**International Journal of Environmental Planning and Management**
Vol. 7, No. 2, 2021, pp. 36-41
http://www.aiscience.org/journal/ijepm
ISSN: 2381-7240 (Print); ISSN: 2381-7259 (Online)

# Microbial and Heavy Metal Analysis on Abattoir Soils

**Temidayo Michael Ogunlade[1], Babafemi Raphael Babaniyi[2, *], Damilola Orija[1]**

[1]Chemistry Department, Federal University of Technology, Akure, Nigeria
[2]Bioresoures Development Centre, Ogbomoso, Nigeria

## Abstract

The presence of abattoir in major cities is of great concern, not only to the public but also to the environmental policy makers. Waste disposal management in the country has not been able to cope with the volume of solid waste generated industrially and domestically. This study therefore, was done to assess the soil of some abattoirs environment in Ekiti State, Nigeria. Soil samples were collected from three different Abattoir sites namely; Atikankan Abattoir (Ado - Ekiti), Ikere – Ekiti Abattoir (Ikere - Ekiti) and Iworoko Road Abattoir (Ado - Ekiti) Nigeria. The physico-chemical analysis, Heavy metal analysis (Atomic Absorption Spectrometer (AAS, VGP210).) and Microbial analysis was carried out on the soils. The results indicated that, the abattoir soils are slightly alkaline with an average pH of 7.23 in Iworoko road, 8.63 in Ikere, and 7.90 in atikankan, the electrical conductivity ranges from1202.00 to 1692µS/cm in the various sampling locations of the abattoir soils; the soil type was found to be sandy clay loam in all the soils in the three locations; the percentage of organic matter (TOM) varied from 1.72 – 5.36mg/Kg within the location points. The concentration of heavy metals are: Cd (from 0.01 – 0.02mg/kg); Fe (30000.50 to 34200.94mg/kg); Manganese concentrations varied differently across the sites with maximum mean concentration observed in Ikere - Ekiti Abattoir (0.18mg/Kg) and minimum at the Iworoko Road Site (0.13mg/Kg Pb (10.48-30.00 mg/kg) and Ni (0.60 – 1.25 mg/kg). Heavy metal concentrations of the threeabattoir soils fell below the WHO permissible limit. The microbial analysis revealed the population of bacteria and fungi in the soil samples from the three abattoir locations which are considerably high for soils.

## Keywords

Abattoir, Heavy Metals, Microbes, Conductivity, Physicochemical

Received: March 12, 2021 / Accepted: April 14, 2021 / Published online: April 28, 2021



## 1. Introduction

Abattoir is a place where animals are butchered for human consumption. Slaughter house has unique equipment authorized by the regulatory team for hygienic meat production, preservation and management of wastes [1]. It is a known fact that abattoir wastes pollute environment from different meat processing stages. With the increase in daily demand of meat due to high protein content, the abattoir activities also increased with generation of more wastes [2].

Heavy metals in natural environment are present in various chemical forms and display varied effects in term of chemical interactions, mobility, biological abundance and potential toxicity. Heavy metals exist as natural constituents of the earth crust, and are persistent environmental contaminants since they cannot be decomposed [3].

Ado, Iworoko and Ikere - Ekiti, are a big town in Ekiti State of Nigeria, rapid growth in the three towns has increased

* Corresponding author
E-mail address: babafemiraphael@gmail.com (B. R. Babaniyi)

tremendously with increase of farms, commercial activities, and population; also there have been also surge in severalproduction companies in Ado and numerous industries activities in Adebayo Road towards Iworoko Road which has brought in a new status within the workforce and inhabitants therefore imposed a new social demand and accompanying changes in life style and statues of the various work force (human capital) in these companies and other inhabitants there by increasing the population. These increases in population need full assessment in the flow of food chain within the studied environment.

Among the pollutants generated by industry and urbanization, abattoir waste, heavy metals and various pathogenic bacteria are the most dangerous, because they can cause serious health problems to human population. As a consequence of natural and anthropogenic activities, microorganism, heavy metals are present in the environment, so that people come into contact with them especially through the consumption of foods [4]. Hence, this research will unveil the circulation level of heavy metals, and soil microorganism of the area under consideration. This study will generate data and strategies for proper environmental management of the Ekiti State Abattoir and other similar facilities. This goes a long way towards a cleaner and healthier environment.

## 2. Materials and Methods

### 2.1. Study Area

Iworoko, a town in Ado-Ekiti, located in the south west of Nigeria with Latitude 7˚41[1]33.96379 N and Longitude 5˚15[1]18.49316 E. The Iworoko Road Abattoir was established in 2008. Iyalaje Cattle garden is located in Ikere-Ekiti, Ekiti State Latitude 7˚29[1]45.9735 N and Longitude 5˚13[1]48.05872 E established in 2003. The Atikankan abattoir in Ado Ekiti State, was established 50 years ago. The abattoir is located at the centre of Ado-Ekiti with Latitude 7˚37[1]5.96932 N and Longitude 5˚13[1]15.2459 E.

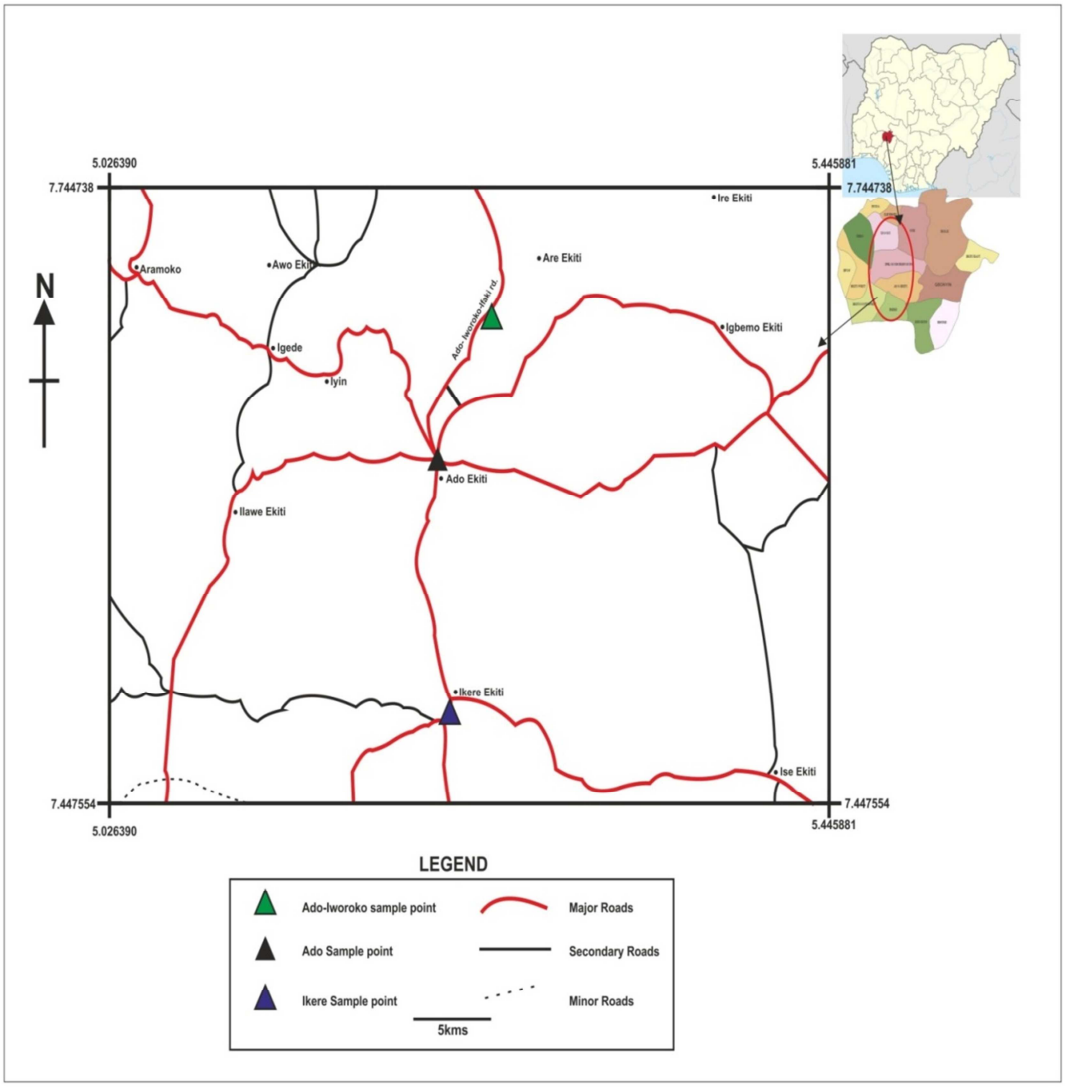


**Figure 1.** Map of Ekiti State showing the sampling points.

### 2.2. Sampling

Four soil samples were collected for this study from the selected abattoir and its environment at the depth of 0 - 15cm (topsoil) by means of a Dutch soil auger at different sampling points within and around the abattoir environment and control sample was collected from non-abattoir environment. The soil samples were labelled in a polyethylene bag.

### 2.3. Soil Sample Preparation and Analysis

The soil samples were air dried and pounded into powder using mortar and pestle. The samples were sieved through a 2.0 mm sieve to obtain a homogenous particle of same surface area, which was later kept in plastic containers and covered prior to heavy metal and for the microbial analysis of the soil.

Physicochemical parameters (pH, Conductivity, Organic Matter and particle Size) were carried on the soil samples using standard procedures. While the heavy metals were extracted using aqua ragia ($HNO_3$-HCl, Ratio 1:3), the extract was then analyzed using Atomic Absorption Spectrophotometer (AAS) [5]. All the parameters was determined in triplicates and the data obtained was subjected to statistical analysis of (ANOVA) and Duncan's New Range Test at 95% confidence level using SPSS 21.0 version.

### 2.4. Microbial Analysis

#### 2.4.1. Isolation and Enumeration of Bacteria and Fungi

Pour plate technique was employed for the enumeration of both bacteria and fungi. Potato dextrose agar (PDA) was used for the isolation of fungi while nutrient agar (NA) was used for bacteria. The medium was prepared according to the manufacturer instruction and sterilized at 121°C for 15min. it was supplemented with 2%(v/v), filter-sterilized oils(petrol, diesel and kerosene) which serve as the only source of carbon [6]. The sediment (1g) samples were serially diluted and 1mL suspension was aseptically transferred from each $10^3$ dilution into sterile petridish and seeded with the medium. The PDA was allowed to gel and incubated at 28±2°C for 3days while NA plates were incubated 35±2°C for 24h. A control (excluding of the sample) was prepared for each set of the experiments. All experiments were performed in triplicates. Colonies were counted after incubation.

#### 2.4.2. Bacteria Isolates Identification

Bacteria isolated were identified based on morphological characteristics and biochemical tests carried out on the isolates. Morphological characteristics were observed from each bacterial colony after 24h of growth. The appearance of the colony of each isolate on the agar media was studied and the characteristics observed include; shape, elevation, edge, optical characteristics, consistency, colony surface and pigmentation. Biochemical characterizations were done according to the method of Fawole and Oso 2004 [7].

#### 2.4.3. Fungi Isolates Identification

The fungi colonies were sub-cultured on potato dextrose agar (PDA). The isolates were identified based on their morphological and microscopic features. Two drops of cotton-blue-in-lactophenol were placed on clean glass slide and small piece of mycelolium free of medium was removed with sterile inoculating needle and transferred on to the stain on the slide. The mycelium was teased (picked) out with the needles and covered with clean cover slip carefully avoiding air bubbles and observed under the microscope for vegetative and reproductive structures [8].

## 3. Results and Discussion

### 3.1. Analysis of Soil Samples

#### 3.1.1. Physicochemical Analysis of Soil Sample

Table 1 shows the physicochemical properties of soil samples from Iworoko Road Abattoir, Ikere Ekiti Abattoir and Atikankan Abattoir. The pH values of the abattoir soil samples range from 7.23 – 8.63. These values indicate an alkaline soil condition and agree with the report made by Rabah et al [6]. According to Arias et al [9]. 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 value of electrical conductivity varied from 1202.00 - 1692µS/cm in the various sampling locations of the abattoir soils. It was observed that conductivity values were higher than those other studies in abattoir by Onwuka et al., Chukwu and Anuchi [10, 11]. High conductivity values mean the existence of soluble salts in the soil as stated by Arias et al [9]. The proportion of sand, clay and silt in the soil test at specific sample locations, were within the range of 80.22 – 90.07% (sand), 6.27 – 8.35% (clay) and 3.41 – 11.66% (silt) respectively. The textural category of the soil was sandy-clay-loam (SCL) [12]. However, the total organic matter (TOM) content varied from 1.72 – 5.36mg/Kg within the location points. TOC (Total Organic Carbon), TOM (Total Organic Matter) and THC (Total Hydrocarbon Content) are used to articulate the organic richness of the soil environment. They have a prevailing effect on soil improvement, fertility, and available moisture. Following water and soil colloids, organic material is subsequently importance to a soil's formation and fertility. The quantity of total organic matter in any soil determines the nutrient content and any changes will vary the quality and quantity of

soil fertility. The steadiness of the TOM stabilizes soil pH (an essential factor in nutrient availability to plants). One of the factors which establish the level of TOM in soil is management practices [13].

**Table 1.** The physicochemical analysis of the abattoir soil samples.

| Parameters | Unit | Iworoko Road | IkereEkiti | Atikankan | Control |
|---|---|---|---|---|---|
| pH | | $7.23^{a}$±0.05 | $8.63^{c}$±0.06 | $7.90^{b}$±0.10 | $7.13^{a}$± 0.05 |
| Conductivity | µS $cm^{-1}$ | $1202.00^{b}$±2.00 | $1951.00^{d}$±10.14 | $1692.33^{c}$±6.7 | $114.00^{a}$±1.02 |
| Sand | % | $90.07^{d}$±0.14 | $88.49^{c}$±0.43 | $80.22^{a}$±0.24 | $82.11^{b}$± 0.13 |
| Silt | % | $3.41^{a}$±0.05 | $5.63^{b}$±0.32 | $11.66^{c}$±0.29 | $13.43^{d}$±0.01 |
| Clay | % | $6.27^{b}$±0.66 | $6.31^{b}$±0.00 | $8.35^{c}$±0.04 | $4.35^{a}$±0.04 |
| T.O.M | % | $3.43^{b}$±0.00 | $5.36^{d}$±0.00 | $1.72^{a}$±0.03 | $4.13^{c}$±0.00 |
| C.E.C | mol/kg | $9.04^{b}$±0.00 | $10.96^{d}$±0.00 | $9.69^{c}$±0.01 | $8.96^{a}$±0.00 |

Data are presented as mean ± S.D (n=3). Values with the same superscript letter(s) along the same row are not significantly different (P<0.05) using Duncan multiple range test

The values of the Cation Exchange Capacity for the soil samples in the locations ranged from 9.04 – 10.96mg/kg. The main ions associated with CEC in soils are exchangeable cations calcium ($Ca^{2+}$), magnesium ($Mg^{2+}$), sodium ($Na^{+}$) and potassium ($K^{+}$) are generally referred to as the base cations [14]. In most cases, summing the analysed base cations gives an adequate measure of CEC. A Duncan multiple range test using the analysis of Variance (ANOVA) revealed that there was a significance difference in most of the physicochemical properties of abattoir soil from the sample sites at P<0.05.

### 3.1.2. Total Concentration of Heavy Metals in the Abattoir Soil Sample

The result of the analysis shows that Cd ranged from 0.01 – 0.02mg/kg in all site samples except in the control which is Below Detection Limit. This may be attributed to the absence of wastes from batteries made with Cd. Ubewa et al (2013) [15] reported a range of 0.0035 to 0.0660 mg/kg for Cd. The concentration of Cr in the studied were below detection limit at the Iworoko Road Abattoir likewise at the Ikere - Ekiti Abattoir and having 0.02mg/kg at the Atikankan Abattoir and also for the control which is still within the maximum permissible limit of the standard used in this study. The concentration of Fe ranged from 300.50 to 342.94mg/kg in all the sample points from the abattoir soil. This range is far below the maximum permissible limit of the standard used in this study and as well as the abundance level of the metal in the earth's soils; 38000 mg/kg [16]. The concentrations of manganese were significantly different across the sites with maximum mean concentration at the Ikere - Ekiti Abattoir (0.18mg/Kg) and minimum at the Iworoko Road Site (0.13mg/Kg).

Both values are lower than the control site which had a mean concentration value of 0.23mg/Kg. Manganese is found naturally in the most soil as it is one of the most essential mineral for life [17]. All the concentration values were found to be lower than the World Health Organization standard for manganese in soil. Nickel was found in the range of 0.60 – 1.20mg/kg in the samples from the abattoir soil. These value which is far below the maximum permissible limit of Nickel which is 6.70 mg/kg. This value was below the result obtained by [15]. Lead is naturally occurring and can be found either in low or high concentrations but toxicity of Pb has placed it as one of the environmental concern even at low concentration level [18]. The result obtained in the study showed Pb concentration ranged from 10.9 – 30.80mg/kg which is lower than the WHO standard of 100mg/kg soil limits [19]. The Pb levels obtained in thisstudy remained lower than the concentration reported by Ubewa et al 2013 [15] in a similar work. The relatively high concentration of Pb in some of the samples in this present study may be attributed to lead additives to petrol and mechanical shops that used Pb batteries in the area investigated [20].

**Table 2.** Total concentration (mg/L) of heavy metals in the abattoir soil sample.

| Location | Cd | Cr | Fe | Ni | Mn | Pb |
|---|---|---|---|---|---|---|
| Iworoko Road | $0.10^{a}$±0.05 | BDL | $32400.94^{c}$±6.07 | $1.25^{c}$±0.01 | $130.4^{a}$±0.00 | $15.0^{a}$±0.00 |
| IkereEkiti | $0.31^{b}$±0.01 | BDL | $34200.59^{d}$±7.00 | $0.60^{a}$±0.00 | $185.3^{c}$±0.00 | $20.8^{b}$±0.01 |
| Atikankan | $0.24^{c}$±0.00 | $0.02^{a}$±0.05 | $30000.50^{b}$±8.10 | $1.10^{b}$±0.01 | $230.4^{d}$±0.00 | $30.8^{c}$±0.01 |
| Control | BDL | $0.02^{c}$±0.01 | $29090.96^{a}$±3.00 | $0.83^{b}$±0.00 | $160.4^{b}$±0.01 | $10.9^{a}$±0.00 |
| WHO(2011) | 3 | 100 | 50000 | 6.70 | 2000 | 100 |

Data are presented as mean ± S.D (n=3). Values with the same superscript letter(s) along the same row are not significantly different (P<0.05) using Duncan multiple range test.
BDL: Below Detection Limit

### 3.2. Microbial Analysis of the Soil

*Bacteria and Fungi Population in Soil*

The loads of the bacteria in the abattoir soil samples of these locations when grown on Nutrient agar (NA) shows the count (Cfu/mL) ranged from 1.38 to 3.12 with the minimum of the bacteria population coming from the Ikere - Ekiti Abattoir which is 1.38Cfu/mL and the maximum from the Iworoko Road Abattoir with 3.12Cfu/mL while that of the Atikankan Abattoir was 2.94Cfu/mL. The population of the soil of these locations fell within the range of the control which is 3.50Cfu/ml. *E.coli* was detectable in all samples of the abattoir locations.

The fungi load was developed on potato dextrose agar (PDA). The fungi population that was detected in the abattoir soil samples from these locations ranged from 6.86 to 7.70Cfu/mL. The maximum fungi count was found at the Iworoko Abattoir with 7.70Cfu/mL, while at the Ikere - Ekiti abattoir has the lowest count of 6.86Cfu/mL. With each site having fungi count higher than the control sample, shows high fungi activities present in the abattoir soils, and if such are soils washed either by water or transported by air; it can pose a serious health concern for both the animals and humans in contact. Table 4 is showing the microbial isolates from the abattoir soil samples.

**Table 3.** Total Counts of bacteria and fungi in the soil samples of the abattoirs.

| Location | Total Bacteria Count (Cfu/mL) × $10^3$ | Total Fungi Count (Cfu/mL) × $10^2$ |
|---|---|---|
| Atikankan | $4.94^{b}$±0.01 | $6.86^{a}$±0.00 |
| Ikere - Ekiti | $6.38^{a}$±0.01 | $7.26^{b}$±0.01 |
| Iworoko Road | $6.12^{c}$±0.00 | $7.70^{c}$±0.00 |
| Control | $1.50^{d}$±0.10 | $1.45^{d}$±0.10 |

Data are presented as mean ± S.D (n=3). Values with the same superscript letter(s) along the same row are not significantly different (P<0.05) using Duncan multiple range test.

**Table 4.** Microbial isolates from the abattoir soil samples.

| Organism | |
|---|---|
| Bacteria | *Bacillus sp, Vibrio sp, Klebsiellapneumonia, Micrococcusleteus, proteussp, Pseudomonas putida.* |

## 4. Conclusion

The assessment of the three abattoirs has revealed that, the soil pH of all the sites were slightly alkaline in nature, and with respect to the activities carried out in the site, the TOM was found to be higher than the control and thus, support the growth of plant in that area; and the soil texture is sandy clay loam.

Though, heavy metal concentration (Pb, Cr, Fe, Ni, Mn and Cd) results obtained from the sites were all found to be in safe limit of WHO, but the level which they are at present is still a concern compared to other abattoir with more activities than the study area, the concentrations of metals were close and in the case of lead higher than the concentrations recorded from those site. This may be due to improper waste management, usage of crude method for slaughtering etc. And if this activities is not curb or regularize, the concentration of this metals may rise to an alarming level as time goes by. The bacteria and fungi count were all found to be higher than samples taken from control soils; the high presence of the Bactria and fungi, though has its uses in the soil, but the danger they pose if they find their way to the food chain cannot be overlooked.

Major reason for the accumulation of metal, bacteria and fungi in the soils of these abattoirs are improper waste management system, which is actually next to non-existence the risk they pose.

## Declarations

Raw data

The data will be made available on request.

## Funding Source

By authors.

## Authors Contribution

This work was carried out in collaboration between all authors. Author TMO anchored the field study. Author BRB interpreted the data. Author DO managed the literature and edited the manuscript. All authors read and approved the final manuscript.

## References

[1] Alonge, D. O. 2005. Meat and Milk Hygiene in the Tropics. Farmose Press, Ibadan, Nigeria. 2nd edition. *Bioresour. Technol,* 41:193-200.

[2] Godwin Asukwo Ebong, Ekomobong Samuel Ettesam and Emmanuel Udo Dan (2020) Impact of Abattoir Wastes on Trace Metal Accumulation, Speciation, and Human Health–Related Problems in Soils within Southern Nigeria. Air, SAGE Journals 13: 1–14.

[3] Osu, C. I., Ogoko, E. C., Emeziem, D. (2014). Metal Species, Mobility and Bioavailability In An Oil Impacted Soil From Ikoku And Alaoji Automobile Spare Parts Markets, Niger-Delta Nigeria. *American Academic & Scholarly Research Journal* 6, 3.

[4] Harmanescu, M., Alda, L. M., Bordean, D. M., Gogoasa, I and Gergen, I (2011). Heavy Metals Health Risk Assessment for Population via Consumption of Vegetables Grown in Old MiningArea; A Case Study: Banat County, *Romania Chemistry Central Journal* 5: 6 65.

[5] Hinton, M. H., Mead, G. C. and Rowlings C. (2000) Microbiology Control in the Meat Industry.

[6] Rabah, A. B., Oyeleke, S. B., Manga, S. B., Hassan, L. G., and Ijah, U. J. J. (2010)Microbiological and Physicochemical Assessment of Soil Contaminated with Abattoir Effluents in Sokoto Metropolis, Nigeria. *Science World Journal*. 5 (3).

[7] Fawole, M. O. and Oso, B. A. (2004) Characterization of Bacteria: Laboratory Manual of Microbiology. 4th Edition, *Spectrum Book Ltd., Ibadan*, 24-33.

[8] Hunter, B. B. and Barnett, H. L. (2000) Illustrated Genera of Fungi, Imperfecti 3rd edition, Burgess Publishing Company, Minnesota, U.S.A, 1972.

[9] Arias, M. E., Gonzalez-Perez J. A., Gonzalez-Villa F. J. and Ball A. S. (2005) Soil Health: A New Challenge for Microbiologist and Chemists. *International Microbiology* 8: 13-21.

[10] Onwuka, O. A. and Uzoukwu B. A. (2008). Studies on the Physicochemical Properties of Soil from Botanic Garden. *Scientia Africana* 7: 156-164.

[11] Chukwu, U. J., and Anuchi, S. O. (2016) Impact of Abattoir Wastes on the Physicochemical Properties of Soils within Port Harcourt Metropolis. *International Journal of Engineering Science* 5: 17-21.

[12] Aransiola SA, Ijah UJJ, and Abioye OP (2013). Phytoremediation of Lead Polluted Soil by Glycine max L. *Applied and Environmental Soil Science*, 10:1155, 631619.

[13] Amos-Tautua. B. M. W, Onigbinde. A. O and Ere. D (2014) Assessment of some Heavy Metalsand Physicochemical Properties in Surface Soils of Municipal Open Waste Dumpsite in Yenagoa, Nigeria. *African Journal of Environmental Science Technology* 8: 41-47.

[14] Kong X. B, Dao T. H, Qin J, Qin H, Zhang F(2009) Effects of Soil Texture and Land Use Interactions on Organic Carbon in Soils in North China Cities' Urban Fringe. Geoderma 154: 86-92.

[15] Ubwa, S. T., Atoo, G. H., Offem, J. O., Abah, J. and Asemave, K. (2013). