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Determination of Selected Soil Physical Parameters in Automobile Repair Workshops of Damaturu Metropolis, Yobe State, Nigeria

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Abstract This research work studied the determination of selected soil physical parameters in automobile repair workshops of Damaturu metropolis, Yobe state, Nigeria. The specific objectives of the study were to identify the selected physical parameters in the soil; determine the concentration of the selected soil physical parameters such as pH, electrical conductivity, bulk density, moisture content and total organic carbon of the sampled soil in the study area; interpret the values according to the level of concentrations of the selected soil physical parameters in the study area. Soil samples were collected from the sampled automobile repair workshops in Damaturu metropolis at the depths of 0-5, 5-10, 10-15, 15-20 and 20-25cm. A simple random sampling technique was employed for the study. Data analysis were carried out using mean ($\bar{x}$), standard deviation (σ) and analysis of variance (ANOVA). The concentration of physical parameters such as soil pH, electrical conductivity (EC), soil moisture content, bulk density and total organic carbon were also analyzed. The concentration of soil pH values ranged from 6.41$\pm$ 0.16 – 8.03$\pm$ 0.38, Electrical conductivity ranged from 9.7$\pm$ 5.3 – 124.4$\pm$ 15.7 µS/cm, moisture content ranged from 0.60$\pm$ 0.07 – 4.16$\pm$ 2.56 %, bulk density ranged from 0.60 $\pm$ 0.01 – 0.74 $\pm$ 0.03gc^{-3} and lastly total organic carbon ranged from 0.12 $\pm$ 0.07 – 12.83 $\pm$ 0.16%. The result further revealed that significant differences ($P<0.05$) were observed in the selected soil physical parameters. The results indicated that soil qualities varied between slightly contaminated to highly polluted status. In order to control issues related to soil contaminations, the study recommended that the automobile repair workshops in the study area should be encouraged to practice accurate collection and disposal of used engine oils.

Keywords Automobile, Concentration, Depth, Physical Parameters, Soil, Workshop

1. Introduction

Soil forms the interface between hydrosphere and lithosphere and thus forming a part of biosphere. The soil may be defined as the uppermost weathered layer of the earth's crust in which are living and non-living organism thrive. The ecosystem and environmental sustainability largely depends on proper soil maintenance (Mbah *et al.,* 2009). Sustainable use of this natural resource on which agriculture depends is absolutely necessary for agricultural productivity. Soil sampling is perhaps the most vital step for any soil analysis. Soil analysis and testing based nutrient management has emerged as a key issue in efforts to increase agricultural productivity and production since optimal use of nutrients can improve crop productivity and minimize wastage of these nutrients (Gurdeep, 2005). Soil is important to humans and plants either directly or indirectly because it is the natural bodies on which agricultural products grow (Sinha and Shrivastava, 2000).

Amukali, (2019) opined that increasing global population growth has necessitated the need for an increase in automobiles workshops to make man move faster, produce more efficiently and harvest in a much timely manner. These are among the major reason for citing more auto-mechanic workshop clusters in major towns to help in repair and servicing of these automobiles. Within the clusters are people who specialize in electrical aspects of auto repairs, while others engage in repairs of brakes and steering, automatic or standard transmission engine, and spray painting, recharging of auto batteries, welding and soldering (Nwachukwu *et al*., 2010). Each of these activities generate various types of waste such as gasoline, diesel, used engine oil and paint which were disposed to nearby bushes or surrounding areas. Therefore, there is the need to frequently monitor their nature, volume, direct harmful effects and current methods of disposal as well as potential impacts on the environment (Udebuani *et al*., 2011). Automobiles used oil (waste) contains oxidation products, sediments, water and metallic particles resulting from machinery wears, used batteries as well as organic and inorganic chemicals used in oil additives and metals poses a severe threat to the environment (EEA, 2007). However, the significance of trace elements in soil chemistry is increasingly becoming an issue of global concern due to the fact that the soil constitutes a crucial component of the environment (Adeniyi *et al*., 2002).

Substantial volumes of soil have been contaminated especially by a large amounts of used engine oil which are liberated into the environment from motor cars, motorcycle, gasoline and petroleum generators and disposed any how has become a common practice by mechanics (Odjegba and Sadiq, 2002). Moreover, various contaminants such as used engine oil and heavy metals have been found to alter soil biochemistry (Atuanya, 1987; Brookes, 1995). This practice adversely affects microorganisms, plants and aquatic lives (Nwoko *et al*., 2007; Adenipekun and Kassim, 2006), because of the large amount of hydrocarbons and highly toxic polycyclic aromatic hydrocarbons contained in the oils (Vwioko and Fashemi, 2005). Physicochemical characteristics of soil such as pH, organic matter (OM), cation exchange capacity (CEC), moisture content and particle size distribution are known to influence the interactions and dynamics of metals within the soil matrix. In spite of the influence of the physical parameters in the soil, the activities of automobile workshops with regards to disposal of spent engine oil in Nigerian cities has become a persistent problems due to indiscriminate disposal of the waste oil either in gutters or open lands. This improper disposal management also result in the accumulation of high level of heavy metals present in the soil. Therefore, this research work aimed to determine selected soil physical parameters in automobile repair workshops of Damaturu metropolis, Yobe state, Nigeria. The specific objectives of the study were to:

- identify the selected soil physical parameters in the automobile repair workshops of Damaturu metropolis.,
- determine the concentrations of the selected soil physical parameters such as pH, electrical conductivity, bulk density, moisture content and total organic carbon of the sampled soil in the study area;
- interpret the values according to the level of concentrations of the selected soil physical parameters in the study area.

2. Materials and Methods

Description of Study Area

Damaturu Local Government Area is located between latitude 11^0 43' and 37" North of Equator and longitudes 11^0 58' and 26" East of prime meridian and elevation of 456m above sea level. It is located in the semi-arid region of Nigeria with a tropical continental climate and a population of 88,014 (NPC, 2006). The area is characterized by a short period of rainfall (June - October) and a long dry season (November - May). The mean daily maximum temperature ranges from 29.2^0C in (July and August) to 45^0C in (March and April). Annual rainfall ranges from 500mm to 1000mm (Google map, 2015). Damaturu LGA is bordered in the North by Tarmuwa LGA, Kaga LGA of Borno state by the East, Gujba LGA by the South and Fune LGA by the West respectively.

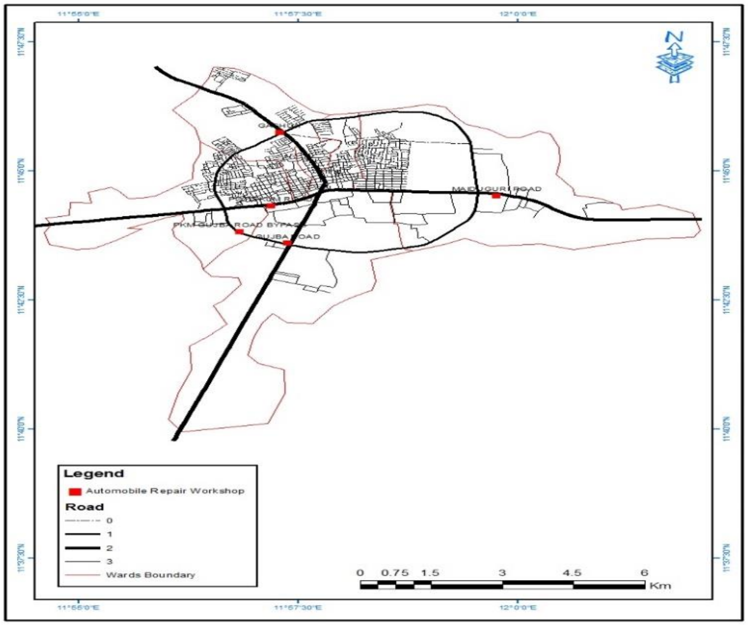

Figure 1: Schematic map of Damaturu town, showing sample collection points (Automobile workshops)

Study Design and Population

A simple random sampling method was adopted for the study. The study population is defined as mechanic operators and this includes auto mechanics, panel beaters, wielders, painters, rewires, battery chargers and vulcanizes.

Sample Collection

Samples was collected across the study area from four (4) automobile workshops across the four (4) major roads of the study area. Simple random sampling was adopted based on the available resources to conduct the work and the spread of the workshops across the study area. Furthermore, samples of topsoil were collected in four (4) different locations from each automobile unit at different depth of 0-5cm, 5-10cm, 10-15cm, 15-20cm and 20-25cm. These samples were used as background status of heavy metals across the area. From the foregoing, a total of 20 samples were collected from the study area. The samples were collected randomly from the selected area and placed in labelled polythene bags and was taken to laboratory for analysis.

Soil sample Treatment and analysis

Soil samples were air-dried at room temperature for 1 week to avoid microbial degradation. The samples were homogenized and gently crushed repeatedly using a porcelain mortar and pestle and passed through a 1mm sieve prior to analysis.

