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Assessment of Some Physicochemical Parameters in Soils from Steel Markets in Port Harcourt, Rivers State, Nigeria

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Abstract Soil samples were collected from steel markets in Kala and Mile III and a control from the Rivers State University and assessed for physicochemical parameters such as pH, electrical conductivity, organic carbon, organic matter and particle size analysis. The parameters were determined using appropriate laboratory procedures to ascertain the level of some physicochemical parameters in the soil. The results indicated that the mean value of pH of the soils ranged between 6.30±0.02-7.10±0.04, electrical conductivity ranged between 51.6±0.51-165±1.47µS/cm, organic carbon ranged between 0.269±0.00-0.432±0.00%, organic matter ranged between 0.465±0.00-0.747±0.00%. Particle size distribution analysis in the soils showed that sand ranged between 71±2.16-75±2.94%, clay ranged between 14±0.82±1.63% and silt ranged between 9±3.4-13±0.82%.The textural class of all the soils analyzed showed that they were sandy loam. The investigation revealed that the soil in the steel markets do not have the potential to support planting of crops in the near future even if the steel markets have been abandoned except fertilizer and proper manuring is applied. The results observed also showed that the soils within the steel markets have been influenced by the steel business within the area.

Keywords soil, physicochemical parameters, steel markets, organic matter, pollution

Introduction

The activities of man all over the world has resulted in widespread pollution of the soil, thereby changing its composition. The negative impact created by humans has led to continuous pollution of the soil and complete deterioration and degradation of the soil environment. The continuous persistence of these regrettable activities causes cumulative effects and eventually lead to health issues in man [1-2]. The soil is the main reservoir of pollutants like heavy metals, petroleum hydrocarbons, agricultural herbicides and pesticides and dead organic matter. These several components in the soil combine together to affect the soil environment by changing both its physical and chemical characteristics. Urban and industrial disposal of wastes, agricultural fertilizers, mining and smelting of metals which are anthropogenic in nature all combine to change the natural form of the soil and its components [3-5].

The soil is a very essential component in the terrestrial ecological system. The importance of soil to man is due to the fact that the top soil is where plant grows and it plays a major part in the food chain [6]. The quality of any soil is a measure of its productivity in an ecosystem and the presence of certain physicochemical parameters at a certain limit affect the soil quality [7]. In order to protect the quality of the soil from deterioration, control measures need to be put in place. Pollution of the soil created by industrial activities, mining, agricultural and other associated activities can be reduced by proper planning [8]. Agricultural soil and its fertility can be monitored statistically and scientifically by laid down monitoring principles by the managers of soil fertility [9]. For proper maintenance of soil for the sustainability of the ecosystem, the important parameters needed to be analyzed in order to enhance soil quality [10].

The development and production of agricultural goods depend to a large extent on the physicochemical parameters of the soil in question. The populace needed to know the type of products obtained from the soil and the practice involved in the outputs generated [11]. Understanding the soil quality through analysis of certain physicochemical parameters and how certain processes affect the soil and its composition and its effect in general on the components of the ecosystem [12]. Soil physical and chemical properties that may be altered due to anthropogenic activities include pH, texture, organic carbon, organic matter, electrical conductivity moisture, soil density and hence affect the livelihood of man.

This study investigated the physicochemical parameters of soil where steel rods (steel markets) are sold for in Port Harcourt, Rivers State Nigeria.

Materials and Methods

Soil Sample Collection

Soil samples were collected within the depth of 10 – 15 cm from two steel markets in Port Harcourt (Mile 3 and Kala) and another one from the Rivers State University, which acts as control with the aid of soil auger. Four soil samples were collected from each location and properly mixed together to form one sample (composite sample) for that particular location. The representative samples were then transferred into a polythene bag with the aid of sterilized spatula, and then transported to the laboratory for pretreatment and further analysis. The soil samples were first air dried for 5 days on a table surface before being pulverized to powder form with mortar and pestle. A homogenous sample was obtained by sieving the ground soil samples with a 2mm mesh and then put in a bottle and stored in a dark cupboard pending further determination. Three measurements were taken for each parameter and the mean value was recorded for data analysis.

