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Research Article

Some Physicochemical Characteristics of Soils Obtained From an Abandoned Dumpsite Located In Rumuolumeni, Port Harcourt, Rivers State, Nigeria

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Abstract

Some physicochemical characteristics of soils used as an abandoned dumpsite in Rumuolumeni, Port Harcourt, Rivers State, Nigeria were collected and after due laboratory pretreatments were evaluated and analyzed using standard conventional methods of analysis to ascertain their level in the studied environment and degree of occurrence. The investigation was carried out between the months of January to May, 2024. The results recorded within the months under investigation revealed that the mean value range of pH was between 6.19±0.14 to 6.78±0.03, mean value range of electrical conductivity was between 34003.14±250.17 to 43395.44±925.50 µS/cm, mean value range of chlorides was between 76±0.71 to 831.12±22.21 mg/Kg and mean value range of salinity was between 1224.97±49.95 to 2303.32±83.16 mg/Kg. For particle size analysis, the results obtained showed that percentage sand was in the mean range of 84.63±0.37 to 88.84±0.54%, percentage clay was in the mean range of 3.66±0.22 to 4.98±0.11% and percentage silt was in the mean range of 7.23±0.02 to 10.39±0.46%. The textural class within the abandoned dumpsite was sandy silt in all the designated points used for the work. Observation from the pattern and levels of occurrence of the physicochemical parameters studied in the abandoned dumpsite site revealed that their values were still within acceptable limits for agricultural soils but there should be complete evacuation of the abandoned dumpsite in order to avert any probable effect on the soil quality and structure and on humans that make use of the soil.

Keywords: contamination, abandoned dumpsite, physicochemical characteristics, pollution, Nigeria.

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Introduction

Uncontrolled and indiscriminate dumping of refuse in urban cities has led to the degradation, deterioration, contamination and pollution of the natural environments [27] and has resulted into serious environmental challenges and concern to man. The increase in the contamination of the human environment due to urbanization has resulted in many health challenges. The immediate human environment is priceless and limited and it is supposed to be treasured and prevented from pollution and deterioration. Humans has only come to this awareness after decades of negligence on the level of pollution and wastes that anthropogenic activities have produced [35]. An indispensable aspect of human life becomes largely affected due to the negligence, carelessness and total ignorance on the part of the general public, that good and healthy environment is needed and important for healthy living and also affect human socio-economic development. The significant and non-replaceable nature of the soil which is a natural link between other natural components like the air and water together make up the environmental cycle. The links between these natural component parts of the environment has enabled the provision of vital necessities of life like food, water, fuel and nourishment for humans and other living organisms [12].

Anthropogenic or human input sources and some other factors like vegetation, parent rock and altitude of an environment, could modify the physiochemical characteristics of the soil, such as pH, soil texture, particle size, electrical conductivity, total organic carbon, cation exchange capacity and moisture content [20]. The mobility and redistribution of available nutrients within any given soil environment depends largely on the extent of the physiochemical properties of the soil. Such characteristics like pH, organic matter, redox conditions and quality of clay are mainly responsible for the mobilization and conduction of nutrients elements and water to the plant that occupy such spaces and are being moved through the food chain to animals and then to humans [28].

One of the key environmental concerns in our cities today is inappropriate solid waste handling, management and eventual disposal [22]. Soils be different in their reactions to organic wastes alterations which has led to the need to investigate on the impact of organic wastes on the characteristics of the soil [23]. Nevertheless it has been reported that disposal of organic waste into agricultural land has helped in improving its properties and that our major cities do not sort waste generated as to classify and identify the unit impact of their inorganic constituents [29]. Pollutants even in waste dumpsites are known to be potential hazards and threats to the ecosystem [31,23]. Amadi et al. [4] reported that Nigerian dumpsites are usually, abandoned burrow pits and areas acquired which were not selected founded on any legal environmental impact evaluation or assessment studies. Subsequently, these waste dumped in the area designated as dumpsites become hazards and potential risk to the soil and groundwater as due to the percolation of leachates with time [33].

