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Some Physicochemical Properties of Soils from Three Steel Welding and Fabrication Workshops in Port Harcourt, Rivers State, Nigeria

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Abstract

Some physicochemical properties were assessed in soils within steel welding and fabrication workshops in Port Harcourt, Rivers State, Nigeria. The study was carried out between May to November, 2020. The physicochemical parameters were determined using standard conventional methods of analysis to ascertain the different levels of the selected physicochemical parameters in the studied environment. The results obtained within the months revealed that pH average range was between 6.8±0.08-7.1±0.05, the electrical conductivity average range was between 65.25±0.83-76±0.71µs/cm, percentage organic carbon was within average range of 0.396±0.001-0.525±0.001%, percentage soil organic matter was in the average range of 0.682±0.002-0.904±0.002% and for particle size analysis, percentage sand was in the average range of 75±0.71-79±0.71%, percentage clay was in the average range 9.25±0.83-11±0.71% and percentage silt was in the average range 10.75±0.43-14±0.71% for the Egbelu, Elioparanwo and Saint John soils respectively. Observation from the nature of occurrence of the physicochemical parameters in the steel-welding and fabrication workshops showed that that the steel-welding and fabrication has not yet influenced the level of the physicochemical parameters in the soils studied.

Keywords: Contamination, Physicochemical properties, Pollution, Soil, Welding, Fabrication.

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Contents

Contribution of this paper to the literature
Some physicochemical properties were assessed in soils within steel welding and fabrication workshops in Port Harcourt, Rivers State, Nigeria.

1. Introduction

The soil is a natural resource and the most useful in the support for production of food for humans due to its importance in agriculture. The soil is important in its constituents and through it, the basic need of food is actualized in the life of man and other living creatures. The soil provides the basic support for agricultural systems and production [1, 2]. Enhancing productivity require the maintenance of the ecosystem which rely on the soil than any other resource and the physicochemical nature, characteristics and biological content of the soil are very important aspects in agricultural productivity [3-5]. The soil is composed of several minerals, broken rocks and organic constituents that have resulted in the alteration of reactions in the environment [6, 7]. The various contaminants and pollutants naturally are absorbed by the soil, no matter the quantity, this has made the soil to become a natural sink to all pollutants. This has resulted in changes in the chemical and physical characteristics of the soil. The ability of the soil to remove impurities, absorb oxygen, destroy disease causing agents and releasing carbon dioxide to the atmosphere has made it a natural purifier [7].

Anthropogenic influence and certain other factors like vegetation, parent rocks and altitude of the given environment can change the physicochemical characteristics of the soil, such as pH, soil texture, particle size, electrical conductivity, total organic carbon, cation exchange capacity and moisture content [8]. The mobilization/immobilization and the redistribution of available nutrients in the soil depends on the physicochemical properties of the soil such as pH, organic matter, redox conditions and quantity of clay that will mobilize and transmit the nutrient elements and water to plants and through the food chain toto animals and humans [9].

Human activities have led to increased contamination of the soil, such contamination/pollution has resulted in life challenges that threatens the existence of humans', animals' and plants' life. Anthropogenic activities such as application of pesticides and fertilizers, mining, discharge of industrial wastes, rupture of storage tanks and manufacturing of goods [10] has resulted in the physical and chemical changes of the natural soil of the environments. The contamination of the soil help in the blocking of air that diffuses the pores of the soil particles [11] and creates changes in the physical nature of the soil by altering the permeability and Atterberg limits [12-14]. The growth and development of plants and soil organisms are affected due to the changes in the chemical nature of the soil, such as pH, mineral nutrients and total organic carbon [15-17]. The continuous deprivation of these requirements is detrimental and produces grievous consequences that leads to inappropriate soil conditions thereby resulting in poor crop growth.

This research work aimed at investigating the concentration of some physicochemical parameters of soil within the vicinities of two steel-welding and fabrication workshops in Port Harcourt, Rivers State, Nigeria.

2. Materials and Methods

2.1. Collection and Preparation of Samples

Soil samples were collected within the vicinities of three steel welding and fabrication workshops in Port Harcourt. Soil samples were collected at random between 0.00-30 cm depth with the help of soil auger. At each location, the samples where thoroughly mixed together to give a bulk composite sample. The soil samples were then put into a prepared polythene bag that was previously sterilized with the aid of a sterilized spatula and then transported to the laboratory for further preparations. The samples were dried to constant weight and the macerated to powder using mortar and pestle. A 2mm mesh was used to sieve the homogenizing soil samples after larger particles like stones have been removed and the samples properly labelled and designated according to their source. The parameters investigated were measured three times and the average value recorded. Samples were collected within the space of eight months at interval of two months.

