

Assessment of Physicochemical Parameters of Soils from Selected Abattoirs in Port Harcourt, Rivers State, Nigeria

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Abstract

Pollution arising from anthropogenic activities is a common phenomenon. Soil samples collected from three abattoirs in Port Harcourt (Agip, Iwofe, and Mile III) between the months of January to July. The samples were analyzed for physicochemical parameters after following laboratory procedures, using the appropriate probes. It was observed that the pH of the soils was acidic, ranging from 4.59 ± 0.03 – 4.99 ± 0.14 , electrical conductivity ranged from 208.00 ± 11.21 – 404.34 ± 7.18 $\mu\text{S}/\text{cm}$, temperature from 33.14 ± 1.29 – 35.04 ± 0.96 °C while salinity had a range of 27.53 – 1.91 – 58.65 ± 2.25 . The textural class was sandy-clay-loam, implying that the soil contains sand in a higher proportion. Total moisture content was within the range of 16.66 ± 1.73 – 21.07 ± 2.05 %, chloride content ranged from 17.10 ± 1.61 – 31.75 ± 2.00 % whereas total nitrogen and nitrogen based parameters were generally very low in concentration in the soil. Extractable phosphorus content in the soil ranged from 0.66 ± 0.03 – 1.34 ± 0.33 %, total organic carbon ranged from 12.81 ± 0.15 – 16.41 ± 0.49 %, and total organic matter ranged from 22.33 ± 0.86 – 29.58 ± 0.72 mg/Kg. Total hydrocarbon content ranged between 11.85 ± 0.48 and 27.12 ± 0.48 mg/Kg. The observed result indicated that human activities within the abattoir have influenced the physicochemical speciation of the abattoirs. The high content of the organic components of the abattoir can serve as useful manure for cultivation of plants. However, constant check on the activities at the abattoirs should be put in place to avoid pollution of the environment.

Keywords: Pollution; Anthropogenic activities; Organic component; Soil

Introduction

Pollution of the environment arises majorly from human activities, which may be industrial or agricultural. Different environmental contaminants or pollutants are discharged into the environment as waste without regard to rules and regulations [1]. The major problem associated with population growth, urbanization and industrialization among low income countries is poor sanitary conditions among the rural dwellers [2]. According to [3], the wastes so generated from different human activities are either useful or harmful to the environment which may constitute environmental hazard to plants, animals and the end user (Human beings). Inputs from both industrial and anthropogenic activities are potential sources of irreversible reactions in the environment and therefore can hinder development [4]. The environment has limited capacity to contain these pollutants depending on environmental factors. While some ecosystem can retain or carry certain pollutants to an appreciable level, others may be very vulnerable to such negative consequences.

Human activities contribute a lot to the degradation, destruction and development of the immediate environment. Human activities (which exerts pressure on the environment), population growth, industrial and technological development has made it difficult to monitor, control and manage the environment successfully [5]. Another factor of importance is the process which controls the transformation, transport, translocation and deposition of these wastes is a complex one which cannot easily be interpreted [6].

Soil naturally is composed of various minerals, organic constituents and broken rocks which have been altered by environmental reactions [7,8]. Soil is a natural sink for various pollutants and contaminants. When pollutants or contaminants find their way into the soil, they interact with the soil and thereby change the chemical and physical properties of the soil. Pollution of the soil is majorly from agricultural practice and industrial activity. However, natural source of soil pollution or contamination cannot be ruled out. Soils have the ability to remove impurities, destroy disease causing agents (pathogens) and degrade contaminants. Soils absorb oxygen and methane and release carbon

dioxide and nitrous oxide. It is from the soil that plants get physical support, air, water, temperature moderation, nutrients, and protection from toxins. The conversion dead organic matter into nutrients for plants and animals takes place in the soil.

This study was carried out to determine the physicochemical parameters of soils found around selected abattoirs (slaughter house) in three locations in Port Harcourt.

Materials and Methods

Soil samples from three abattoirs cited in different parts of Port Harcourt (Agip, Iwofe and Mile III) were collected to a depth of 10–15 cm with soil auger and transferred into black polythene bags. Five samples each were randomly collected each month and mixed together to form a representative sample. The samples were transported to the Research Laboratory of the Chemistry Department of Ignatius Ajuru University of Education, Port Harcourt, Rivers State. The samples were air dried to constant weight for two weeks. The samples were then sent to the Jaros Base Laboratory for physicochemical parameters analysis.

