Atomic Absorption spectrophotometry (AAS). A 1 g soil sample was weighed and digested with 10 ml of concentrated nitric acid, 5 ml of concentrated sulphuric acid and 2.5 ml perchloric acid. The samples were digested for about 2-30 minutes at 95

± 5°C and allowed to cool before filtering with a filter paper. The digest was made up to 50 ml and analysed for metals using AAS (Buck Scientific 210, Connecticut, USA). The calibration curve was prepared from the corresponding standard solutions of the metals prepared in the range 0-100 mg/l.

Statistical Analysis

Data collected were subjected to descriptive (mean and standard deviation) and inferential (Analysis of variance ANOVA at $\alpha_{0.05}$ and Duncan Multiple Range Test DMRT) statistics using SPSS for Windows version 22.0.)

Results and Discussion

Table 1 presents the different pH and EC values for the top and sub soil samples at different distances. The data showed that the soils were moderately alkaline in nature with the pH ranging from 7.95 to 8.53. The result of EC ranged from 459 to 1634 µS cm^{-1}. The EC revealed that there was no significant (P>0.05) difference in the values of top soil. However, there was significance (P<0.05) in the sub soil samples between locations 75 and 100 m within the vicinity of the dumpsite.

Table 1: pH and EC values of soil samples

Distance (m)	Soil depth (cm)	pH	EC (µS cm^{-1})
0		8.3 ± 0.1^{abc}	943 ± 260^{ab}
25		8.4 ± 0.1^{abc}	668 ± 160^{ac}
50	0 – 15	8.4 ± 0.0^{abc}	689 ± 151^{bc}
75		8.5 ± 0.0^{a}	625 ± 11^{bc}
100		8.5 ± 0.0^{a}	858 ± 329^{abc}
0		8.4 ± 0.1^{ab}	715 ± 166^{bc}
25		8.2 ± 0.2^{c}	688 ± 120^{bc}
50	15 – 30	8.4 ± 0.0^{abc}	690 ± 48^{bc}
75		8.2 ± 0.3^{bc}	471 ± 12^{c}
100		8.4 ± 0.1^{abc}	1152 ± 482^{a}

EC-Electrical conductivity, similar alphabets along the same column are not significant at p>0.05 according to Duncan Multiple Range Test

Table 2 shows the distribution patterns of particle size of the top and sub soil samples at different distances. There was no significant (P>0.05) difference in the distribution of silt and clay in all the top and sub soil samples along various distances within the dumpsite. The % sand determined indicated significant level (P<0.05) in the subsoil at 0, 50, 75 and 100 m away from the dumpsite. Also it was observed that the major percentage of the soil sample was loamy.

Table 2: Particle size of soil in Saje dumpsite

Distance (m)	Soil depth (cm)	Sand	Silt	Clay	Textural Class
		g kg^{-1}			
0		740 ± 0^{ab}	156 ± 20^{a}	104 ± 20^{b}	Loamy
25		780 ± 20^{a}	136 ± 0^{ab}	84 ± 20^{b}	Sandy Loam
50	0 – 15	750 ± 10^{ab}	136 ± 0^{ab}	80 ± 58^{b}	Loamy
75		760 ± 0^{ab}	166 ± 10^{a}	74 ± 10^{b}	Sandy Loam
100		760 ± 20^{ab}	136 ± 0^{ab}	104 ± 20^{b}	Loamy
0		730 ± 50^{b}	156 ± 40^{a}	114 ± 10^{ab}	Loamy
25		780 ± 20^{a}	106 ± 10^{b}	114 ± 10^{ab}	Loamy
50	15 – 30	730 ± 10^{b}	156 ± 20^{a}	114 ± 10^{ab}	Loamy
75		680 ± 20^{c}	166 ± 10^{a}	154 ± 30^{a}	Loamy
100		780 ± 20^{a}	116 ± 0^{b}	104 ± 20^{b}	Loamy

Similar alphabets along the same column are not significant at p>0.05 according to Duncan Multiple Range Test