2.2. Determination of pH and Electrical Conductivity

The method of Bamgbose, et al. [18] was used in the determination of the pH of the soil. 10 g of soil samples previously air dried was weighed into a 100 ml beaker then distilled water of 200 ml volume was added to the soil in the beaker. The mixture was stirred with a glass rod and allowed to stand for 30 minutes. A pH meter was then inserted into the mixture when it was partially settled and the pH of the soil was then measured.

The electrical conductivity of the soil was measured using a conductivity meter. The conductivity of the soil was determined using a ratio of 1:5 of soil and distilled water solution. The model of the conductivity meter used was WTW model [8].

2.3. Percentage Organic Carbon and Organic Matter

The method of Walkey and Black [19] was used in determining the amount of organic carbon in the soil. About 2 g of the already prepared soil sample was weighed into a conical flask, then a standard solution of 10 ml $K_2Cr_2O_7$ was added to the sieved soil sample and then 20 ml of concentrated H_2SO_4 was added so that chloride ions will not interfere in the process. The solution was then allowed to settle down for a time interval of 30 minutes, while stirring was done occasionally. Dilution of the content in the conical flask was performed by the addition of 10 ml of distilled water. A ferroin indicator was used as an indicator to determine the excess $K_2Cr_2O_7$ which was titrated with standard 1.0 N ferrous sulphate solution.

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

$$\% \text{ Organic Carbon} = \frac{(Mc\text{K2Cr2O7} - \text{McFeSO4})\ x\ 0.003\ x\ 100\ x\ F}{weight\ of\ soil(g)}$$

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

2.4. Particle Size Determination

Soil particle size determination of the samples was performed in accordance with the method of Bouyoucos [20]. A 50 ml solution of cagon was used in soaking 50 g of the sieved soil sample overnight. The prepared mixture was put into a measuring cylinder of 1000 ml volume. The mixture was then added to the 1000 ml mark then shaken and allowed to settle for 40 seconds before the hydrometer was dipped into the soil for the sandy content determination, the clay and silt contents were determined after an interval of 3 hours (when the mixture have settled down) following the same method. The temperature at 40 seconds and 3 hours intervals were recorded simultaneously with the hydrometer readings and designated T_1 and T_2, H_1 and H_2 respectively. The particle size analysis calculations were then made thus,

$$\% \text{ Sand} = 100 - [H_1 + 0.2 (T_1 - 68) - 2.0]^2$$

$$\% \text{ Clay} = [H_2 + 0.2 (T_2 - 68) - 2.0]^2$$

$$\% \text{ Silt} = 100 - (\% \text{ sand} + \% \text{ clay})$$

3. Results and Discussion

The results for the physicochemical properties of the soil within the vicinities of the steel-welding and fabrication workshops during the months of investigation are shown in Tables 1-4, while the average values of the physicochemical parameters within the months are shown in Table 5.

3.1. Soil pH

The results obtained from the sample locations showed that the values of pH ranged from 6.7-6.9 with a mean value of 6.8±0.08, 6.8-7.0 with a mean value of 6.9±0.11 and 7.0-7.1 with a mean value of 7.1±0.05 for Egbelu, Elioparanwo and St. John soils respectively. The results obtained were within the limit approved by World Health Organization (WHO) [21] of 6.5-8.5. the values of pH in this study were lower than that of Elemile, et al. [22] that ranged between 7.19±0.25-7.83±0.02 in a soil impacted by the activities of abattoir, but was higher than that obtained by Osakwe and Okolie [23] that had a mean pH value of 5.15±0.48 and was also slightly above or below the range 6.22-7.52 in a study conducted by Ediene and Iren [24] on the impact of abattoir effluents on the pH of the soil. Soil pH affects the metal dynamics of the soil due to its ability to control the adsorption and precipitation which are useful in the retention of metals in the soils. A decrease in pH makes the metals to be more soluble and are more in the cationic forms are can be easily absorbed by plants [25]. Soil pH in the range 6-8.5 shows a normal soil [2]. The pH results recorded in this work therefore revealed that the steel-welding and fabrication workshops has not impacted negatively on the soil pH within the vicinity of the studied area. This might be due to the proximity of the workshops to the drainage system in the areas investigated and possibly the falloffs were easily washed to the drain giving rise to the results obtained.