The continuous growth and increase in human population, effective economy, urban development and search for better living standards in societies is go together with the issue of rapid production of municipal solid waste in unindustrialized or developing nations. These undesirable wastes are components produced from common effects of residential, industrial and commercial activities obtainable within the occupied area [7]. Solid wastes could be in the form of biological material or inorganic material, which might possess hazardous properties such as toxicity, could easily cause flame, radioactive or cause infection [34]. The control, management and disposal of waste within the cities typically lies with waste management authorities or agencies established by the government, which are being delegated to improve the quality of the environment for proper sustainability and development. Nevertheless, the inhabitants frequently face problems outside the capacity of the municipal power to handle. This is principally due to incompetent or inactive structural organization, insufficient financial means, hindrances and a system that is given multi-dimensional obligations [11,26].

The indiscriminate discharge and the delay in the evacuation of wastes from dumpsites could constitute threat to the environment and could also result into the introduction of new constituents that were originally not existing within the area [27]. Dumpsites are basically provided for solid wastes which encompasses both organic and inorganic wastes. Waste generation and production is mainly as a result of rapid increase in production and consumption from normal human, industrial, agricultural and even animal activities within urban settlements. The non-useful parts or constituents of these undertakings (production and consumption) are continuously thrown away and considered as wastes. These activities in effect, on the long or short run could leads to pollution complications to the human environment [9]. The nature, mode and composition of the wastes released or discharged on dumpsites differs from place to place due to season, types of activities within the locality, socio-economic conditions and location [18,27].

The acceptance that soils within the proximity of dumpsites are productive and fortified with appropriate plant nutrients and organic manure has brought about the establishment of small farms (especially vegetable gardens) within areas close to dumpsites. This is grounded on the total ignorance in most cases of the farmers on the implicit aftermath effects that could possibly come about from the consumption of such plants grown close to dumpsites [30]. Therefore, this research work was carried out to investigate the levels of selected physicochemical properties in an abandoned dumpsite soils located in Rumuolumeni, Port Harcourt, Rivers State, Nigeria.

MATERIALS AND METHODS

The study area

The study site where the abandoned dumpsite is located is in Rumuolumeni, Port Harcourt, Rivers State, Nigeria. Rumuolumeni runs approximately south-west of the city of Port Harcourt and measures about 5km^2. The zone, especially Ignatius Ajuru University of Education has been heavily affected by contaminants from the dumpsite. The three sampling points chosen within the dumpsite were designated Location 1, Location 2, and Location 3 respectively, which were some distances and degrees away from each other. These locations were strategically chosen based on the physical appearances of the water and land use pattern and the economic activities taking place within the area.

Collection of soil samples

Soil samples were collected at random from three points within an abandoned dumpsites located at Ignatius Ajuru University Campus, Rumuolumeni, Port Harcourt with the help of soil auger. The samples were collected at three different points at a sampling area or location and then well mixed or combined together to form a composite sample. After each sampling, the auger was thoroughly washed in water and dried in order that the samples from one station does not affect another station. Already labelled polythene bags were used in the preservation of the collected samples before being conveyed to the laboratory for soil pretreatment, and further laboratory preparations before analysis and determination of the levels of physicochemical properties of the soil.

Determination of pH and electrical conductivity

The procedure employed by Bamgbose et al. [8] was adopted in the determination of the pH of the soil. 10g of soil samples that was previously air dried was weighed into a 100ml beaker and was then distilled water of 200ml volume was added to the soil in the beaker. The mixture was then stirred with a glass rod and was allowed to stand for a period of 30minutes. A pH meter was then put in into the mixture when it was incompletely settled and the pH of the soil was then measured and obtained.

The electrical conductivity of the soil was estimated with a conductivity meter. The conductivity of the soil was analyzed using a ratio of 1:5 of soil and distilled water solution. The model of the conductivity meter employed was WTW model [20].

Particle Size Determination

The soil particle size analysis and determination was achieved in accordance to the technique adopted by Bouyoucos [10]. A 50ml solution of cogon was employed in cooking 50g of an already sieved soil sample over an ingle. The prepared mixture was putt into a measuring cylinder of 100ml volume. The mixture was then added to the 100ml mark and then shaken and was allowed to set for 40 second before the hydrometer was dipped into it for the sandy content. The determination the clay and salt content were done after an interval of 3 hours (when the mixture have settled down properly) following the same procedure. The temperature at 40 seconds at 3 hours interval were recorded at the same time with the hydrometer reading designated as T, and T2, H, and H2 respectively.