Table 3 present the results of organic carbon, nitrogen and phosphorus of soil samples. The organic carbon contents of soil samples at sampling site 25 m after the dumpsite were higher than those of other sampling sites for both topsoil (68±10 g kg^{-1}) and subsoil (95±27 g kg^{-1}). A similar trend was also observed for nitrogen where the highest levels were observed at sampling site 25 m after the dumpsite. However, for phosphorus, the highest concentrations were measured at site 75 m after the dumpsite for topsoil (34±4 g kg^{-1}) and subsoil (24±2.5 g kg^{-1}).

Table 3: Organic carbon, Nitrogen and Phosphorus of soil samples

Distance (m)	Soil depth (cm)	Organic Carbon g kg^{-1}	Nitrogen g kg^{-1}	Phosphorus mg kg^{-1}
0	0 – 15	50.8±15.9^{bc}	5.0±1.5^{bc}	25.1±7.3^{b}
25		68.3±10.4^{ab}	6.5±1.0^{b}	15.3±1.4^{d}
50		57.8±7.9^{bc}	5.5±0.8^{bc}	16.3±1.7^{cd}
75		41.3±2.4^{bc}	4.0±0.3^{bc}	32.8±4.5^{a}
100		47.8±15^{bc}	4.7±1.5^{bc}	16.5±4.7^{cd}
0	15 – 30	32.4±30.4^{c}	3.3±3.0^{c}	14.1±1.9^{d}
25		94.7±26.9^{a}	9.2±2.7^{a}	21.3±7.6^{bcd}
50		61.8±3.9^{bc}	5.9±0.5^{bc}	20.2±5.6^{bcd}
75		35.4±4.4^{bc}	3.4±0.5^{bc}	23.9±2.5^{bc}
100		58.3±25.4^{bc}	5.6±2.5^{bc}	2.7±0.4^{e}

Similar alphabets along the same column are not significant at p>0.05 according to Duncan Multiple Range Test

Table 4: Cation Exchangeable Capacity of soil samples

Distance (m)	Soil Depth (cm)	Na	K	Mg	Ca
		cmol kg^{-1}			
0	0 – 15	4.60±1.34^{ab}	2.73±0.90^{abc}	7.04±0.38^{a}	41.1±0.6^{c}
25		2.94±0.19^{c}	1.65±0.10^{bcd}	6.61±0.03^{a}	49.9±0.3^{abc}
50		2.75±0.03^{c}	1.53±0.04^{bcd}	4.94±0.01^{ab}	55.0±2.0^{a}
75		3.22±0.21^{bc}	1.82±0.14^{abcd}	5.51±1.01^{ab}	43.1±1.5^{bc}
100		4.85±2.03^{a}	2.88±1.31^{ab}	5.47±0.55^{ab}	48.3±3.5^{abc}
0	15 – 30	2.44±0.81^{c}	1.39±0.46^{cd}	3.45±2.62^{b}	28.4±16.2^{d}
25		2.89±0.17^{c}	1.59±0.12^{bcd}	6.59±0.24^{a}	54.5±0.3^{ab}
50		2.42±0.32^{c}	1.31±0.19^{d}	5.19±0.16^{ab}	49.9±1.3^{abc}
75		3.07±0.06^{c}	1.70±0.04^{abcd}	3.56±0.13^{b}	49.4±0.4^{abc}
100		2.14±0.61^{c}	3.0±1.47^{a}	6.33±2.00^{a}	45.3±9.2^{abc}

Similar alphabets along the same column are not significant at p>0.05 according to Duncan Multiple Range Test

Table 5: Concentrations of heavy metals in soil samples

Distance (m)	Soil Depth (cm)	Cu	Zn	Cr	Cd	Pb
		mg kg^{-1}				
0	0 – 15	223±45^{ab}	1189±261^{bc}	20±2^{a}	11.1±3.1^{bc}	86±73^{c}
25		188±12^{b}	1430±128^{bc}	16.1±0.1^{abc}	4.0±0.5^{c}	247±82^{bc}
50		322±133^{a}	2568±242^{bc}	18.4±3.4^{ab}	11.6±1.4^{ab}	516±210^{a}
75		159±12^{b}	2140±360^{bc}	13.9±1.6^{abc}	3.9±0.4^{c}	198±46^{bc}
100		257±73^{ab}	1154±228^{c}	15.3±4.0^{abc}	5.4±3.9^{c}	203±72^{bc}
0	15 – 30	139±98^{b}	1402±225^{bc}	10.8± 4.8^{c}	6.8±6.0^{bc}	105±95^{c}
25		237±67^{ab}	1354±150^{bc}	10.6±3.1^{c}	3.0±0.3^{c}	181±3^{bc}
50		218±4^{ab}	6893±3085^{a}	13.6±1.9^{bc}	13.8±4.3^{a}	305±16^{b}
75		175±16^{b}	3275±1363^{b}	15.9±3.9^{abc}	4.8±0.8^{c}	166±29^{bc}
100		165±9^{b}	1093±189^{c}	10.0±2.0^{c}	3.1±2.4^{c}	150±49^{bc}

Similar alphabets along the same column are not significant at p>0.05 according to Duncan Multiple Range Test

The data of Cation Exchangeable Capacity of soil samples are presented in Table 4. Calcium (Ca) was the highest measured CEC followed by Mg, Na, and K in that order. The results of CEC showed different varying concentrations in relation to sampling sites. For examples, Na had the highest value of 4.85±2.03 cmol kg^{-1} for topsoil at location 100 m after the dumpsite, while for subsoil the highest level of Na (3.1±0.1 cmol kg^{-1}) was observed at site 75 m. The average heavy metal concentrations ($mgkg^{-1}$) of soil samples from the dumpsite at the different distances is shown in Table 5, among the observed metals, Zn had the highest concentration in all sample with ranged from 926 to 2810 mg kg^{-1} for topsoil and between 904 to 9979 mg kg^{-1} for subsoil. The mean concentrations of Cu ranged from 159 to 454 mg kg^{-1} for topsoil and 41 to 304 mg kg^{-1} for sub soil. Lead (Pb) ranged from 14 to 726 mg kg-1 for topsoil and 11 to 322 for sub soil, while Cr varied from 11 to 22 mg kg^{-1} for topsoil and 6 to 20 mg kg^{-1} for subsoil and Cd showed the lowest concentration of 1.5 to 14 mg kg^{-1} for topsoil and 0.8 to 18mg kg^{-1} for sub soil samples.

Discussion

The average pH of the soil samples for both top and sub soils showed that the soil was moderately alkaline in nature. The pH of the soil could have contributed to retention in the soil of Pb and Zn resulting in low mobility of the metals [16, 17, 18]. Also, the moderate amount of electrical conductivity determined in the soil samples indicated significant presence of some soluble inorganic salts in soils studied [19].

The present study revealed significant increase in the concentration of Pb in the top and sub soil of the sample collected at 50 m from the centre of the landfill which suggests that factors that contributed to the high concentration of Pb could be the presence of dry cell batteries or lead-containing waste present in the area [19]. Some of the soil also showed the Pb level greater than the EU [20] and WHO [21] permissible level of 400 mg kg^{-1} for soil sample (Table 6).

Table 6: Standards for Heavy Metals in Soil

	Soil screening level †	Soil screening level †	Soil screening level †
	WHO[21]. (mg kg^{-1})	EU [20]. (mg kg^{-1})	MAFF[22]. (mg kg^{-1})
As	0.3	0.09	0.41
Cd	74	0.52	3
Cr	270	50	50
Cu	30	180	260
Pb	400	400	600
Ni	1500	78	110
Zn	24,000	900	1800

This could result into environmental and health risk problems. Pb may bio-accumulate in plants and animals and consequently initiate various diseases ranging from aggressiveness to death [23].

