Determination of Some Physicochemical Parameters of Soil in an Abandoned Waste Dumpsite in Rumuolumeni, Port Harcourt

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D.O.I: 10.56201/ijccp.v9.no1.2023.pg27.35

ABSTRACT

This research work studied the levels of some physicochemical parameters such as pH, electrical conductivity, moisture content, organic carbon, organic matter, total nitrogen, total phosphorus and alkalinity of soil in an abandoned waste dumpsite in Rumuolumeni, Port Harcourt. Soil samples were collected at three different points within the abandoned waste dumpsite for the determination of the levels of the studied physicochemical parameters. The different physicochemical parameters studied were analyzed appropriate laboratory methods. The average range of values recorded for the different physicochemical parameters studied within the period of investigation in the abandoned dumpsite were; pH; 6.38±0.13 to 6.82±0.12, electrical conductivity; 879.69±17.67 to 1062.77±16.77 µS/cm, moisture content; 20.84±0.50 to 23.33±1.00%, % organic carbon; 4.55±0.04 to 5.46±0.13%, %organic matter; 7.85±0.06 to 9.42±0.23%, total nitrogen; 0.13±0.01 to 0.18±0.00%, total phosphorus; 1.30±0.05 to 2.18±0.02% and alkalinity; 5.75±0.06 to 7.98±0.22mg/Kg. The degree of occurrence of the investigated parameter in the abandoned waste dumpsite were within limits acceptable by FAO/WHO for agricultural soil. The results recorded indicated that even at this stage that there should be proper monitoring of waste dumpsites and that planting of crops should be discouraged so that human health will be preserved.

Keywords: *alkalinity, dumpsite, electrical conductivity, moisture content, phosphorus, pH, total nitrogen*

INTRODUCTION

MATERIALS AND METHODS

Collection of Soil Samples

Soil samples were randomly collected from three temporary dumpsites in Ignatius Ajuru University Campus, Rumuolumeni, Port Harcourt at designated points with the aid of soil auger. The samples were collected at three different positions within a sampling site or location and was properly mixed or combined together to produce or form a composite sample. After each sampling, the soil auger was washed thoroughly with water and then allowed to dry so that sample collected from one location does not have influence on another location. Previously labelled polythene bags were used in preserving the collected samples before being conveyed to the laboratory for necessary laboratory pretreatments before analysis and determination of the concentrations of some physicochemical characteristics of the soil.

Determination of pH and electrical conductivity

The method of Bamgbose et al. (2000) was adopted in the determination of the soil pH. About 10g of soil samples that was previously air dried was weighed into a 100ml beaker and then 200ml by volume of distilled water was added to the soil in a beaker. The mixture was then stirred thoroughly with a glass rod and allowed to stand for about 30minutes. A pH meter was then inserted into the mixture at the time that it has partially settled and the pH of the soil was then measured.

The measurement of electrical conductivity of the soil was done using a conductivity meter. The conductivity of the soil was measured or determined using a ratio of 1:5 of soil and distilled water solution. The WTW model conductivity meter used measuring the conductivity of the soil (Fomenky et al., 2018).

Moisture content

The soil moisture content gives an indication of the quantity or amount of water existing in soil. It was determined using the method that was described in the work of Anderson and Ingram (1993). 1g of a representative sample was taken from the moist soil sample and was then placed in a clean, dry crucible of known mass with its lid security in position. The mass of the container and moist soil was determined with a weighing balance model AE163. Afterward, the lid was detached and the crucible was placed in oven maintained at 110±5% for 4h to attain a constant content of the soil. The mathematical formula for moisture content is expressed as:

$$\text{Moisture content } \%^{n} = \frac{Moist\ soil - Dry\ soil}{Moist\ soil}\ x\ 100$$

Percentage Organic Carbon and Organic Matter

The amount or quantity of organic carbon in the soil was determined using the method of Walkey and Black (1934). About 2g of the already pretreated and prepared soil sample was weighed into a conical flask and an addition of about 10ml standard solution of $K_2Cr_2O_7$ was put into the conical flask containing the sieved soil sample and afterwards an addition of 20ml of

concentrated H_2SO_4 was made in order that chloride ions will not interfere in the process. The prepared solution was then allowed to settle down for about 30 minutes interval while stirring was done occasionally. A further dilution of the total content in the conical flask was achieved through the addition of 10ml of distilled water. A ferroin indicator was used as an indicator to determine the excess $K_2Cr_2O_7$ which was then titrated with standard 1.0N ferrous sulphate solution.