Analysis of samples

Determination of Soil pH

The pH of the soil was determined according to the method described in ASTM (1995). The sample was air dried and sieved through a No. 1mm mesh sieve to remove the coarser soil fraction. The air-dried and sieved soil sample (10g) was weighed, placed into a glass container and 10 mL of distilled water was added. The sample was mixed thoroughly and allowed to stand for 15 minutes. The value was measured by the pH meter and recorded.

Determination of electrical conductivity

Soil water suspension (1:5) was prepared by weighing 10g air-dried soil into a bottle, then 50ml deionized water was added and mechanically shake at 150 rpm for 1 hour to dissolve soluble salts. The conductivity meter was calibrate according to the manufacturer's instructions using the KCl reference solution to obtain the cell constant, and then the sample's conductivity was measured. (Piper, 1942). The formula for determining electrical conductivity is expressed thus;

$$EC = \frac{K - S}{K}$$

Where:

S = Measured EC of suspension

K = Measured EC of KCl solution

Determination of moisture content

The moisture content of the soil was determined according to the method described in AOAC (1995). A clean crucible dish was dried to a constant weight in an oven at 105°C, cooled in a desiccator and Weighed (W1). 2.0g of soil was weighed into a labeled crucible and reweighed (W2). The crucible containing the sample was dried in an oven to constant weight (W3) and the percentage of the moisture content was calculated using the following relation.

$$\%\ \text{Moisture content} = \frac{W2 - W3 \times 100}{W2 - W1}$$

Where,

W1 – Weight of empty crucible

W2 - Weight of empty crucible + soil

W3 - Weight of empty crucible + soil after drying

Determination of bulk density

The bulk density was determined according to the method described in EMA/CHMP (2010). 100g of the sample was weighed into a dry graduated (250ml) cylinder without compacting. The powder was carefully level without compacting, and the unsettled apparent volume (*Vo*) was read to the nearest graduated unit. The cylinder was tapped 500 times and the volume was read, and then the tapping was repeated 500 more time until there was no change in volume observed after every 100 taps. The bulk density in g per ml was calculated by the formula *m/Vo*. Three (3) replicate determinations were made for the determination of this property.

Determination of total organic carbon

1g of soil was weighed and transferred into a 500 ml conical flask and10ml of 1M $K_2Cr_2O_7$ solution was added and mixed well. Concentrated H_2SO_4 (20ml) was added and the flask with the content was swirled 3 times and allow to stand for 30 minutes until the reaction reached to completion. Distilled water (200ml) was added into flask to dilute the suspension, 10ml of 85% H_3PO_4 and 1ml of Diphenylamine indicator was added and back titrated with 0.5M Ferrous Ammonium Sulphate solution, till the colour flashed from violet through blue to bright green as the endpoint. The volume of the Ferrous Ammonium Sulphate was recorded. Similar procedure was carried out to obtain a blank titre value (McLeod, 1973).

$$2Cr_2O_7^{2-} + 3C + 16H^+ \rightarrow 4C^{3+} + 8H_2O + 3CO_2\uparrow$$

Percentage (%) of total organic carbon in soil was expressed thus,

$$R = \frac{(v_1 - v_2) \times M \times 0.003 \times 100 \times C}{W}$$

Where,

W - Weight of Sample

V_1 - Blank Titre value

V_2 - Titre value of the Sample

M- Morality of $K_2Cr_2O_7$ (Here it is 1M)

C - Correction Factor (1.334)

Data Analysis

Both descriptive and inferential statistic were used to analyze the objectives of the study. Descriptive statistic such as mean ($\bar{x}$) and standard deviation (σ) and inferential statistic such as analysis of variance (ANOVA) were used to analyze the whole objectives of the study.

3. Results and Discussion

The results of the analysis of soil physical parameters were presented in Table 1.1 and 1.2. The results of the analysis revealed the concentrations and levels of the selected physical parameters in the sampled soil across the four (4) major roads in the study area. The analysis of the result were carried out from different soil depth at 0-5cm, 5-10cm, 10-15cm, 15-20cm and 20-25cm respectively.

Soil Physical Parameters

Soil pH

The mean ($\bar{x}$) and standard deviation (σ) for pH ranged between 6.25±0.12 - 8.03±0.38 in soil samples across the different location as shown in Table 1.1. The highest mean value of soil pH 8.03±0.38 was recorded at Potiskum road at a depth of 20-25cm. This was attributed to the presence of organic matter at the depth region. Therefore the movement of these cations from the surface to the underlying soil layer will be at a slow rate. It was observed that the soil pH value along Maiduguri road was increasing as the depth increased. The high pH value indicate high level of acidity of the soils which could be attributed to spilled acid discharged from motor batteries. Soil pH value which ranged 7.3-8.5 indicates presence of calcium carbonate ($CaCO_3$) which are present in alkaline conditions. Soil pH values observed in this study falls within the normal soil pH of 5.5-7.2 which indicates acidic to neutral soils which are the best pH condition for nutrient availability and suitable for most crops. In Gujba road, the trend at which element percolates down to the grown level with a low value (6.49±0.07) at the depth of 0-5cm and highest value at a depth of 15-20cm (6.91±0.09) was obtained. This indicated that the pH values were relatively higher due to high activities in the automobile workshops and contribute immensely to acidity of the soils. The mean value for soil pH in Gashua road also showed that the element were descending down to the ground level with low value (6.25±0.12) at depth 10-15cm while highest value was recorded at depth 15-20cm (7.33±0.10).

The implication of this study is that, since the whole soil pH values recorded in all the locations falls within the normal soil pH of 5.5-7.2 which indicates acid to neutral soil are considered to be the best soil pH conditions for nutrient availability and suitability for most crops. It was observed that in Potiskum road alone, the soil pH was found to be higher at a depth of 20-25cm which indicates that the soil is rich in carbonate which in turns has an effect on nutrient availability in the soil as well as crop growth and development. Therefore the movement of these cations from the surface to the underlying soil layer will be definite, albeit at slow rate. This study agrees with the findings of Olayinka, (2014) which opined that the average pH values of the soil sample at hospital incinerator sites at different soil depth were 6.69±0.21, 6.59±0.33 and 6.59±0.24 respectively. The values also indicated that the soil pH values observed were slightly acidic and neutral. Dauda and Odoh (2012) also revealed that the mean pH value that was observed at abattoir site was slightly acidic. The pH values observed in the soil samples were lower than the value reported by Farombi *et al.* (2013) and Jintao *et al.* (2011).

Table 1.2 revealed the analysis of variance (ANOVA) of the sampled soil in the four major roads in the study area. The concentration of soil pH in Maiduguri road shows that there is no significant difference ($P > 0.05$) between depths 5-10cm (6.62^{ab}) and 10-15cm (7.04^{ab}) while significant difference was observed at depths 0-5cm, 15-20cm and 20-25cm respectively. In Gujba road, no significant differences were observed between the depths of 10-15cm (6.72^{b}) and 15-20cm (6.91^{b}) whereas 0-5cm (6.49^{a}), 5-10cm (6.65^{ab}) and 20-25cm (6.58^{c}) soil depth indicated a significant difference. This indicates that with an increase in depth, the pH values also increases. Moreover, the analysis also revealed that in Potiskum road, there was no significant different ($P>0.05$) between the depth of 0-5cm, 10-15cm and 20-25cm while significant difference was observed between depths 5-10cm (6.41^{ab}) and15-20cm (6.39^{c}) respectively. The result in Gashu'a road shows no significant difference between depth 0-5cm, 5-10cm and 15-20cm while significant differences were observed between depth 10-15cm (6.25^{c}) and 20-25cm (7.09^{b}) respectively. This implies that there is slightly difference between the major roads in the study area. This may be attributed to the fact that the soil has similar characteristic and may result into an increase in the soil pH as the depth increases.

Electrical Conductivity (EC)

The mean (x̄) and standard deviation (σ) for soil EC lies between 9.7±5.3-128.7±15.3 µS/cm in soil samples across the four (4) different location. The highest mean value of soil EC (128.7±15.3 µS/cm) was recorded along Gashua road at a depth of 15-20cm. It was observed that the concentration of soil EC along Maiduguri road was increasing at 0-5cm (29.7±19.9), but subsequently decreases as the depth increases. The differences in the values might be due to the nature of the soil profile because the soil surface is sandy-loam which is coarse in nature and percolation can be easier for heavy metals down to the soil which possibly indicates anthropogenic influence on the quality of the soil. The mean value for soil EC in Gujba road showed a decrease of the element as the depth increases, though it increased at depth 20-25cm (107.2±6.7 µS/cm) as shown in Table 1.1**.** This implies that there is high EC in the soil due to reasonable or significant presence of ions at the top layer.

The result further revealed that in Potiskum road, an increase of the element in the soil was observed as the depth increases (89.9±4.8 µS/cm-124.4±15.7 µS/cm). The differences obtained might be due to the nature of the soil as the top soil usually revealed lower value. The higher concentration of EC obtained was attributed to the presence of trace metal ions or ionisable materials in the soil which could be leach into the underground water, making it unfit for animal and human consumption. Thus, the findings was observed to be far below the permissible limit recommended by WHO of 300 μScm^{-1}. By implication, the observed EC values could be attributed to the reactions between some spilled acids from car batteries and other related scrap metals in the automobile workshops, leading to formation of some soluble and ionizable inorganic salts in the soils but are however far below the level that will lead to some health hazard to the inhabitants of the area. These findings are in agreement with Joseph *et al*. (2017) who stated that the values of the soil samples from all sites ranged from 31.00-143.67 µScm-1. Similarly, the range of values obtained in this study is higher than the one reported by Egbenda *et al.* (2015) but lower than the values reported by Badejo, (2013).

Furthermore, from the result of the analysis of variance (ANOVA) in Maiduguri road presented in Table 1.2 shows no significant difference (P>0.05) was observed between the whole soil depths. In Gujba road, there was no significant difference (P>0.05) between the depths except at depth 0-5cm (102.07^{ab}) which indicate a significant difference (P<0.05). Statistically, significant difference (P<0.05) was observed at depth 0-5cm (89.90^{b}) in Potiskum road while the other depths shows no significant difference (P>0.05). So also, the result in Gashu'a road indicates no significant differences (P>0.05) between the depths. This implies that there was no significant differences in the values obtained at the depths except at 0-5cm soil depth where significant differences was observed as a result of the presence of trace metal ions or materials at the top of the soil. This study supported the view of Fuller, (1995) who also revealed that there was a significant differences between the sampled soils.

Soil Moisture Content

Table 1.2 presents the mean (x̄) and standard deviation (σ) for soil moisture content which varied between 0.42±0.15-4.16±2.56% across the different location of the soil samples. The highest mean value of soil moisture content was found to be 4.16±2.56% at Maiduguri road at a depth of 5-10cm. The concentration along Maiduguri road was increasing, but subsequently decreases as the depth increased. This implies that the decrease in moisture content as the depth increases is due to the nature of soil texture in the area which is partly sandy. The value in Gujba road showed an increase of the element as the depth increases, though decreases at depth 5-10cm, 10-15 and 15-20cm. The highest value was observed at a depth of 20-25cm (1.18 ±1.20%). This indicate high percolation rate and was attributed to the presence of organic matter at the depth region. In Potiskum road, there was an increase of the element as the depth increases, though decreases at depth 20-25cm (0.94±0.35%). The highest percentage was recorded at 5-10cm (2.32±1.26%). This might be attributed to the nature of the soil which is clay in nature. The result also revealed that in Gashua road, there was a decreased of the element as the depth increases, though increased at depth 20-25cm

(0.80±0.27%). The differences might be as a result of the retention nature of the element by the soil from clay and organic matter region which shows higher retention at depth 20-25cm.

The implication of the study is that the moisture content of the top soil were found to be the highest in terms of the values recorded during analysis and this was found to be partly similar across all the sampled soil in the study area which were perceived to be attributed to the presence of spilled oil and other related materials disposed unto the soil. The study is in line with the findings of Toluwanimi, (2014) in Temidire which indicates a value ranged from a mean concentration of 2.8±2.1% for top soil and 5.8±4.6% for sub soils were recorded respectively. While in Ojoo, the values recorded were within the ranged of 2±3.2% and 8.4±5.4% for top soil and sub soils. In a similar study, Bahuguna *et al*. (2011) stated that the moisture content of the soil samples varied from 0.472-1.864 mg/g of soil. The results showed that AMT-7 has highest soil moisture content (1.864 mg/g) and AMT-4 has minimum (0.472 mg/g) soil moisture content. The low moisture contents of contaminated soils are due to the presence of hydrocarbons and PAHs which cause an increase in soil hydrophobicity leading to decrease in the soil moisture holding capacity (Balk *et al*., 2002).

Table 1.1: Analysis of Physical Parameters in Soil Samples across Automobile Repair Workshops in Damaturu Metropolis

Physical Parameter	**Soil Depths**				
Soil pH	**0-5cm**	**5-10cm**	**10-15cm**	**15-20cm**	**20-25cm**
Maid RD	6.59±0.09	6.61±0.33	7.04±0.24	6.42±0.16	7.42±0.21
GJB RD	6.49±0.07	6.65±0.01	6.72±0.09	6.91±0.09	6.58±0.05
PKM RD	6.56±0.17	6.41±0.16	7.36±0.10	6.39±0.06	8.03±0.38
GSH RD	6.51±0.05	6.75±0.12	6.25±0.12	7.33±0.10	7.10±0.04
EC(µS/cm^{-1})					
Maid RD	29.7±19.9	51.1±22.9	42.4±15.1	9.7±5.3	14.0±6.9
GJB RD	102±10.7	101.3±35.1	76.9±4.8	87.5±3.9	107.2±6.7
PKM RD	89.9±4.8	98.1±8.9	109.5±1.0	124.4±15.7	98.9±9.2
GSH RD	122.5±9.2	124.0±14.6	118.1±5.3	128.7±15.3	113.8±9.2
SMC(g/100g)					
Maid RD	1.70±0.77	4.16±2.56	0.83±0.15	1.03±0.73	0.78±0.23
GJB RD	0.86±0.11	0.67±0.07	0.82±0.17	0.60±0.07	1.18±1.20
PKM RD	1.56±0.43	2.32±1.26	1.62±0.75	1.59±0.21	0.94±0.35
GSH RD	0.58±0.42	0.42±0.15	0.46±0.13	0.50±0.28	0.80±0.27
BD(g/cm^{-3})					
Maid RD	0.73±0.03	0.65±0.01	0.65±0.01	0.62±0.01	0.63±0.01
GJB RD	0.74±0.03	0.63±0.01	0.63±0.01	0.66±0.03	0.66±0.01
PKM RD	0.70±0.02	0.63±0.01	0.64±0.01	0.60±0.01	0.60±0.01
GSH RD	0.68±0.03	0.66±0.02	0.64±0.01	0.62±0.01	0.66±0.01
TOC (%)					
Maid RD	9.87±0.14	7.42±0.14	4.90±0.16	3.35±0.16	1.51±0.10
GJB RD	12.83±0.03	9.06±0.14	3.94±0.08	0.28±0.14	6.91±0.14
PKM RD	0.12±0.07	11.07±0.06	7.84±0.07	6.94±0.14	6.27±0.14
GSH RD	11.43±0.16	12.45±0.11	1.33±0.06	10.09±0.12	3.31±0.16

* The values of the concentrations are represented as mean ± standard deviation (SD) of five different determinations of the soil samples.

Key: Maid RD; Maiduguri road, GJB RD; Gujba road, PKM RD; Potiskum road and GSH RD; Gashu'a road.

From the result of ANOVA presented in Table 1.2 along Maiduguri road shows that there was no significant difference (P>0.05) observed between the depths recorded except at a depth of 15-20cm (0.62^b) which indicate a significant difference (P<0.05) at 5% level of significance. The result in Gujba road also revealed similar level of significance at 15-20cm (1.18^a) whereas no significant differences (P>0.05) was observed between the other depths considered for the study. Statistically, in Potiskum road, there was no significant difference (P>0.05) between the whole soil depths as shown in Table 1.2. The result in Gashu'a road further reveals no significant difference (P>0.05) was recorded between some of the depths, however significant difference was observed at depth 20-25cm (0.93[a]). This implies that the differences might be attributed to the fact that as the depth increases, there is partly going to be a significant differences in terms of the soil moisture content of the sampled soil due to the nature of soil texture.

Soil Bulk Density

The soil bulk density ranged between 0.60±0.01-0.74±0.03 gcm^{-3} in soil samples across the four major road in Damaturu metropolis. The highest mean ($\bar{x}$) and standard deviation (σ) of soil bulk density 0.74±0.03 g/cm^3 was recorded in Gujba road at a depth of 0-5cm. The study observed that the concentration of soil bulk density along Maiduguri road gradually decreases as the depth increase for e.g. at 0-5cm soil depth, 0.73±0.03 gcm^{-3} was recorded and in 5-10cm depth, 0.65±0.01 g/cm^3 was recorded. This shows that the element percolates down to the grown level with low concentrations. In Potiskum road, highest concentration 0.70±0.02 g/cm^3 was recorded at depth 0-5cm. The concentration of soil bulk density gradually decreases with an increase in depth. The differences obtained might be due to the nature of the soil as the top soil revealed higher value. The value for bulk density in Gashua road shows that the concentration increases but subsequently decrease at it goes down. Highest concentration 0.68±0.03 g/cm^3 was recorded at depth 0-5cm. The findings implies that the low value of soil bulk density are pre requisite for available water holding capacity, plant growth and movement of air and water through soil. Moreover, soil compaction in some sampled area increase bulk density and reduces crop yield and vegetables available to serve as soil cover.

The result indicated that the soil samples in the study area are within the desirable soil bulk density of (< 1.5g/cm^3) for optimum movement of air and water through the soil (Hunt and Gilkes, 1992; Mckenzie *et al.*, 2004). This is due to the fact that bulk density greater than 1.6g/cm^3 tend to prevent root growth, however, the results indicates that the bulk density in the study area can support plant growth and the water are meant for consumption. The reason for the low values could be due to low or less disturbance on the sites. In a contrary study by Odueze, (2017), higher values were obtained at Apir between 1.502±0.102 g/cm^{-3} and 1.517±0.389 g/cm3 for North bank and 1.488±0.104 g/cm^3 for the control site. This indicates that the bulk densities are commonly higher than in the present study. The bulk density values obtained in this study were within the ranges expected in most mineral soils as indicated by Mbagwu (2003).

The result of ANOVA presented in Table 1.2 shows that there was no significant difference (P>0.05) observed between the depth of 15-20cm and 20-25cm, however significant difference (P<0.05) was observed between depth 0-5cm, 5-10cm and 10-15cm with a value of 0.73[ab], 0.65[bc] and 0.65[a] respectively. In Gujba road, there was no significant difference (P>0.05) between depth 0-5cm, 15-20cm and 20-25cm while significant difference (P<0.05) was observed between depth 5-10cm (0.63[c]) and 10-15cm (0.64[b]) respectively. Moreover, in Potiskum road, no significant difference (P>0.05) was observed between the depths but however, significant difference was observed at depth 15-20cm (0.62[b]). In Gashu'a road, significant difference was observed at depth 20-25cm (0.66[a]) while no significant differences was observed at the other soil depths. This implies that no significant differences was observed in most of the sampled sites.

Total Organic Carbon

From the result of soil organic carbon presented in Table 1.1. The mean ($\bar{x}$) and standard deviation (σ) ranged between 0.12±0.07-12.83±0.03% across the sites. The highest mean value of soil organic carbon 12.83±0.11% was recorded in Gujba road at a depth of 5-10cm. In Maiduguri road, the values increases, but subsequently decreases as the depth increases. For example, at 0-5cm soil depth, 9.87±0.14% was recorded while at 5-10cm depth, 7.42±0.14% was recorded. The differences in the values might be due to the nature of the soil profile. The presence of organic carbon increases the cation exchange capacity of the soil which aids in nutrients retention and assimilation by plants. The concentration in Potiskum road at a depth of 0-5cm recorded (0.12±0.07%) and increases greatly at depth 5-10cm (11.07±0.06%). This might be attributed to the nature of the soil which favour the activities of soil micro-organisms. The result in Gashu'a road shows a decrease in the element as the depth increases, though increases at depth 10-5cm. The amount of soil organic carbon recorded at depth 0-5cm was 11.43±0.16% and increases greatly at depth 5-10cm (12.45±0.11%). This might be attributed to the nature of the soil at depth 5-10cm which is silt in nature.

The relatively high level of soil total organic carbon (12.83±0.16%) in Gujba road auto mechanic workshops when compared to other sites indicated possible presence of organic matter content which normally increases following the addition of carbonaceous substances as was the case in the study due to the presence of used oil and other carbonated fluid in the auto mechanic workshops. According to Osuji and Nwoye (2007), this might cause an increase in the presence of soil micro-organisms which are in the business of breaking down organic compounds in soils. This observation clearly shows that a significant quantity of the oil has undergone appreciable decomposition process. Eugene-Lamare and Singh, (2019) reported that the amount of total organic carbon were found to gradually increase in percentage as distance from factory increases. Its concentration varied from 1.31%-2.10%; 1.33%-2.30%; and 1.82%-2.55% at different sampling sites SC1_R1, SC1_R2 and SC1_R3, respectively. The result was found to be lower than the findings observed in the present study.

The result of the analysis of variance (ANOVA) presented in Table 1.2 shows that in Maiduguri road, there was a significant difference (P<0.05) at a depth of 10-15cm (4.89^{b}) compare to other depths which indicate no significant differences (P>0.05). In Gujba road, the result also indicates significant difference (P<0.05) were observed between all the depths considered in the study. Furthermore, no significant differences (P>0.05) was observed between depth 15-20cm and 20-25cm in Potiskum road but however significant difference were observed between depth 0-5cm (0.12^{e}), 5-10cm (11.08^{b}) and 10-15cm (7.84^{a}) respectively. The result in Gashu'a road shows significant difference (P<0.05) were observed between the soil depths considered for the study. This implies that there is a significant differences in almost all the soil depths across the four (4) locations due to the texture of the soil and accumulation of carbon related substances.

Table 1.2: Analysis of Variance (ANOVA) of Physical Parameters in Soil Samples across the Automobile Repair Workshops in Damaturu Metropolis

Physical Parameter	Soil Depth (cm)	Location				SEM
		Maid Road	**Gujba Road**	**Potiskum Road**	**Gashua Road**	
Soil pH	0-5	6.59^{a}	6.49^{a}	6.56^{a}	6.51^{a}	0.05^{NS}
	5-10	6.61^{ab}	6.65^{ab}	6.41^{ab}	6.75^{a}	0.06^{*}
	10-15	7.04^{ab}	6.72^{b}	7.36^{a}	6.25^{c}	0.12^{*}
	15-20	6.42^{c}	6.91^{b}	6.39^{c}	7.33^{a}	0.12^{*}
	20-25	7.24^{b}	6.58^{c}	8.03^{a}	7.09^{b}	0.14^{*}
EC	0-5	29.73^{c}	102.07^{ab}	89.90^{b}	122.47^{a}	11.86^{*}
	5-10	51.07^{b}	101.27^{a}	98.17^{a}	124.03^{a}	10.69^{*}
	10-15	42.40^{c}	76.93^{b}	109.53^{a}	118.17^{a}	9.68^{*}
	15-20	9.73^{c}	87.50^{b}	124.43^{a}	128.77^{a}	13.40^{*}
	20-25	14.07^{b}	107.13^{a}	98.90^{a}	113.83^{a}	12.09^{*}
SMC	0-5	1.69^{a}	0.86^{ab}	1.56^{ab}	0.57^{b}	0.17^{*}
	5-10	4.17^{a}	0.67^{b}	2.32^{ab}	0.42^{b}	0.47^{*}
	10-15	0.83^{ab}	0.82^{ab}	1.62^{a}	0.47^{b}	0.14^{*}
	15-20	1.03^{ab}	0.59^{b}	1.59^{a}	0.50^{b}	0.13^{*}
	20-25	0.78^{a}	1.18^{a}	0.93^{a}	0.80^{a}	0.15^{NS}
BD	0-5	0.73^{ab}	0.74^{a}	0.71^{ab}	0.68^{ab}	0.01^{*}
	5-10	0.65^{bc}	0.63^{c}	0.63^{c}	0.66^{b}	0.09^{*}
	10-15	0.65^{a}	0.64^{b}	0.64^{ab}	0.64^{ab}	0.01^{*}
	15-20	0.62^{b}	0.66^{a}	0.62^{b}	0.62^{b}	0.06^{*}
	20-25	0.64^{b}	0.66^{a}	0.60^{c}	0.66^{a}	0.05^{*}

TOC	0-5	9.87^{d}	12.84^{a}	0.12^{e}	11.44^{c}	1.25*
	5-10	7.41^{e}	9.05^{c}	11.08^{b}	12.45^{a}	0.52*
	10-15	4.89^{b}	3.93^{d}	7.84^{a}	1.33^{e}	0.56*
	15-20	3.35^{d}	0.28^{e}	6.93^{c}	10.09^{b}	1.07*
	20-25	1.51^{e}	6.91^{b}	6.27^{c}	3.31^{d}	0.78*

*Means within each row with different superscripts are indication of different level of significance at 5% ($P<0.05$)

4. Conclusion

The study concludes that the physical parameters of soil samples showed different but with some certain slightly similar values at different site and soil depths. This is attributed to the concentration or mean values of different parameters in the soil profile. Thus, the operational activities of automobile repair workshops in soils pose a great challenges to the levels of soil physical parameters within the top soils. The soils are not yet readily polluted to call for alarm but these contaminations can extend to nearby farmlands if measures to control the activities that increase the concentration at these sites are not implemented. All used oil are expected to be stored by the in plastic containers or gallons rather than the present attitude of spilling on the ground. This challenges pose a serious soil and environmental effects on the study area. The low value of some physical parameters in the soil is an important indicator for successful agricultural plant growth and soil management practice. There is also the need to clearly indicate specific regulations guiding the establishment and operation of automobile mechanic workshops.

5. Recommendations

Based on the research findings, the following recommendation were made:

i. The automobile mechanic workshops in the study area should be encouraged to practice accurate collection and disposal of used engine oil.
ii. Automobile workshops should be properly planned and their mode of operation should be redesigned based on the ethics of the practice.
iii. Awareness campaign should be provided to automobile workshops on environmental implications of poor waste management.
iv. Regular evaluation of automobile activities must be carried out to ensure compliance to with environmental regulations and hygiene.
v. Waste management facilities should be provided by relevant bodies or government agencies to avoid indiscriminate disposal of waste in the study area.

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