3.2. Electrical Conductivity

The values obtained from the results in Tables showed that the electrical conductivity of the soils in the different locations ranged from 64-66 µS/cm with a mean value of 65.25±0.83 µS/cm, 72-74 µS/cm with a mean value of 73±0.71 µS/cm and 75-77 µS/cm with a mean value of 76±0.71µS/cm for Egbelu, Elioparanwo and St. John respectively. The values of electrical conductivity obtained in this work was far lower than that reported by Edori and Iyama [7] which was between 269.22-406.86 µS/cm in soils from selected abattoirs in Port Harcourt and far higher than that recorded by Fomenky, et al. [8] which was between 0.043-0.148 µS/cm in a research conducted in soils around some rivers in Cameroon. High values of electrical conductivity indicate high presence of salts that are soluble in the soil [26]. Soil electrical conductivity show the presence of ions and ionizable inorganic materials in the soil [27]. Electrical conductivity is an important soil property useful in checking the soil quality and also a useful check on the health status of soils [28].

3.3. Percentage Total Organic Carbon and Soil Organic Matter

The results from Tables showed that percentage total organic carbon from the study locations were in the range 0.394-0.397% with a mean value of 0.396±0.001% for Egbelu, 0.523-0.526% with a mean value of 0.525±0.001% for Elioparanwo and 0.446-0.449% with a mean value of 0.448±0.001%, for St. John soils. The values shown in the results for percentage soil organic matter were in the range 0.679-0.684% with a mean value of 0.682±0.002% for Egbelu, 0.902-0.907% with a mean value of 0.904±0.002% for Elioparanwo and 0.769-0.774% with a mean value of 0.772±0.002% for St. John soils.

The values of percentage organic carbon recorded in this work was lower than that obtained by Olayinka, et al. [29] which had an average value of 4.80±2.65% at a depth of 0-5cm and 2.40±0.29% at a depth of 10-15cm and also lower than that obtained by Edori and Iyama [7] in soils used for abattoir within Port Harcourt Metropolis with value range of 12.69-16.97%. The values obtained by Abdulhamid, et al. [25] which fell within the range of 0.95-2.25% was also higher than the recorded values in this work. The values of percentage organic carbon recorded in this work was far lower than that approved for organic soil of 12-18%. The percentage organic matter recorded in this work was lower than the range 1.63-3.87% recorded by Abdulhamid, et al. [25] and that obtained by Fomenky, et al. [8] with a range of 0.81-3.53% and also that obtained by Martínez-Mera, et al. [5] of 2.90-6.45% in an irrigation district in Colombia.

Total organic carbon and total organic matter are useful tools and indices in understanding the level of organic materials in the soil and also show the fertility, moisture available and level of soil development for agricultural purposes [7]. Soil organic matter is a sink and major source of soil organic carbon and the organic content of carbon vary from place to place [25, 30]. Soil organic matter increases the ability of the soil to hold more water, affects the soil structure, the rate of air and water infiltration biological activities and also the contribution of nutrients. Soil organic matter also help in indication of cation exchange capacity of soil [31]. The low content of organic carbon and organic matter from the studied soil might have come from the fact that the steel-welding and fabrication workshops were situated at elevated positions and were close to the drainage system hence the soils of the workshops are always swept away by rain or wind into the drainage. Due to the low content of organic carbon and organic matter in the soils of the studied locations, the soil might not be good enough for agricultural production such as crop planting.

3.4. Particle Size Distribution and Analysis

The results indicated in the Tables showed that particle size distribution and analysis from the locations were in the range of 74-76% with a mean value of 75±0.71%, 77-79% with a mean value of 78±0.71% and 78-80% with a mean value of 79±0.71% for sand in Egbelu, Elioparanwo and St. John soils respectively, 10-12% with a mean value of 11±0.71%, 8-10% with a mean value of 9.25±0.83% and 10-11% with a mean value of 10.5±0.5% for clay in Egbelu, Elioparanwo and St. John soils respectively and 13-15% with a mean value of 14±0.71%, 11-14% with a mean value of 12.75±1.09% and 10-11% with a mean value of 10. 75±0.5% for silt in Egbelu, Elioparanwo and St. John soils respectively.

The observed values of the percentage of sand particles in this work was within the range or higher than that observed by Fomenky, et al. [8] which was between 44-76%, and higher than that observed in the work of Olayinka, et al. [29] that ranged between 48.45±3.31-70.35±15.82% in the soils around abattoirs, filling stations, mechanic workshops and hospital incinerators sites within a depth range of 0-5cm, 5-10cm and 10-15cm, and was also higher than that recorded by Edori and Iyama [7] with a mean value range of 53.00±0.81-56.50±1.73% in selected abattoirs in Port Harcourt. The percentage of clay obtained in this work were lower than that observed in the work of Edori and Iyama [7] with an average value of 26.75±1.5-28.75±5±0.96%, but higher than that obtained in the work of Olayinka, et al. [29] that had a low range of 2.90±3.48-9.38±1.21% and that of Fomenky, et al. [8] that ranged from 2-7%. The observed value of percentage silt in this work were lower than that recorded by Fomenky, et al. [8] which ranged from 20-29% and that of Edori and Iyama [7] that ranged from 14.75±1.6-19. 75±1.71% and also that of Olayinka, et al. [29] that was between 20.08±10.66-48.43±4.04%.

The percentages of the different particle sizes of the soils considered in the studied locations, sand, clay and silt is known as textural class. The soil texture measures the physical characteristics of the soil. Such physical characteristics include water retention capacity, permeability, soil toughness or ease of tillage, soil plasticity and soil productivity [32]. The sandy nature of the soil observed in this work will allow easy percolation of water and therefore has the high tendency to promote the contamination of the groundwater. Clay particles which helps in preventing water percolation due to its slimy and non-porous nature and closed pore spaces had a low percentage in this work hence the soil under investigation may not have the potential to hold much water. This observation is in agreement with that observed by Brady [33]. Water percolation cannot be easily prevented [34] because clay acts naturally to filter water and other contaminants [7]. The clay particles have exchange surfaces substantial enough to absorb and stabilize soil organic matter and available heavy metals [35] and to make them useful to plants. The low level of silt recorded in this work stem from the fact that the top soil was always swept away and there is not enough time given in the workshops for decay and deposition of materials that will form silty particles over the years.

Table-1. Physicochemical Properties of Steel-welding and Fabrication Soils in the Month of May.

Sample Location	Physicochemical Parameters						
	pH	Electrical Conductivity (µS/cm)	% Soil Organic Carbon	% Soil Organic Matter	Particle Size Analysis		
					% Sand	% Clay	% Silt
Egbelu	6.7	65	0.396	0.683	75	10	15
Elioparanwo	6.8	73	0.523	0.902	78	8	14
St. John	7.0	76	0.446	0.769	79	11	10

Table-2. Physicochemical Properties of Steel-welding and Fabrication Soils in the Month of July.

Sample Location	Physicochemical Parameters						
	pH	Electrical Conductivity (µs/cm)	% Soil Organic Carbon	% Soil Organic Matter	Particle Size Analysis		
					% Sand	% Clay	% Silt
Egbelu	6.9	66	0.394	0.679	76	11	13
Elioparanwo	6.7	72	0.525	0.905	77	10	13
St. John	7.1	75	0.447	0.771	80	10	11

Table-3. Physicochemical Properties of Steel-welding and Fabrication Soils in the Month of September.

Sample Location	Physicochemical Parameters						
	pH	Electrical Conductivity (µs/cm)	% Soil Organic Carbon	% Soil Organic Matter	Particle Size Analysis		
					% Sand	% Clay	% Silt
Egbelu	6.8	64	0.397	0.684	74	12	14
Elioparanwo	6.9	74	0.526	0.907	79	10	11
St. John	7.0	77	0.449	0.774	78	11	11

Table-4. Physicochemical Properties of Steel-welding and Fabrication Soils in the Month of November.

Sample Location	Physicochemical Parameters						
	pH	Electrical Conductivity (µs/cm)	% Soil Organic Carbon	% Soil Organic Matter	Particle Size Analysis		
					% Sand	% Clay	% Silt
Egbelu	6.7	66	0.395	0.681	75	11	14
Elioparanwo	7.0	73	0.524	0.903	78	9	13
St. John	7.1	76	0.448	0. 772	79	10	11

Table-5. Mean Value of Physicochemical Properties of Steel-welding and Fabrication Soils in the Months under Investigation.

Sample Location	Physicochemical Parameters						
	pH	Electrical Conductivity (μs/cm)	% Soil Organic Carbon	% Soil Organic Matter	Particle Size Analysis		
					% Sand	% Clay	% Silt
Egbelu	6.8±0.08	65.25±0.83	0.396±0.001	0.682±0.002	75±0.71	11±0.71	14±0.71
Elioparanwo	6.9±0.11	73±0.71	0.525±0.001	0.904±0.002	78±0.71	9.25±0.83	12.75±1.09
St. John	7.1±0.05	76±0.71	0.448±0.001	0.772±0.002	79±0.71	10.50±0.50	10.75±0.43

4. Conclusion

The impact of steel-welding and fabrication was assessed to understand how such activity affected the soil quality within the environment where it is sited. The study revealed that the physicochemical characteristics of the soil within the steel-welding and fabrication workshop were not altogether higher than those of the recommended values. Further study should be carried out on the physicochemical parameters in steel-welding and fabrication workshops to further ascertain this observation, since there is the possibility that the workshops used in the study became operational few years ago and might not have impacted on the soil. 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 welding and fabricating of steel materials to avert the possibility of its effect on the soil quality and structure in the near future.

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