The mean concentrations of Cr in the dumpsite top and sub soils were lower than the critical permissible level of 50 mg kg^{-1} for soil recommended for agricultural activities (EC[20]., and MAFF[22]) in agreement with the WHO standard (0 to 35 mg kg^{-1}). Excessive chromium in soils as reported by Ideriah et al [24] might emanate from discarded plastic materials and wastes of coloured polythene bags within the area. The significant increase in Cr content for soil sampled from the dumpsite according to Monechot *et al.* [25] indicates the presence of significant proportion of chromium containing wastes at the dumpsite. Furthermore, sources of chromium in soil may be attributed to waste-like chrome pigment containers as well as dysfunctional boilers used as anticorrosive agent.

The mean concentrations of cadmium measured within the vicinity of the dumpsite soils were less than the WHO permissible standard. The presence of cadmium in soil within the dumpsite can be attributed to proportion of cadmium containing wastes at the dumpsite. Monechot *et al.* [25] stressed that that chromium and cadmium could be introduced into soil through discarded rechargeable batteries, fabrics, tanned leather, stainless steel, dysfunctional electrical equipment such as alloys, and chromium and cadmium waste materials, which are used as anti-corrosive agents. This may lead to congenital disorder, or initiate other chronic health conditions. The pattern of abundance of heavy metals studied in the soils follows Zn > Cu >Pb> Cd, which was similar to the order of metals analysed in Olusosun landfill [26]. A survey by Adjia and Fezeu [27] on landfill soil in Cameroon showed Pb level comparable with this present study, while that on heavy metals contents of the fine grain fraction of municipal solid wastes had also been carried out by [28]. The study showed lower concentrations for all the metals considered in this study. Adedosu *et al*. [26] stated that the factors that determine the heavy metals content in landfill soil could include, the type of wastes that are dumped, the ability to sufficiently stabilize the pollutants in wastes to tolerable limits before dumping, and the life span of the wastes within the landfill. Monechot *et al* [25] also opined that the existing soil characteristics at some dumpsites coupled with biological and chemical reactions taking place within the waste matrix influenced the ambient soil characteristics. Therefore, to properly evaluate the properties of soil will depend upon the waste composition and the type of landfill disposal

method practiced, as well as the topography of the site.

Bada *et al*. [28] reported that abandoned waste dumpsites were high in soil nutrient. The OC, exchangeable cations; Na, K, Mg and Ca were also present in large quantities, which might be attributed to why we have variable nutrients within the soil in this study; even though they were within the permissible WHO standard. In a similar study, Anikwe [29] reported high levels of soil organic matter, nitrogen, Na, Ca, Mg and Kin an Abaliki dumpsite in relation to those of control.

Conclusion

This study had assessed the effect of dumpsite on soil quality in the vicinity of Saje dumpsite in Abeokuta, Ogun state, Nigeria. Top and sub soil samples were collected from five points at varying distance 0 to 100 m. Soils were analysed for important parameters such as organic carbon, total nitrogen, sodium, calcium, magnesium, potassium and heavy metals. The result showed that the concentrations of organic carbon, total nitrogen, sodium, calcium, magnesium, potassium and heavy metals were higher in soil samples collected within the vicinity of the dumpsite than those collected around 100 m (control) after the dumpsite. The presence of heavy metals in the soils around the dumpsite calls for environmental concerns in term of metal bio-accumulation in crops and plants. The result revealed the trend of heavy metal concentration in the soil as Zn > Cu >Pb> Cr > Cd. The study also revealed high levels of important nutrients including organic carbon, nitrogen phosphorus and cation exchange capacity. This study therefore, recommends that dumping of wastes especially toxic waste on this dumpsite should be highly regulated and possible urgent protection of the dumpsite needs to be done. Awareness on the pollution status of soils within the vicinity of the dumpsite needs to be studied to avert health related problems from plant metal uptake.

References

[1] Bacud, L., Sioco, F., Majam, J. 2008. A descriptive study of the water quality of drinking wells around Payatas dumpsite, Unpublished BSc Thesis, University of the Philippines College of Public Health, 1994, 12 – 24

[2] Awomeso, J. A., Taiwo, A. M., Gbadebo, A. M., Arimoro, A. O. 2010. Waste disposal and pollution management in urban areas: A workable remedy for the environment in developing countries. American Journal of Environmental Sciences, 6(1): 26 – 32

[3] Olarinoye, I.O., Sharifat, I., and Kolo, M. T. 2010. Heavy metal content of soil samples from two major dumpsites in Minna. Natur. Appl. Sci. J., ISSN: 1119–9296; www.naasjournalng.org., 11(1): 90-102.

[4] Bishop, P.L. 2000. Pollution prevention: Fundamentals and Practice. McGraw-Hill, Companies Inc., USA, pp: 98.

[5] Amusan, A.A., Ige, D.V., Olawale, R. 2005. Characteristics of Soil and Crop uptake of metals in municipal waste dumpsites in Nigeria. J. Hum. Ecol. KamlaRja 1(2): 167-171.

[6] Ogunyemi, S., Awodoyin, R.O., Opadeji, T. 2003. Urban Agricultural Production: Heavy Metal Contamination of *Amaranthus cruenties* L. Grown on Domestic Refuse Landfill Soil in Ibadan, Nigeria. Emir, Jour. Agric. Sci, 87-94.

[7] Ademoroti, C. M. A. 1990. Bio-accumulation of heavy metals in some Mangrove Fauna and Flora.In Environmental chemistry and toxicological consultancy, Benni, 180-182.

[8] Bodur, M. N., and Ergin, M. 1994. Geochemical characteristics of the recent sediment from the Sea of Marmara. Chem. Geol., 115, 73-101. http://dx.doi.org/10.1016/00092541(94)90146-5

[9] Zonta, R., Zaggia, L., & Argese, E. 1994. Heavy metal and grain-size distribution in estuarine shallow water sediments of the Cona Marsh, Venice Lagoon, Italy. Sci. Total Environ., 151, 19-28. http://dx.doi.org/10.1016/00489697(94)90482-0

[10] Marijan, J. (2002) Heavy Metal Pollution of Soils Collected near a Municipal Solid Waste Incinerator: Human Health Risk. Bull. Environ. Contam. Toxicol., 59(6): 861-867.

[11] Eddy, N.O., Odoemelem, S.A. and Mbaba, A. 2006. Elemental Composition of Soil in Some Dumpsites. Electronic Journal of Environmental, Agriculture and Food Chemistry, 5(3):1349-1365.

[12] Adefemi, O. S., and Awokunmi, E. E. 2009. The impact of municipal solid waste disposal in Ado Ekiti metropolis, Ekiti State, Nigeria. African Journal of Environmental Science and Technology, 3(8), 186-189.

[13] Alloway, B. J., Davies B. E. 1971. Heavy Metal Content of Plants growing on Soil Contaminated by Lead Mining J. Agric. Sci. Cambridge 3(2): 321-323

[14] Ufoegbune, G.C., Oguntoke, O., Adeofun, C.O., and Salako, A. 2008. Remote Sensing

Techniques applied to Time Related Changes in the Land use of Abeokuta and its Environs, South Western Nigeria. Asset Series A. 8(1):98-108

[15] Taiwo, A.M., Gbadebo, A.M., Oyedepo, J.A. Ojekunle, Z.O. Alo, O.M., Oyeniran, A.A., Onalaja, O.J. Ogunjimi, D. and Taiwo, O.T. 2016. Bioremediation of industrially contaminated soil using compost and plant technology. Journal of Hazardous Materials. 304; 166-172

[16] Alloway, B. J. 1990. Heavy Metal in Soils. 2nd Edition, Glasgow: Blackie Publishers, p.50.