The particle size analysis calculation were then estimated thus,

% Sand =100-(H1+0.2[(T1-68) -2.0]2

% Clay = (H2+0.2[(T2- 68)-2.0)]2

% silt =100-(%sand + % clay)

Determination of chloride and salinity

Chloride in soil samples were analyzed using the method of APHA [6]. The estimation of chloride concentrations in the samples were determined using titrimetric method. 10g of soil samples that was previously air dried was weighed into a 100ml beaker and then distilled water of 200ml volume was added to the soil in the beaker. The mixture was stirred with a glass rod and then allowed to stand for an interval of 30minutes. To the sample, two drops of potassium chromate indicator was added. The sample-indicator mixture was titrated against a 0.0282 M silver nitrate solution to a brick red colour. A blank titration was also conducted and the value of the standardized silver nitrate solution used was recorded. The concentration of chloride in the sample was calculated and recorded in mg/Kg.

Chloride concentration

$$= \frac{(Vs - Vb) x\, normality\, x\, 35.5\, x\, 1000}{Volume\ of\ sample taken}$$

Where

Vs = Volume of silver nitrate used for the sample

Vb = Volume of silver nitrate used for the blank

Salinity of the soil was analyzed according to the procedure of Dirican [13]. The salinity of the samples were determined by the use of a digital electronic meter. The soil samples were treated as in the case of chloride. Then, the electrical conductivity of the meter was adequately calibrated. Then probes were inserted into the sample and moved up and down to remove all air bubbles around the probes (electrodes). The probes were then allowed to attain the water temperature and the reading of the salinity was taken. The probes were cleaned by rinsing them in deionized water before taken other readings. The observed values were then recorded as mg/Kg.

Results and Discussion

Levels of some physicochemical parameters in the abandoned dumpsite

The results recorded for the levels of the different physicochemical parameters at the different point in the abandoned dumpsite in Rumuolumeni, Port Harcourt are given in Tables 1 to 3 while the mean concentrations of the different physicochemical parameters are given in Table 4.

Table 1: Levels of physicochemical parameters obtained from the abandoned dumpsite in January

Sample identity	Station		
	1	2	3
pH	6.75	6.35	6.00
Electrical conductivity (µS/cm)	33675.00	35400.00	42100.00
Chloride (mg/Kg)	800.00	1000.00	1325.00
Salinity (mg/Kg)	1155.00	1650.00	2186.00
% Clay	3.80	4.50	5.00
% Sand	89.00	87.00	85.00
% Silt	7.20	8.50	10.00
Textural class	Sandy silt	Sandy silt	Sandy silt

Table 2: Levels of physicochemical parameters obtained from the abandoned dumpsite in March

Sample identity	Station		
	1	2	3
pH	6.78	6.45	6.21
Electrical conductivity (µS/cm)	34281.75	37196.20	44205.06
Chloride (mg/Kg)	850.40	1030.65	1368.70
Salinity (mg/Kg)	1268.30	1840.50	2369.20
% Clay	3.83	4.52	5.10
% Sand	88.1	86.95	84.78
% Silt	7.26	8.53	10.12
Textural class	Sandy silt	Sandy silt	Sandy silt

Table 3: Levels of physicochemical parameters obtained from the abandoned dumpsite in May

Sample identity	Station		
	1	2	3
pH	6.82	6.57	6.35
Electrical conductivity (µS/cm)	34052.68	36842.71	43881.25
Chloride (mg/Kg)	842.96	1014.84	1357.88
Salinity (mg/Kg)	1251.62	1866.38	2354.75
% Clay	3.35	5.02	4.84
% Sand	89.41	86.51	84.12
% Silt	7.24	8.47	11.04
Textural class	Sandy silt	Sandy silt	Sandy silt

Table 4: Mean levels of physicochemical parameters obtained from the abandoned dumpsite during the study period

Sample identity	Station		
	1	2	3
pH	6.78±0.03	6.46±0.09	6.19±0.14
Electrical conductivity (µS/cm)	34003.14±250.17	36479.64±776. 94	43395.44±925.50
Chloride (mg/Kg)	831.12±22.21	1015.16±12.51	1350.53±18.58
Salinity (mg/Kg)	1224.97±49.95	1785.63±96.48	2303.32±83.16
% Clay	3.66±0.22	4.68±0.24	4.98±0.11
% Sand	88.84±0.54	86.82±0.22	84.63±0.37
% Silt	7.23±0.02	8.50±0.02	10.39±0.46
Textural class	Sandy silt	Sandy silt	Sandy silt

Levels of some physicochemical parameters in the abandoned dumpsite

pH

The results recorded for pH in the abandoned dumpsite within the months under study from the different points selected within the dumpsite where the sample was collected ranged from 6.00 to 6.82. The mean level of pH in the abandoned dumpsite within the stations was in the range of 6.19±0.14 to 6.78±0.03 during the time of investigation. The results recorded for pH in this very study were within or close to the permissible limit required by World Health Organization (WHO) [37] which fall between 6.5 to 8.5. The recorded values of pH in this investigation were below that which was reportedly obtained by Elemile et al. [19] which gave range of values from 7.19±0.25 to 7.83±0.02 in soils affected by abattoir activities, and that which was also reported by Ediene and Iren [14] that was recorded to be within the range of 6.22 to 7.52 in an investigation on the influence of abattoir effluents on soil pH. The values recorded in this work were observed to be higher than that which was recorded and obtained in the work carried out by Osakwe and Okolie [32] with pH value of 5.15±0.48. Soil pH influences the movement or dynamics of metals in the soil. pH has the ability to control the adsorption and precipitation processes of metals in the soil which are indispensable factors in metal retention in the soil. At low pH value metals exist in a more soluble form and hence more cationic form that could be easily made accessible for plants absorption [1]. pH range of 6.00 to 8.5 show a suggestion that the soil is normal [34]. The recorded results obtained for pH in this study showed therefore that the activities within the abandoned dumpsite have not negatively affected the soil pH at the time this investigation was carried out.

Electrical conductivity

The results recorded for Electrical conductivity in the abandoned dumpsite within the months under study from the different points selected within the dumpsite where the sample was collected ranged from 33675.00 to 44205.06 µS/cm. The mean level of Electrical conductivity in the abandoned dumpsite within the stations was in the range of 34003.14±250.17 to 43395.44±925.50 µS/cm during the time of investigation. The recorded values for electrical conductivity in the soils of the abandoned dumpsite were far above the results recorded in the work of Igwe and Bekee [21] around steel markets environments in Port Harcourt which fell between 51.6±0.51 to 165±1.47 µS/cm, and that which was recorded by Edori and Iyama [17] that gave the range of values from 280.00±11.21 to 404.34±7.18 µS/cm from three different abattoirs in Port Harcourt. The results obtained in this research work were observed to be lower than that which was recorded in an investigation undertaken by Edori and Edori, [16] in automechanic works villages in Port Harcourt and also that which was obtained in Guraj, India in a site contaminated with gasoline by Khan et al. [25]. Electrical conductivity is imperative in the measurement of soil quality. The levels of electrical conductivity of soil increases when there is resultant increase in the levels of ions present in the soil. Conductivity estimates or measures the level of existence of ions in any given soil environment and also provides knowledge and information on the probable amount of ions in any particular soil environment [36,21]. The combination of soil electrical conductivity and soil pH help in influencing the mobility of ions in the soil and also affects the usage and availability of the ions present in the soil to plants and animals [2,21].

Particle size analysis

The analysis of particle size distribution showed that the results recorded for sand in the abandoned dumpsite fell between 84.12 to

89.41%, with a mean range of 84.63±0.37 to 88.84±0.54%, clay values fell between 3.35 to 5.02% with a mean range of 3.66±0.22 to 4.98±0.11% and silt values fell between 7.20 to 11.04% with a mean range of 7.23±0.02 to 10.39±0.46 within the different stations at the time of this study. The recorded results in this work indicated that the textural class of the soil in all the points samples were collected within the abandoned dumpsite were sandy silt. The textural class reported in the work of Edori and Iyama [17] was sandy clay loam and that reported in the work of Khan et al. [25] was clay loam. The results obtained for sand were above that reported in the work of Edori and Iyama [17] and also that which was reported in the work of Khan et al. [25], but the results obtained in this investigation for clay and silt were lower than the values reported in the work of Edori and Iyama [17] and also that which was reported in the work of Khan et al. [25]. The elevated level of sand in the soils of the abandoned dumpsite under investigation indicated that the soil has low ability of water retention owing to the fact that sand is porous and permits water to permeate through it easily and hence low moisture content. There is high aeration of such soil but it has the inability to support the planting of crops [21,15]. Soil texture measures the physical properties of soil which includes soil plasticity, soil permeability, toughness or ease of soil tillage, water retention capacity and soil productivity [5]. The soil in this work is more of sand and therefore has low potential of holding water and allows much water percolation through it easily and hence promotes the contamination of groundwater as compared to soil that is more of clay and silt that has the potential of holding water and preventing it from permeating or penetrating without difficulty through it [3] and thereby providing natural means of filtration of contaminants and pollutants of the natural ground water.

Chlorides

The results recorded for chlorides in the abandoned dumpsite within the months under study from the different points selected within the dumpsite where the sample was collected ranged from 800.00 to 1368.70 mg/Kg. The mean level of chlorides in the abandoned dumpsite within the stations was in the range of 831.12±22.21 to 1350.53±18.58 mg/Kg during the time of investigation. The values obtained for chloride in the soils of the abandoned dumpsite were far higher than that reported by Edori and Iyama [17] in abattoirs within the Port Harcourt that had value range of 17.10±1.61-31.75±2.00 mg/Kg. The value observed for chlorides ions in the soils of the abandoned dumpsite in this work was also higher than that obtained and while investigating soils used for abattoirs in Port Harcourt metropolis. The concentration of chlorides ions in this work could be as a result of the high salinity value of the soil and due to its closeness to the section of New Calabar River which is saline in nature. Chlorine come about in the soil in the form of soluble chlorides and is connected with organic matter. Chlorides in the soil always occurs in dissolved form and has the tendency to accumulate in saline salts due its capability to form compounds with sodium, calcium and magnesium. The accessibility and availability of chlorides to plants is influenced by soil acidity, aeration and organic matter [17]. High concentrations of chloride ions in the soil could result into increased levels of uptake by plants and which can bring about toxicity challenges in crops and thus resulting in the reduction of crop yield. However, chloride ion is very important in photosynthetic processes [17].

Salinity

The results recorded for salinity in the abandoned dumpsite within the months under study from the different points selected within the dumpsite where the sample was collected ranged from 1155.00 to 2369.20 mg/Kg. The mean level of salinity in the abandoned dumpsite within the stations was in the range of 1785.63±96.48 to 2303.32±83.16 mg/Kg during the time of investigation. The mean values obtained for salinity in this research work as at the time of this study were far higher than the values recorded and reported by Edori et al. [15] in a soils used for dumpsites in Port Harcourt, Nigeria which lie within the range of 52.11±5.54 to 53.624.42 mg/Kg and also that which was reportedly obtained in the work carried out by Edori and Iyama [17] in abattoirs within Port Harcourt that was within the range of 25.00 to 61.07 mg/Kg. The high salinity value experienced in the studied area might possibly be due to its closeness to the section of New Calabar River which is saline in nature. Salinity is vital, useful and also a significant factor under considerable environmental situations. This could probably be as a result of its effect on the type and species of floras and faunas that occupy or inhabit that environment and also has serious consequence on the soil type and the use to which it is being put into [15,16].

Conclusion

The results obtained in this research revealed that the pH, electrical conductivity, soil particle size, chlorides and salinity levels in the studied dumpsites that has been abandoned were within acceptable limits for agricultural soils. The study also revealed that the studied physicochemical characteristics of the abandoned dumpsite soil within the stations used in the investigation were not above that which is recommended by FAO/WHO for agricultural soils. Although the physicochemical parameters in the soil of the abandoned dumpsite studied have not reached a concentration that will affect the ecosystem, effort and proper control measures should be put in place at checkmating the further dumping of wastes within the studied environment and also the removal or complete evacuation of the abandoned dumpsite in order to avert the possibility of its effect on the soil quality and structure and that of humans that make use of the soil within the area for agricultural purposes in the near future.

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The authors did not employ AI tools to assist in writing, analyzing, or interpreting research data. Final oversight and responsibility for the work remain entirely with the authors.

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