The percentage organic carbon in the sample was then calculated using the formula:

% Organic Carbon = ((Mc $K_2Cr_2O_7$ - Mc$FeSO_4$) x 0.003 x 100 x F)/(weight of soil(g).

Where,

Mc = normality of solution x volume (ml) of solution used

F = correlation factor = 1.33

The percentage organic matter was then calculated using the expression

% Organic Matter = % organic carbon x 1.724.

Determination of Nitrogen, phosphorus and alkalinity

The total soil nitrogen in the soil was determined using the Kjeldahl method (vlab.amrita.edu., 2013). The available soil nitrogen in the process was converted to HNO_3 through the digestion of the soil sample with concentrated H_2SO_4 in the presence of $CuSO_4.H_2O$ as a catalyst and K_2SO_4 that raised the digestion temperature. The organic material then decomposed into several components. The ammonia content of the digest was then analyzed by distillation with excess NaOH and absorption of the evolved NH_3 was in standard HCl. The excess of standard HCl was titrated against standard NaOH using methyl red as an indicator. The decrease in the multi equivalence of acid as determined by acid-base titration gave a measure of the nitrogen content of the soil sample and the end point was determined by a change in colour from pink to yellow. The determination of phosphorus was performed using the method of colorimetry (Dandwate, 2020) while the level of alkalinity in the soil was determined by the use of pH meter.

RESULTS AND DISCUSSION

The results obtained for the physicochemical parameters at the time of investigation in the different stations of the abandoned dumpsites are provided in Tables 1 to 3 while the mean concentrations within the stations at the same period are provided in Table 4.

Table 4.1: Concentrations of physicochemical parameters at the abandoned dumpsites in June

Parameters	Stations		
	1	2	3
pH	6.96	6.50	6.62
Electrical conductivity	856.67	1056.20	1086.32
Moisture content	21.52	24.74	22.69
% Total organic carbon (TOC)	4.60	5.65	5.25

% Total organic matter (TOM)	7.93	9.74	9.05
% Total nitrogen	0.13	0.18	0.11
% Phosphorus	1.58	2.21	1.36
Alkalinity	6.65	8.15	5.82

Table 4.2: Concentrations of physicochemical parameters at the abandoned dumpsites in July

Parameters	Stations		
	1	2	3
pH	6.84	6.44	6.59
Electrical conductivity	899.62	1036.22	1053.47
Moisture content	20.68	22.54	21.21
% Total organic carbon (TOC)	4.54	5.39	5.17
% Total organic matter (TOM)	7.83	9.29	8.91
% Total nitrogen	0.14	0.17	0.13
% Phosphorus	1.47	2.18	1.29
Alkalinity	6.57	8.12	5.75

Table 4.3: Concentrations of physicochemical parameters at the abandoned dumpsites in August

Parameters	Stations		
	1	2	3
pH	6.66	6.19	6.52
Electrical conductivity	882.79	1032.43	1048.53
Moisture content	20.32	22.72	21.02
% Total organic carbon (TOC)	4.51	5.35	5.14
% Total organic matter (TOM)	7.78	9.22	8.86
% Total nitrogen	0.16	0.18	0.14
% Phosphorus	1.43	2.15	1.25
Alkalinity	6.49	7.66	5.68

Table 4.4: Mean concentrations of physicochemical parameters at the abandoned dumpsites during the period of study

Parameters	Stations		
	1	2	3
pH	6.82±0.12	6.38±0.13	6.58±0.04
Electrical conductivity	879.69±17.67	1041.62±10.43	1062.77±16.77
Moisture content	20.84±0.50	23.33±1.00	21.64±0.75
% Total organic carbon (TOC)	4.55±0.04	5.46±0.13	5.19±0.05
% Total organic matter (TOM)	7.85±0.06	9.42±0.23	8.94±0.08
% Total nitrogen	0.14±0.01	0.18±0.00	0.13±0.01
% Phosphorus	1.49±0.06	2.18±0.02	1.30±0.05

Alkalinity	6.57±0.07	7.98±0.22	5.75±0.06

pH

The mean values recorded for pH from the different stations during the months of investigation around the studied dumpsites varied from 6.38±0.13 to 6.82±0.12. The recorded values of pH during period of study were close to the neutral pH range or very slightly acidic in nature. The values recorded in this investigation was either lower or within the same range obtained by Igwe and Bekee (2021) in soils from steel markets in Port Harcourt which varied from 6.30±0.02-7.40±0.14 during the time of study but was higher than the values recorded by Edori et al. (2022) at selected temporary dumpsites in Port Harcourt with value range of 5.49±0.11-5.66±0.25.The observed values were also higher than that which was reported by Edori and Iyama (2017) in selected abattoirs in Port Harcourt which ranged from 4.19-5.13. Arias et al., (2005) observed that Soil pH possess significant influence on the accessibility of nutrients to plants and also types of organism that is found in the soil. The pH also influences the level of solubility of metals and how readily they are made availability to plants. The pH obtained in any particular soil or environment is the hydrogen ion concentration of that particular soil or environment. pH measures the acidic characteristic of matter. In regions with high rain, as exemplified in this study, the soils has the tendency to be more acidic as compared to areas with low rainfall. This is due to the fact that basic cations are removed from the soil colloids through mass action of hydrogen ions from the rain (Edori and Iyama, 2017).

Electrical conductivity

The mean values recorded for Electrical conductivity from the different stations during the months of investigation around the studied dumpsites varied from 879.69±17.67 to 1062.77±16.77 µS/cm. The recorded value of electrical conductivity obtained was far higher than the values obtained by Edori and Iyama (2017) which ranged from 269.22-406.86 µS/cm in selected abattoirs in Port Harcourt and also that which was reported by Edori et al. (2022) at temporary dumpsites in Port Harcourt which ranged from f 88.67±11.44-90.33±12.23 µs/cm. The observed high value of electrical conductivities of the soil from abattoirs is an indication of interference from anthropogenic factors. Fomenky et al. (2018) also reported electrical conductivity value range of 0.043-0.148ds/m in an investigation undertaken in Cameroon soils close to some rivers. High electrical conductivity values suggest the existence of soluble salts in the soil (Arais et al., 2005,). This observation corroborates what was obtained in this work, due to the fact that the electrical conductivity obtained was high. This showed the soil studied had high level of ions and inorganic matter. This agreed with the observation made by Fuller et al. (1995) that electrical conductivity indicate the presence in soil of ions and inorganic matter which are ionizable (Fuller et al., 1995). Electrical conductivity is vital in soil characteristics that is suitable in the examination of the degree of soil quality and also an important check on the health condition of the soil (Tale & Ingole, 2015).

Moisture content

The mean values recorded for percentage moisture content from the different stations during the months of investigation around the studied dumpsites varied from 20.84±0.50 to 23.33±1.00%.

The percentage moisture content obtained in this investigation were above the values reported in the work of Edori and Iyama (2017) in abattoirs selected from different parts of Port Harcourt which varied from 16.66±1.73 to 21.07±2.05%. The level of water in the soil is useful in dissolving nutrients and thereby making it easily available for plants use. The percentage soil moisture content controls soil heat and also the survival of soil organisms and plants. The amount of water available in the soil is completely due to the type of soil and also and that of the area studied. Clay soil hold high percentage of moisture while sandy soil permits water to pass through it easily and hence possessing low moisture retention (Edori & Iyama, 2017). The soil potential to retain high level of organic materials is a function of the soil to hold water over a long time and also take lengthier period for that particular soil sample to become dry. The level of percentage moisture obtained in the soil studied was primarily as a result of available air displaced in the soil, thereby resulting into low level of soil oxygen. This ultimately help in the reduction of microbial activities taking place in that particular soil environment (Osuji & Nwoye, 2007).

Percentage total organic carbon and soil organic matter

The mean values recorded for percentage organic carbon from the different stations during the months of investigation around the studied dumpsites varied from 4.55±0.04 to 5.46±0.13%. The mean values recorded for percentage organic matter from the different stations during the months of investigation around the studied dumpsites varied from 7.85±0.06 to 9.42±0.23%. The values of percentage organic carbon and organic matter obtained in this work were more than that which was obtained in the work of Igwe and Bekee (2021) in soils from steel markets in Port Harcourt which varied from 0.269±0.00-0.432±0.00% for percentage organic carbon and 0.465±0.00-0.747±0.00% for organic matter.

The values recorded for total organic matter were higher than the approved level of 1.3-4.76% by FAO/WHO (2007) for soil irrigation. The value recorded in this work for organic carbon and organic matters were higher than that reported by Ojo et al., (2017) in a study of physicochemical parameters at dumpsites in Akure and also that reported by Edori and Iyama (2017) while evaluating some physicochemical parameters in selected abattoirs in Port Harcourt, Nigeria. These organic parameters show to what extent the soil studied is rich in organic matter. The fertility of the soil and its development give a mark or degree of organic content in the soil environment investigated. This possibly could have come from the decay and decomposition of animals and plants materials. The soil nutrient composition is majorly a function of the quantity of total organic materials existing within that soil environment. This is also useful in the Stabilization of soil pH (Avramidisa et al., 2015; Edori & Iyama, 2017). Soil organic matter is important and a vital instrument in retaining metal elements in the soil and also help in the decrease of their movement and bioavailability to plants, thus effectively enhancing their use in soil for agricultural purposes (Akpoveta et al., 2010).

Percentage total nitrogen

The mean values recorded for percentage total nitrogen from the different stations during the months of investigation around the studied dumpsites varied from 0.13±0.01 to 0.18±0.00%. The mean values obtained for percentage total nitrogen in the different the stations of the soil affected by diesel was higher than that obtained in soil used as temporary dumpsites in Port Harcourt by

Edori et al. (2022) which varied from 0.340±0.02-0.359±0.004mg/Kg but was lower than the level recorded in the work of Dandwate (2020) that varied from 140.10 to 252.68 kg/ha. Nitrogen is a vital plant nutrient, it is useful for plant growth and development. The deficiency of nitrogen in the soil bring about stunted growth and development and yellowish green leaves are observed in plants which is a sign in protein content reduction which finally affect yields. Nitrogen content was observed to be low in the soil samples studied. Nitrate is a vital part of the soil environment. Waste products that are excreted by soil inhabiting creatures like nitrogen fixation bacteria increases soil nitrate concentration in the soil.

Percentage total phosphorus

The mean values recorded for percentage total nitrogen from the different stations during the months of investigation around the studied dumpsites varied from 1.30±0.05 to 2.18±0.02%. The mean values obtained for percentage total nitrogen in the different the stations of the soil affected by diesel was higher than that obtained in soil used as temporary dumpsites in Port Harcourt by Edori et al. (2022) which varied from 4.22±0.28-4.33±0.25 mg/Kg and that which was also recorded by Chaudhari (2013) that varied from 0.021- 0.026mg/Kg but was lower than the level recorded in the work of Dandwate (2020) that varied from 15.11 to 54.13 kg/ha. Phosphorous is characterized as the principal or key element in the analysis of soil quality. It is a most important element in all single living cell. It is requisite for growth, division of cell, development of root and seed elongation, fruity development and early ripening (Kachhave & More 1982). Phosphorus also help in the storage and transfer of energy. Phosphorus is well-known as the least mobile of the major plant nutrients.

Alkalinity

The mean values recorded for alkalinity from the different stations during the months of investigation around the studied dumpsites varied from 5.75±0.06 to 7.98±0.22mg/Kg. Alkalinity is the potential to neutralize acids. In the soil environment, alkalinity majorly come from the salts of weak acids like hydroxides, carbonates and bicarbonates. Some reactions that might be natural or being facilitated by humans are like those of CO_2, $CaCO_3$ and $MgCO_3$ can bring about the production of considerable amounts of bicarbonates (Wokoma & Edori, 2020). Additional sources of alkalinity are organic acids such as humic acid which reacts to form salts that can result in the rise of alkalinity in the environment (Kumar & Chopra, 2012).

CONCLUSION

The results obtained in this research revealed that the pH, electrical conductivity, moisture content, percentage organic carbon, percentage organic matter, total nitrogen, total phosphorus and alkalinity levels in the studied dumpsites within acceptable limits for agricultural soils. The study also showed that the studied physicochemical characteristics of the soil within the dumpsites were not above that which is recommended by FAO/WHO for agricultural soils.

Although the physicochemical parameters in the soils of the studied area have not reached a concentration that will affect the ecosystem, effort and proper control measures should be kept in place at checkmating the further dumping of wastes within the studied environment in order to avert the possibility of its effect on the soil quality and structure in the near future.

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