Percentage Organic Carbon and Organic Matter Determination

Two grams of soil sample previously air dried and pretreated was measured and put into a dry conical flask and 1N solution of potassium dichromate of10ml was then added and shaken gently in order for the soil to disperse effectively in the solution. A 20ml concentrated H_2SO_4 was then added into the conical flask rapidly and then gently agitated in order for the soil sample and reagent to mix thoroughly and the flask was then shaken vigorously for a period of 1 minute. In an already prepared fume cupboard, the conical flask was allowed to stand for about 30 minutes. The solution was then titrated with 0.5N $FeSO_4$ after addition of four drops of an indicator to obtain a maroon colour. A blank titration was performed in order to standardize the dichromate, using the method of Walkey and Black [13], Okoye and Okunrobo [14]. The calculation for % organic carbon was performed thus,

$$TOC (\%) = \frac{(M_1e_1K2G_2O_2 - M_2e_2FeSO_4) \times 0.003 \times 100 \times f}{(g)\text{Weight of air-dried soil sample}}$$

Where,

f = correction factor (1.33)

M_1= normality of $K_2G_2O_2$ used

e_1 = volume of$K_2G_2O_2$

M_2 = normality of $FeSO_4$

e_2 = titre value obtained for each titration

g = weight of air-dried sample

Percentage organic matter was then calculated as

% organic matter = 1.29 x % organic carbon

Soil pH and Conductivity Determination

The pH and the conductivity of the soils were determined by adding 5cm^3 of water to 5g soil sample and shaken vigorously. The solution was then allowed to stand for 24 hours and a pH meter was inserted and the value recorded. The pH meter model used was Kent EK 7020. The conductivity of the soil was also determined at the same time with the conductivity meter. Both the pH and conductivity of the soil were determined according to the method of Edori and Edori [15].

Particle Size Analysis

The particle size analysis was determined using the method of Bouyoucos [16]. Soil sample (50g) properly air dried was put into a 500ml beaker and 100ml of water was then added to the soil sample on a shaker. There after a 20g weight of sodium hexametaphosphate was also added into the beaker. After the solution has been allowed a period of 40 seconds to settle down, the buoyant force was enough for the concentration of different particle sizes to be determined. At the end of the 40 seconds period the solution was allowed to settle down, the buoyant force generated on the hydrometer emanated from the concentration of clay and silt particles in the soil. After 2 hours interval, the silt particles settled down at the bottom of the beaker and the reading on the Bouyoucos hydrometer was recorded. Water and dispersing agent were used for blank calibration of the hydrometer. The calibration of the Bouyoucos hydrometer was done at 20^{o}C. The percentages of clay, silt and sand were then calculated using the relations,

$$\% \text{ clay} = \frac{corrected\ \ 2{-}hr\ hydrometer\ \ reading}{dry\ weight\ of\ soil}\ x\ 100$$

$$\% \text{ silt} + \% \text{ clay} = \frac{corrected\ \ 40{-}sec.\ blank\ \ hydrometer\ reading}{dry\ weight\ of\ soil}\ x\ 100$$

% sand = 100 - % silt + % clay.

Results and Discussion

The results obtained for the physicochemical parameters studied for five months at two months intervals in two steel markets and a control are summarized in Tables 1-3, and the mean values obtained during the period of study is summarized in Table 4.

The pH values obtained in the study ranged from 6.28-7.50 within the stations in the months under study. The lowest value was obtained from the control station which is the Rivers State University (RSU). The mean pH values obtained ranged from 6.30±0.02-7.40±0.14 in the stations in the months under investigation. The pH range observed in this work were within the neutral pH range and was found to be higher than the values obtained by Edori and Iyama [17] in abattoirs in Port Harcourt and that of Eze *et al.,* [5] in soil from the bank along Mpape River and fell within the same range of that observed by Ojo *et al*., [6] at selected dumpsites in Akure and Wang *et al*., [18] in an oil polluted field in China. The pH of the soil plays an important part on how nutrients are made available to plants that occupy the soil space. The soil alkalinity and acidity (pH) also influences the solubility of metal elements in the soil and how it is made available for plants to access. pH measures the acidic property of the soil and help metal elements to be made more available to plants at higher pH values [17, 19]. The increase in soil pH decreases metal uptake and their mobility as a result of the precipitation of hydroxides and carbonates and insoluble organic complexes that are formed [20].

The electrical conductivity values obtained in the soils of the steel markets and the control varied from 50.90-167µS/cm in the months under investigation, with the lowest value obtained in the control station. The mean value obtained varied from 51.6±0.51-165±1.47µS/cm in the stations in the months that investigations were carried out. The results obtained in this work was far less than that obtained and recorded by Edori and Edori [15], in automechanic works villages in Port Harcourt and also less than that recorded by Khan *et al*., [21], in a site contaminated by gasoline in Gujarat, India and that also obtained by Edori and Iyama [17] in some selected abattoirs in Port Harcourt. The electrical conductivity of the soil in partnership with the soil pH influences the movement of metal ions in the soil and how these metals are made readily available for the flora and fauna in the soil [22]. Soil conductivity is also a measure of the soil quality and also increases with the increase in the concentrations of ions in the soil. It also provides information on the level of ions present in the soil [12].

The percentage organic carbon in the work varied from 0.269-0.433% in the stations within the months under consideration, with a mean variation of 0.269±0.00-0.432±0.00% during the same period. The percentage organic matter in the soil of the steel markets varied between 0.465-0.749% in the various stations and a mean variation of 0.465±0.00-0.747±0.00 was observed during the period of study in the stations. The values of total organic matter were lower than the 1.3-4.76% approved by WHO/FAO [23] for soil irrigation. The observed value of organic carbon and organic matters in this work were less than that recorded by Ojo *et al*., [6] while investigating physicochemical parameters in dumpsites in Akure and that of Edori and Iyama [17], in the assessment of physicochemical parameters in abattoirs in Port Harcourt and also that of Eze *et al*., [5] in the assessment of soil physicochemical parameters on irrigated sites along Mpape River bank in Abuja, Nigeria. These parameters give an expression of how rich the soil environment is concerning organic matter. Soil fertility and development is a mark of the level of organic materials in that particular soil environment. This might have originated from the decomposition of plants and animals. The nutrient content of the soil is a function of the amount of total organic matter present which also help in Stabilizing the soil pH [17, 24-25]. Soil organic matter is a significant tool in the retention of metal elements in the soil and decreases their mobility and bioavailability, thereby enhancing effective use of such soil for agricultural purposes [26].

The particle size distribution analysis revealed that the value of sand in the studied areas ranged from 68-78% with an average value range between 71±2.16-75±2.94%.Clay values ranged from 13-20% with an average value that lies between 14±0.82-18±1.63% and silt values recorded were within 5-14% range with average values that lies between 9±3.74-13±0.82% in the stations during the months of investigation. The results also showed that the soil textural class in all the stations during the period under study were all sandy loam. The recorded values for sand were more than that observed by Edori and Iyama [17] and that of Khan *et al*., [21], but the value recorded for clay and silt in this work were less than that recorded by Edori and Iyama [17] and that of Khan *et al*., [21]. The textural class recorded by Edori and Iyama [17] was sandy clay loam while that recorded by Khan *et al* [21] was clay loam. The high presence of sand in the soils showed that the soil has low potential of retaining water due to the porosity of sand but has high aeration and hence low moisture content and cannot support crop planting. 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 [27]. 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 which has the tendency to hold water from percolating easily through it [28] and provides natural means of filtering contaminants and pollutants of the ground water.

Table 1: Some Physicochemical Parameters in Soil of Two Steel Markets in Port Harcourt in January

Sample Station	pH	Electrical Conductivity (μS/cm)	% Organic Carbon	% Organic Matter	Particle Size Distribution		
					% Sand	% Clay	% Silt
Mile 3	7.15	167	0.372	0.644	68	20	12
Kala	7.50	72.50	0.432	0.747	73	14	13
RSU (Control)	52.10	52.10	0.268	0.463	76	16	8

Table 2: Some Physicochemical Parameters in Soil of Two Steel Markets in Port Harcourt in March

Sample Station	pH	Electrical Conductivity (μS/cm)	% Organic Carbon	% Organic Matter	Particle Size Distribution		
					% Sand	% Clay	% Silt
Mile 3	7.10	163.50	0.375	0.648	72	16	12
Kala	7.20	72.60	0.431	0.745	75	13	12
RSU (Control)	6.28	50.90	0.270	0.467	71	15	14

Table 3: Some Physicochemical Parameters in Soil of Two Steel Markets in Port Harcourt in May

Sample Station	pH	Electrical Conductivity (µS/cm)	% Organic Carbon	% Organic Matter	Particle Size Distribution		
					% Sand	% Clay	% Silt
Mile 3	7.05	164.50	0.375	0.648	73	18	9
Kala	7.50	71.80	0.433	0.749	71	15	14
RSU (Control)	6.30	51.8	0.269	0.465	78	17	5

Table 4: Some Physicochemical Parameters (mean ± SD) in Soil of Two Steel Markets in Port Harcourt

Sample Station	pH	Electrical Conductivity (µS/cm)	% Organic Carbon	% Organic Matter	Particle Size Distribution		
					% Sand	% Clay	% Silt
Mile 3	7.10±0.04	165±1.47	0.374±0.00	0.647±0.00	71±2.16	18±1.63	11±1.41
Kala	7.40±0.14	72.30±0.36	0.432±0.00	0.747±0.00	73±1.62	14±0.82	13±0.82
RSU (Control)	6.30±0.02	51.6±0.51	0.269±0.00	0.465±0.00	75±2.94	16±0.82	9±3.74

Conclusion

The physicochemical properties of the soil in the steel markets were at the level that cannot support cropping. The soil quality of the steel markets has been totally hampered due to the nature of the steel business. Therefore, steel markets should be sited in places where farming is not encouraged in order not to waste arable farmlands that will be useful in boosting food production.

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