[17] Amadi, A. N., Olasehinde, P. I., Okosun, E. A., Okoye, N. O., Okunlola, I. A., Alkali, Y. B., and Dan-Hassan, M. A. 2012. A Comparative Study on the Impact of Avu and Ihie Dumpsites on Soil Quality in Southeastern Nigeria. American Journal of Chemistry, 2(1), 17-23.

[18] Yoshida, M., Ahmed, S., Nebil, S., and Ahmed, G. 2002. Characterization of leachate from Henchir El Yahoidia close landfill. Water Waste Environ. Res., 1, 129-142.

[19] Ojekunle, Z.O., Ojajuni, K. O., Sangowusi, R.O., Oyebanji, F.F., Ojekunle, V.O., Adekitan, A.A., and Odjegba, E.E. 2015. Evaluation of Soil Contaminant Level at Dumpsites in Nigeria. Elixir Agriculture 80: 30995-31001. Available online at www.elixirpublishers.com ISSN: 2229-712X

[20] EC (Council of the European Communities) (1986) Directive 86 278 EEC on the Protection of Environment and in Particular of the Soil when Sewage Sludge is Used EEC. Brussels.

[21] WHO. 1993. Toxicological evaluation of certain food additives and contaminants. Prepared by the 41st Meeting of the Joint FAO/WHO Expert Committee on Food Additives. Geneva, World Health Organization, International Programme on Chemical Safety (WHO Food Additives Series No. 32).

[22] MAFF (Ministry of Agriculture, Fisheries and Food) and Welch Office Agriculture Department. 1992. Code of Good Agriculture Practice for the Protection of Soil. Draft Consultation Document, MAFF, London.

[23] Taiwo, A. M., Arowolo, T. A., Adekunle, I. M. and Adetunji, M. T. 2013. Evaluating the environmental impacts of poultry farming on stream water quality: A study from Abeokuta, Nigeria. Environmental Quality Management. 22 (4); 79-93

[24] Ideriah, T.J.K., Omuaru, V.O.T., and Adiukwu, P.A. 2005. Heavy metal contamination of soils around municipal solid wastes dump in Port Harcourt, Nigeria. Global Journal of Environmental Sciences. Vol. 4 No 1, 1-4.

[25] Monechot, W. O., Eno-obong S. N., and Onyekachi C. I. 2014. Heavy Metal Characteristics of Soils at the Municipal Solid Wastes Dumpsite at Uyo Metropolis, AkwaIbom State, South-South, Nigeria. Chemistry and Materials Research Vol.6 No.7, 2014

[26] Adedosu, H.O., Adewuyi, G.O., and Adie, G.U. 2013. Assessment of Heavy Metals In Soil, Leachate And Underground Water Samples Collected From The Vicinity Of Olusosun Landfill In Ojota, Lagos, Nigeria. Transnational Journal of Science and Technology June 2013 edition vol.3, No.6.ISSN 1857-8047

[27] Adjia, R., Fezeu, W.M.L., Tchatchueng, J.B., Sorho, S., Echevarria, G., Ngassoum, M.B. 2008. Long term effect of municipal solid waste amendment on soil heavy metal content of sites used for periurban agriculture in Ngaoundere, Cameroon Afr. J. Environ. Sci. Tech., 2(12): 412-421.

[28] Esakku, S., Palanivelu, K., Kurian, J. (2003) Assessment of Heavy Metals in a Municipal Solid Waste Dumpsite, Workshop on Sustainable Landfill Management, Chennai, India, 3–5 December, p139-145.

[29] Bada, B.S., Oyewole, O. A., and Sadiq, K. I. 2008. Levels of heavy metals in soil and water leaf (*Talinum triangulare*) collected from abandoned dumpsites in Abeokuta, Nigeria. Proceedings of the 1st West African Summit and 4th National Conference on Organic Agriculture. 103-106pp

[30] Anikwe, M.A. 2002. Long term effect of municipal waste disposal on soil properties and productivity of soil used for urban agriculture in Abaliki. Journal of bioresources technology 83 (3): 241-50pp