The pH and conductivity of the soil samples were determined by the method described by Edori et al. in his previous study [2]. The temperature of the soil was measured *In situ* with a mercury thermometer. The thermometer was allowed to remain in the soil until a constant temperature was noted. The salinity and moisture content of the soil were estimated by the method of [9] previously. The particle size distribution (percentage sand, clay and silt) was determined by

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the method adopted by [10] in his research. The textural class was determined by the method of [11] in his work.

Nitrates and chlorides were determined by the methods described and provided the method for analyzing total carbon [12]. The method proposed by [13] was used to determine the total organic matter of the soil. Extractable phosphorus was determined by the method of [14] in his study. The total hydrocarbon content was determined by the method described by [15] in their previous work (Figure 1).

Results and Discussion

The pH values from the various abattoirs within the months in the various stations varied from 4.19-5.13. The pH values of the abattoirs were slightly acidic in nature. This observation is at variance with those observed by [16,17] for dumpsites. According to [18], Soil pH (acidity and alkalinity) play the greatest influence on availability of nutrients to plants and the type of organism found in the soil. The pH also affects the solubility of metal and therefore its availability to plants is made more accessible to plants at acidic pH. The pH is defined as the hydrogen ion concentration. It is the measure of the acidic property of matter. In areas with high rainfall, soils tend to be more acidic in nature. This is because the basic cations are forced off the soil colloids by the mass action of hydrogen ions from the rain as those attach to the colloids.

The value of the electrical conductivity varied from 269.22-406.86 $\mu\text{S}/\text{cm}$ within the months in the various sampled stations. The observed high value of electrical conductivities of the soil from abattoirs is an indication of interference from anthropogenic factors. Conductivity values were higher than those observed in other studies in abattoir [19,20]. High conductivity values imply the presence of soluble salts in the soil [18].

The monthly variation of the temperature of the soils ranged from 31.62-36.24°C in the different sample stations. The temperature of a given soil is determined by the absorptive properties of that soil. It is the ratio of the energy absorbed by the soil to the energy given out by the soil. The germination of seed and the growth of plants are regulated by the temperature of the soil. Furthermore, Soil temperature determines the availability of nutrients to plants. Soil temperature varies with seasons, months and daily and this variation is determined by such factors as water content, soil color, and relief (slope, orientation, and elevation), and soil cover (shading and insulation).

The salinity values for the months varied from 25.00-61.07 mg/Kg. Soil salinity results from irrigation and poor drainage [21]. In dry lands, salinity can also be caused by erosion, prolonged wetness of the land which results in erosion and the water table especially when the water table is close to the surface. Capillary action carries the saline salts to the surface of the soil [22].

The percentage of sand, clay and silt in the soil samples within the months of examination and in the stations, were within the range of 52-59% (sand), 25-30% (clay) and 13-22% (silt) respectively. The textural class of the soil was sandy-clay-loam (SCL). The percentage of sand, clay and silt are categorized as textural class. Soil texture is a measure of the physical properties of the soil. These properties include plasticity of the soil, water retention capacity, soil productivity, soil permeability and ease or toughness of tillage of the soil [23]. The soil texture showed it to be a sandy-loamy soil (sand>clay>silt). This soil therefore has the potential to hold more water within the particles due to the presence of a relatively high percentage of clay [24]. Sandy soils retain little water and therefore percolation of water through it is high and so promotes ground water contamination while clayey texture prevents water

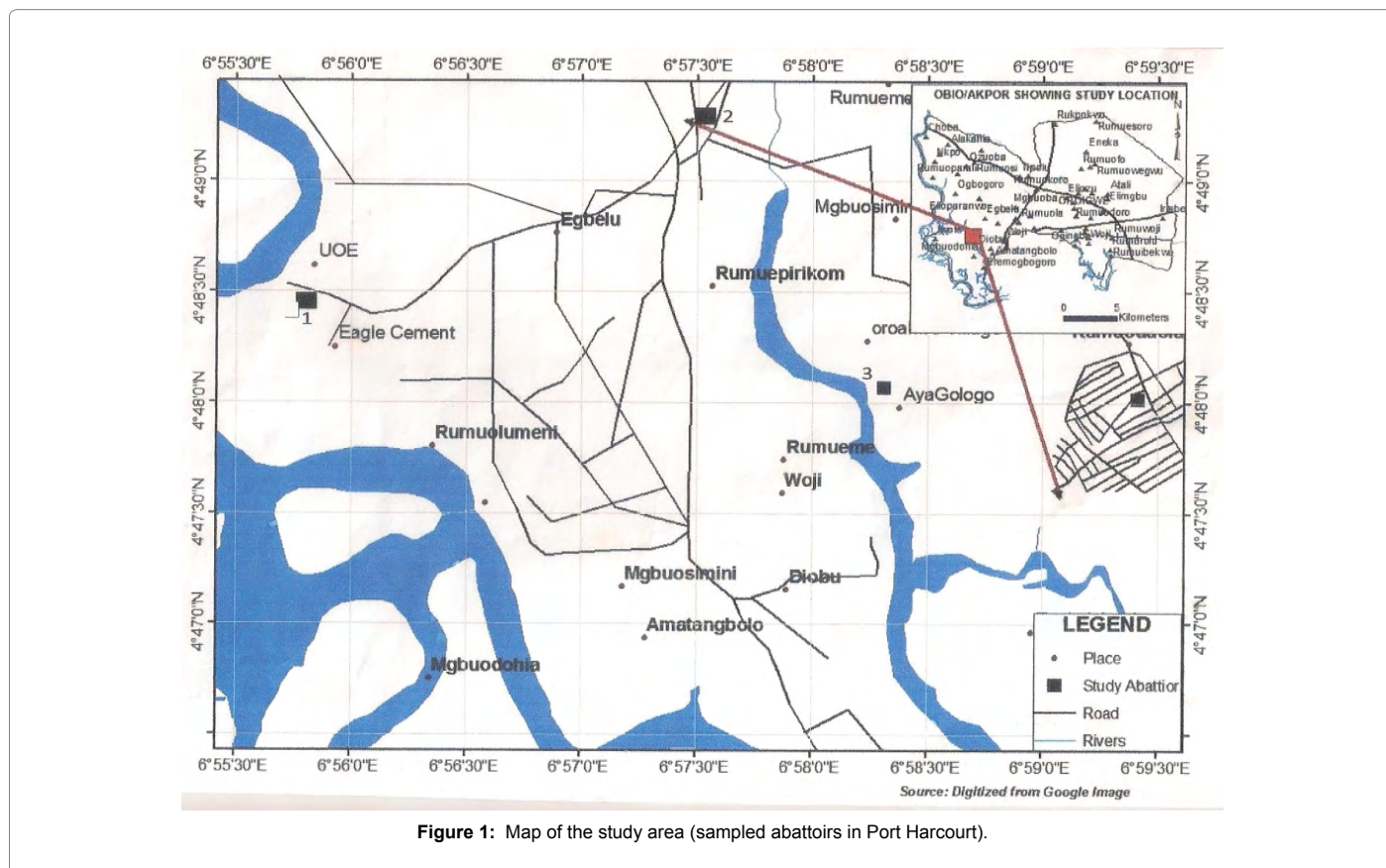


Figure 1: Map of the study area (sampled abattoirs in Port Harcourt).

percolation according [25], and therefore acts as natural filter of water contaminants and pollutants.

The total moisture content of the abattoirs within the months varied from 14.84-24.02% with an average value of 16.66 ± 1.73, 19.01 ± 2.85 and 21.07 ± 2.05% at Agip, Iwofe and Mile III stations respectively. The amount of water remaining in a soil drained to field capacity and the amount that is available are functions of the soil type. Sandy soil will retain very little water, while clay will hold the maximum amount. Any soil with high concentration of organic components such as observed in this work has the capacity to retain water for a long time and drying of such samples takes longer than usual. According to [26], high moisture content is due to de-aeration which displaced air in the soils and also the oxygen content of the soil and decreased microbial activity.

The chloride content of the abattoir soils ranged from 18.12-33.67 mg/Kg with a mean value of 17.10 ± 1.61, 20.44 ± 2.36 and 31.75 ± 2.00 mg/Kg at the Agip, Iwofe and Mile III stations. The observed concentrations of chlorides ions in the soils is very low when compared with the values obtained in a similar study in Port Harcourt metropolis [20]. Chlorine exists in the form of soluble chlorides in the soil and is strongly associated with minerals or organic matter. It is always in dissolved form in the soil solution and has the tendency to accumulate in saline salts because it readily forms compounds with sodium, calcium and magnesium. The availability of chlorides to plants is affected by soil acidity, aeration and organic matter [27]. High levels of chloride ions lead to increased concentrations in its uptake by plants and so results in toxicity problems in crops and consequent reduction in the yield. However, it is very important in photosynthesis [20].

The concentrations of the total nitrogen in the abattoir soils in the months fell within the range of 0.48-3.01%. The average values for the different sample stations were 1.55 ± 0.46, 1.80 ± 0.05 and 2.43 ± 0.42% at Agip, Iwofe and Mile III. The measured values of nitrate (NO₃⁻) in the sampled soils ranged from 0.43 -0.88%. The mean values for NO₃⁻ in the stations were 0.48 ± 0.03, 0.59 ± 0.05 and 0.68 ± 0.14 for Agip, Iwofe and Mile III stations respectively. The concentrations of the nitrate-nitrogen (NO₃-N) within the sampled stations and the months varied from 0.43-0.88 mg/Kg, with mean values in the stations being 0.53 ± 0.05 mg/Kg (Agip), 0.63 ± 0.10 mg/Kg (Iwofe) and 0.68 ± 0.12 mg/Kg (Mile III). Ammonium Nitrate (NH₄NO₃⁻) concentrations in the abattoirs soils ranged between 2.65-3.67 mg/Kg. The mean values at the various abattoir stations were 2.71 ± 0.07 mg/Kg (Agip), 2.95 ± 0.09 mg/Kg (Iwofe) and 3.23 ± 0.30 mg/Kg (Mile III). Nitrogen is required for proper plant growth. The inorganic forms of nitrogen (NH₄⁺, NO₂⁻ and NO₃⁻) are than 5% of the total nitrogen in soil [28]. Nitrogen is available to plants as either ammonium (NH₄⁺-N) or nitrate (NO₃⁻-N). When nitrogen is present in the soil, it undergoes different transformation which determines its availability to plants [29]. Furthermore, mineralization converts organic nitrogen present in soil organic matter, crop residues, and manure to inorganic nitrogen. When bacteria interact with the organic nitrogen, NH₄⁺-N is released. The release of NH₄⁺-N is proportional to the microbial activity in the soil [30].

Ammonium-N has very important properties for nitrogen management in soils. Plants can absorb nitrogen better in the form of NH₄⁺-N. Since the Ammonium is positively charged, it is attracted by negatively charged soil and soil organic matter. Thus, implying that NH₄⁺-N does not move downward in soils, but rather taken up by plants. However, any nitrogen in the form of NH₄⁺-N not taken up by plants undergoes other changes such as nitrification in the soil.

The concentrations of extractable phosphorus in the abattoirs ranged from 0.624 -1.83%. The average values for the months in the

different stations were 0.66 ± 0.03% (Agip), 1.05 ± 0.16% (Iwofe) and 1.34 ± 0.33% (Mile III). The observed values of extractable phosphorus were lower than the values observed in a similar study in major cities of Delta State, Nigeria [31]. Phosphorus occurs in the form of phosphates with other elements. Different forms of phosphates which are complex in nature are found in the soil, water, plants, animals and humans. They exist in the soil as phosphates (PO₄³⁻), monohydrogen phosphate (HPO₄²⁻), and dihydrogen phosphate (H₂PO₄⁻), which are readily inter-converted to one another and the predominant species is determined by the pH of the solution or soil [32]. Excess phosphorus in soil can become a point source of pollution, because the excess not utilized by plants is wash away by runoffs into ponds, lakes and rivers. Though phosphorus promotes plant growth in soils, yet its excess in water promotes algal growth, which if persistently continues can lead to algal bloom. Algal bloom, leads to oxygen deficiency in water with the consequence of death of aquatic animals and odour. In soils with inadequate phosphorus content, plants will suffer, growth of crops will be stunted, leaves may change colour to purple and there will be a delayed time to flowering and growth of new shoots [33].

The total organic carbon (TOC) content varied from 12.69 -16.97% within the months in the various sampled stations. The mean values were 14.39 ± 0.56 (Agip), 12.81 ± 0.15 (Iwofe) and 16.41 ± 0.49 (Mile III). The total organic matter (TOM) content varied from 22.07 -30.31 mg/Kg within the months in the various sampled stations. The mean values were 23.73 ± 1.08 (Agip), 22.33 ± 0.86 (Iwofe) and 29.58 ± 0.72 (Mile III). The total hydrocarbon content (THC) varied from 11.37 -27.68 mg/Kg within the months in the various sampled stations. The mean values were 11.85 ± 0.48 (Agip), 20.84 ± 0.32 (Iwofe) and 27.12 ± 0.48 (Mile III). These three parameters (TOC, TOM and THC) are used to express the organic richness of the soil environment. They have a powerful effect on soil development, fertility, and available moisture. Following water and soil colloids, organic material is next in importance to a soil's formation and fertility. The soil organic carbon is obtained by decomposition of the plants, animals and anthropogenic sources such as chemical contaminants, fertilizers or organic rich waste [34]. The amount of total organic matter in any soil determines the nutrient content and any changes will alter the quality and quantity of soil fertility. The stability of the TOM stabilizes soil pH (an important factor

Parameters	AGIP	IWOFE	MILE III
pH	4.19	4.53	4.79
Electrical Conductivity (µS/cm)	289.21	311.46	410.37
Temperature (°C)	34.61	33.60	35.30
Salinity (mg/Kg)	29.00	43.00	59.00
Sand (%)	52	54	55
Clay (%)	28	29	30
Silt (%)	20	17	15
Texture Class	SCL	SCL	SCL
Total Moisture Content%	14.84	16.81	19.42
Chloride (mg/Kg)	18.12	21.02	32.68
Total Nitrogen (%)	1.64	1.76	2.40
Nitrate (NO ₃ ⁻) (%)	0.49	0.58	0.62
Nitrate-Nitrogen (NO ₃ -N) (mg/Kg)	0.514	0.589	0.632
Ammonium Nitrate (mg/Kg)	2.72	2.96	3.07
Extractable Phosphorus (%)	0.685	0.927	1.10
Total Organic Carbon (%)	14.69	12.87	16.97
Total Organic Matter (mg/Kg)	24.21	22.07	29.27
Total Hydrocarbon Content (mg/Kg)	11.37	20.38	27.68

Table 1: Physicochemical parameters of soils from selected abattoirs in Port Harcourt in January.

in nutrient availability to plants). One of the factors which determine the level of TOM in soil is management practices [35,36]. Total hydrocarbons content (THC) in any environmental is contaminant and is toxic to humans and other environmental receptors. The moderate concentrations of this parameter in the abattoir soils may have originated from handling sources such as storage, transportation, disposal, and spillages from illicit sources (Tables 1-5) [37,38].

Conclusion

The abattoir soils have been influenced by the nature of the activities which took place. The acidic nature of the soils is not good for most agricultural activities and therefore need further treatment before the soils can be good for cropping. However, the concentration of the organic based components of the soils is an indication that if properly treated, can serve as a good source of manure for agricultural purposes. From this study, there is strong indication that citing of abattoir near a water body (which the prevalent practice) can cause great pollution and ecological consequences.

Parameters	AGIP	IWOFE	MILE III
pH	4.50	4.68	5.02
Electrical Conductivity ($\mu\text{S}/\text{cm}$)	290.12	309.65	406.22
Temperature ($^{\circ}\text{C}$)	35.43	34.64	36.24
Salinity (mg/Kg)	29.02	45.26	61.07
Sand (%)	53	54	56
Clay (%)	25	26	29
Silt (%)	22	20	15
Texture Class	SCL	SCL	SCL
Total Moisture Content (%)	15.91	16.63	20.02
Chloride (mg/Kg)	18.22	22.90	33.67
Total Nitrogen (%)	2.11	1.89	3.01
Nitrate (NO_3^-) (%)	0.50	0.67	0.88
Nitrate-Nitrogen ($\text{NO}_3\text{-N}$) (mg/Kg)	0.614	0.786	0.862
Ammonium Nitrate (mg/Kg)	2.82	3.00	3.67
Extractable Phosphorus (%)	0.679	1.27	1.83
Total Organic Carbon (%)	15.02	13.00	16.68
Total Organic Matter (mg/Kg)	24.95	22.92	30.31
Total Hydrocarbon Content (mg/Kg)	11.52	21.02	26.99

Table 2: Physicochemical parameters of soils from selected abattoirs in Port Harcourt in March.

Parameters	AGIP	IWOFE	MILE III
pH	4.98	5.03	5.13
Electrical Conductivity ($\mu\text{S}/\text{cm}$)	269.22	290.68	393.92
Temperature ($^{\circ}\text{C}$)	33.67	32.71	34.63
Salinity (mg/Kg)	27.10	40.00	58.90
Sand (%)	54	57	59
Clay (%)	27	26	28
Silt (%)	19	17	13
Texture Class	SCL	SCL	SCL
Total Moisture Content (%)	18.90	22.61	24.02
Chloride (mg/Kg)	14.76	17.23	29.03
Total Nitrogen (%)	0.99	1.62	2.02
Nitrate (NO_3^-) (%)	0.43	0.56	0.60
Nitrate-Nitrogen ($\text{NO}_3\text{-N}$) (mg/Kg)	0.504	0.580	0.601
Ammonium Nitrate (mg/Kg)	2.68	2.82	3.00
Extractable Phosphorus (%)	0.624	0.923	1.21
Total Organic Carbon (%)	13.81	12.69	15.93
Total Organic Matter (mg/Kg)	22.46	23.11	28.73
Total Hydrocarbon Content (mg/Kg)	12.41	21.08	26.54

Table 3: Physicochemical parameters of soils from selected abattoirs in Port Harcourt in May.

Parameters	AGIP	IWOFE	MILE III
pH	4.69	4.90	5.00
Electrical Conductivity ($\mu\text{S}/\text{cm}$)	271.43	303.67	406.86
Temperature ($^{\circ}\text{C}$)	32.51	31.62	33.99
Salinity (mg/Kg)	25.00	40.07	55.63
Sand (%)	53	55	56
Clay (%)	29	26	28
Silt (%)	18	19	16
Texture Class	SCL	SCL	SCL
Total Moisture Content (%)	16.98	19.99	20.802
Chloride (mg/Kg)	17.28	20.62	31.63
Total Nitrogen (%)	1.46	1.95	2.30
Nitrate (NO_3^-) (%)	0.48	0.56	0.61
Nitrate-Nitrogen ($\text{NO}_3\text{-N}$) (mg/Kg)	0.504	0.570	0.609
Ammonium Nitrate (mg/Kg)	2.65	3.00	3.18
Extractable Phosphorus (%)	0.667	1.06	1.20
Total Organic Carbon (%)	14.03	12.68	16.08
Total Organic Matter (mg/Kg)	23.31	21.23	30.02
Total Hydrocarbon Content (mg/Kg)	12.10	20.91	27.25

Table 4: Physicochemical parameters of soils from selected abattoirs in Port Harcourt in July.

Parameters	Stations		
	AGIP	IWOFE	MILE III
pH	4.59 \pm 0.33	4.78 \pm 0.22	4.99 \pm 0.14
Electrical Conductivity ($\mu\text{S}/\text{cm}$)	280.00 \pm 11.21	303.87 \pm 9.40	404.34 \pm 7.18
Temperature ($^{\circ}\text{C}$)	34.06 \pm 1.26	33.14 \pm 1.29	35.04 \pm 0.96
Salinity (mg/Kg)	27.53 \pm 1.91	42.08 \pm 2.54	58.65 \pm 2.25
Sand (%)	53.00 \pm 0.81	55.00 \pm 1.41	56.50 \pm 1.73
Clay (%)	27.25 \pm 1.71	26.75 \pm 1.50	28.75 \pm 0.96
Silt (%)	19.75 \pm 1.71	18.25 \pm 1.50	14.75 \pm 1.26
Texture Class	SCL	SCL	SCL
Total Moisture Content (%)	16.66 \pm 1.73	19.01 \pm 2.85	21.07 \pm 2.05
Chloride (mg/Kg)	17.10 \pm 1.61	20.44 \pm 2.36	31.75 \pm 2.00
Total Nitrogen (%)	1.55 \pm 0.46	1.80 \pm 0.50	2.43 \pm 0.42
Nitrate (NO_3^-) (%)	0.48 \pm 0.03	0.59 \pm 0.05	0.68 \pm 0.14
Nitrate-Nitrogen ($\text{NO}_3\text{-N}$) (mg/Kg)	0.53 \pm 0.05	0.63 \pm 0.10	0.68 \pm 0.12
Ammonium Nitrate (mg/Kg)	2.71 \pm 0.07	2.95 \pm 0.09	3.23 \pm 0.30
Extractable Phosphorus (%)	0.66 \pm 0.03	1.05 \pm 0.16	1.34 \pm 0.33
Total Organic Carbon (%)	14.39 \pm 0.56	12.81 \pm 0.15	16.41 \pm 0.49
Total Organic Matter (mg/Kg)	23.73 \pm 1.08	22.33 \pm 0.86	29.58 \pm 0.72
Total Hydrocarbon Content (mg/Kg)	11.85 \pm 0.48	20.84 \pm 0.32	27.12 \pm 0.48

Table 5: Physicochemical parameters (mean \pm SD) of soils from selected abattoirs in Port Harcourt.

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