Analysis of physicochemical properties during wet and dry season at two major dumpsites was carried out in Ogun, Nigeria. A total of eight composite samples were collected at a depth of 0-15 cm, it was air dried, sieved and was analyzed. The pH, percentage total nitrogen (TN%), percentage organic matter (OM%) and particle size distribution were carried out using standard analytical methods. pH values ranged from 5.95±0.21 to 7.60±0.14 and 7.35±0.21 to 7.60±0.14 for wet and dry seasons, respectively. TN ranged from 0.24% to 0.42% for wet season and 0.08% to 0.29% for dry season, while the OM for the dumpsites were 2.85% to 3.32% and 4.06% to 4.72% for wet and dry seasons, respectively. The soil particle size was 80.8% sand, 17.2% clay and 20% silt. The results obtained shows that the soil was both alkaline and acidic, it was loamy sandy, and was also found to be higher in organic matter content. The soil acidic nature is not good enough for agricultural activities. So far, the organic content of the soils showed clearly that it can be a good source of manure for agricultural uses.

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Capsule Summary: Physicochemical properties of dumpsite soils using standard analytical methods were analyzed and the soil was rich in organic matter which is useful for agricultural purposes.


INTRODUCTION

Management of waste is a major concern on the environment and also a fast increasing issue for developing cities and countries in the world (Abdus-Salam, 2009). Huge waste dumps are commonly found within industrial and residential areas of most developing countries and also wastes are found on street and major roads due to regulation by the enforcement agencies which are not adequate. In Nigeria, some of these wastes are used for agricultural purposes and for recycling materials such as plastics, glass and metals. This is used to augment personal incomes and solve food insecurities issues being faced by rural-urban dwellers (Wuana et al., 2012). Dumpsite is defined as an ancient way or means of disposing waste which is the same as landfill method of waste disposal. Dumpsites are set up in an excavated pits, mining and disused quarries which are away from residential areas. Government agency, corporate bodies are designated and individuals to collect wastes and ensure their proper disposal on these dumpsites (Ibor et al., 2020; Oluwatuyi et al., 2020; Popoola and Adenuga, 2019; Roy et al., 2018; Somani et al., 2020).
Modern landfills are not found in these dumpsites in Nigeria, and these have brought about wastes not being sorted out into degradable, non-degradable and recyclable substances to be achieved. Improper dumpsites management may bring about a number of unfavourable imparts on the environment which includes mice attraction, wind-blow litter and pollutants (leachates) which pollutes soil bed and aquifer. During biodegradation of solid wastes, landfill gas such as methane and carbon dioxide are generated (Abdus-Sallam, 2009).

Fig. 1: Map of study area
Soil is a vital part of the Earth. It functions as a natural means for plants growth (Osuocha et al., 2016). Plants as an integral part of the ecosystem when grown on polluted soil contaminates fruits, food crops due to the accumulation of toxic metals and has become an inevitable problem because the entry of these heavy/toxic metals such cadmium, lead, zinc, chromium, arsenic and hydrocarbons into the food chain may lead to higher vulnerability and exposure to metal poisoning by the populace (Igbanoi et al., 2019; Ikenyiri et al., 2019; Iqbal et al., 2019; Khalil et al., 2018).

The environmental challenges caused by soil waste ranges from repulsive sight, offensive odour soil pollution, water pollution and health hazards and occupancy to increase in ambient temperature levels. These experiences are as a result of lack or poor waste management systems. The resultant of these is the degradation of our environmental quality (Nagendran et al., 2006; Peter et al., 2018; Roy et al., 2018). In Nigeria, trivial or no attention are being paid to the management of wastes and the impact of wastes disposal on the environment by individuals, government and environmental agencies, even though it is their statutory responsibility. Domestic and industrial wastes generated on a daily basis are disposed and managed by agencies like the Department of Petroleum Resources (DPR), Ministry of Environment, Federal Environmental Protection Agency (FEPA), and even local authorities (dos Santos Filho et al., 2020; Rodrigues et al., 2020; Zhao et al., 2020).

Useful information about the techniques development needed for solving the challenges of pollutants in soil and their effects on the environment is carried out by...
determining the strength or capacity of the wastes and effects of these pollutants on soil through soil analysis. The focus of this study is aimed at determining the physicochemical characteristics such as pH, organic carbon, percentage nitrogen, soil particle size, soil texture etc. at different dumpsites in Ilisan town, Ogun State.

MATERIAL AND METHODS

Study area

Ilisan Remo is a town located within Irepodun Local Government Area of Ogun State, South-Western, Nigeria. It is located within Latitude 6° 89′ 32° E and Longitude 3° 71′ 05° N in the rain forest climatic region of the country. The first private University in Nigeria–Babcock University–has its location in Ilisan Remo town. Two major dumpsites and one control site (which was about 1 km from the dumpsites) within the town were used for the study. The first dumpsite (tagged dumpsite A) is located along old Ikenne-Ilisan road, whereas the second dumpsite (tagged dumpsite B) is located at Ilisan-Iperu road.

Sample collection

During the wet and dry season between September and December 2018, soil samples were collected from two major dumpsites and one control site which is about 1 km far from the dumpsites (Fig. 1). The samples were collected at about 0-15 cm depth using a stainless steel soil auger. The samples were collected at eight different points on each site and composite and representative samples were obtained using the quartering method.

DETERMINATION OF PHYSICOCHEMICAL PROPERTIES

pH

Following Folsom method, the pH of soil was ascertained using water (Folsom, 1981). One gram representative soil sample was dissolved into 20 mL of distilled water. The mixture was agitated for 30 minutes with a glass rod and the pH reading was taken. Calibration of pH meter was carried out using buffer 4, 7 and 9 solutions. The electrode was rinsed with distilled water and was used to take the pH reading by immersing into the soil-water mixture and the pH was obtained as pH (H2O)

Total organic carbon

The Waldey-Black rapid wet oxidation method was used in determining the total organic carbon (Walkley and Black, 1934). Half gram of the soil was weighed into a 250 mL flask; 10 mL of 1 M K2Cr2O7 solution was added into the flask and twisted carefully to wet the sample thoroughly. To this mixture, 20 mL concentrated H2SO4 was added and the whole mixture was left to cool for 30 minutes. One hundred milliliter of distilled water was thereafter added, followed by few drops of the Ferroin indicator and the mixture was titrated against 0.5 M FeSO4 solution to a wine-red endpoint. A blank titration was carried out simultaneously.

\[
OC (\%) = \left( \frac{B - T \times 0.003 \times 1.33}{Weight \ of \ sample} \right) \times 100
\]  

(1)

\[
OM (\%) = \frac{Organic \ carbon \ (\%)}{1.729}
\]

(2)

Where, OC = organic carbon, OM = organic matter, B = titre value for blank, T = titre value for sample, F = factor of correction = 1.33 and 0.5 M is the ferrous sulphate.

Total nitrogen

Macro-kjeldahl method was used to determine the total nitrogen (Black, 1965). To a 0.5 g soil sample weighed into a kjeldahl flask, 10 mL of concentrated H2SO4 and a selenium tablet were added and the mixture was digested for about 2 hrs until a clear solution was obtained. The digest was distilled into a 2% boric acid solution containing a mixed indicator. Ammonia was trapped out of the whole digest by using 20 mL of 40% NaOH solution. The liberated ammonia was released into boric acid in receiver flask, which turns light green. Distillation continued until about 50 mL of distillate was collected into receiver flask. The solution obtained from the distillation was titrated against 0.1 M HCl until the initial colour (pink) was detected at the end point.

Particle size determination

Particle size of the soil sample was determined using the Hydrometer method (Bouyoucous, 1962) and the textural class determined from the Textural Triangular Diagram (Loganathan, 1984). Fifty gram of soil sample was weighed and transferred to a dispersing cup and 100 mL of 5% dispersing solution was added and was mixed for 60 s. The suspension was carefully transferred to a 1000 mL graduated cylinder and filled to mark with deionized water and the suspension was left to stand overnight to equilibrate. For 40 s reading, the hydrometer was inserted and the reading was taken after 40 s to measure the amount of silt plus clay suspended. After, 6 h, the reading was taken again to know the amount of clay in the suspension.

\[
Clay (\%) = \frac{[Hydrometer \ reading \ at \ 6 \ h]}{Weight \ of \ sample} \times 100
\]

(3)

\[
Silt (\%) = \frac{[Hydrometer \ reading \ at \ 40 \ s]}{Weight \ of \ sample} \times 100
\]

(4)

\[
Sand (\%) = 100 - [Silt (\%) + Clay (\%)] \times 100
\]

(5)

RESULTS AND DISCUSSION

pH
The results of physicochemical properties are shown in Table 1. Soil pH has a significant outcome on metal dynamics. This is due to the mechanism of metal retention in soil, which includes adsorption and precipitation (Abdulhamid et al., 2015). The mean pH values of the dumpsite soils ranged from 5.95±0.21 to 7.60±0.14 for wet season (Fig. 2) and 7.35±0.21 to 7.50±0.14 for dry season while the control site had a mean pH of 6.30±0.00 and for wet season and 7.60±0.14 for dry season. These values show that some of the soils were slightly acidic whereas others were slightly alkaline. The values reported from the study are within the range of those previously reported–Yahaya et al. (2009)–6.3, Iyaka and Kakulu (2009)–5.0-7.5 and Parth et al (2011)–5.7-8.9.

At low pH (acidic), metals are more soluble and bioavailable in the soil. The range of values obtained from the study site soils during wet season will favour plant uptake of heavy metals and hence there is possibility of toxicity problem (Osakwe et al., 2015). The higher pH of the study site soils, especially during the dry season could be due to the presence of cement materials and blocks, which are sources of calcium carbonate. The rainfall event during wet season, which diluted the soil solution the more could have also led to increase in pH (Yahaya et al., 2009). The higher pH in the dumpsite soils compared to their control site soil could possibly result from liming materials and some microbial activities on the solid wastes (Ayade, 2003; Ideriah et al., 2006).
Organic carbon

The mean percentage organic carbon of soils ranged from 1.65±0.01 to 1.92±0.01 for wet season and 2.34±0.13 to 2.73±0.08 for dry season at the dumpsites (Fig. 3). The mean values for the control site soil had an organic carbon ranging from 1.62±0.28 for wet season to 2.29±0.13 for dry season. The highest mean value was 2.73±0.08 (from dumpsites B) during dry season, while the least mean value was 1.65±0.01 (from dumpsite A) in wet season.

These values of organic carbon obtained were lower than 12-18% reported (for organic soils, as classified) by Troeh and Louis (2005). They were however similar to those stated by Abdulhamid et al. (2015)–0.95-2.25% and 1.0-1.93% by Akinnusotu and Arawande (2016). On another hand, they were higher than values reported by Ideriah et al. (2017)–0.633%-1.05%.

Organic matter

The organic matter value of the dumpsite soils ranged from 2.85 to 3.32% and 4.06 to 4.72% for wet and dry seasons, respectively while the control site soil was 2.80% and 3.97% for wet and dry season, respectively (Fig. 4). These values show that the dumpsite and control site soil had high organic matter value of the dumpsite soils ranged from 1.65±0.01 to 1.92±0.01 for wet season and 2.34±0.13 to 2.73±0.08 for dry season at the dumpsites (Fig. 3). The mean values for the control site soil had an organic carbon ranging from 1.62±0.28 for wet season to 2.29±0.13 for dry season. The highest mean value was 2.73±0.08 (from dumpsites B) during dry season, while the least mean value was 1.65±0.01 (from dumpsite A) in wet season.

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These values were agreeable with those stated by Akinnusotu and Arawande (2016)–0.69±0.01 to 3.35±0.02%. However, it was higher than 0.0248 to 0.707% and 0.028 to 0.409% for OM and OC, respectively as reported by Abdulsalam et al. (2011) for Lokoja dumpsite in Nigeria. These values were lower than those reported by Maneyahilishal et al. (2018)–13.83±0.48 to 16.60±0.90 and Olayinka et al. (2014)-14.78%. The percentage OM of soil at dumpsite A and control site during wet season fell into the medium class (1.50-3.00%) while others fell into the high class > 3 (FAO, 1990). Organic matter is important in soil structure, water retention, formation of complexes and cation exchange (Alloway and Ayre, 1997).

Total nitrogen

The mean percentage total nitrogen ranged from 0.15±0.01 to 0.42±0.00 for wet season and 0.24±0.05 to 0.29±0.02 for dry season on the dumpsite soils while the control site soil was 0.24 ± 0.02 for wet season and 0.08 ± 0.03 for dry season (Fig. 5). The higher value of % N was obtained at the dumpsite A in wet season while the least was 0.15% at dumpsite B during wet season. The result were similar to 0.12 to 0.21 as reported by Akinbile (2012) for % N of soil samples within a landfill in Akure, Nigeria and 0.053% to 0.977% as reported by Ideriah et al. (2017). The % N of soil at dumpsite A during wet season and control site in dry season fell into the low class, while soil at dumpsite A and dumpsite B for dry season and dumpsite A and control during wet season fell into the high class (> 0.15) as reported by FAO (1990).

Particle size of soil

The dumpsite soils particle size and texture is represented in Fig. 5. The soil particle size distribution were between 80.8% sand, 17.2% clay, and 2% silt for the dumpsite soils and 82.8% sand, 15.2% clay and 2% silt for control site soil (Fig. 6). The soil textural class was loamy sandy for control and the two dumpsite soils for wet and dry seasons. The particle size distribution showed that the soil has higher sand composition than clay and silt at all the sites.
The low clay % can be attributed to the low cation exchange capacity since clay in the soil determines its water retention capacity and also the volume of water is directly proportional to the pore spaces in any given soil. The sandy nature of the soil could be due to breakdown of humus from the soil (Maneyahlilishal et al., 2018). The particle size obtained in this study was similar to 83% sand, 11% clay and 5% silt and the soil texture of loamy sandy as reported by Obianefo et al. (2017).

The organic contents are good, which could possibly be used for soil application, however, the mechanical properties of soil play a major role before its use, i.e., shear strength, and long term creep settlement should be investigated.

CONCLUSIONS

Studying of physicochemical properties of soil is quite crucial for management of soil and growth of plants. From this study, the results obtained show that the soil was both alkaline and acidic, it was loamy sandy, and was also found to be higher in organic matter content. The soil acidic nature is not good enough for agricultural activities. Hence, the organic content of the soils showed clearly that it can be a good source of manure for agricultural uses.

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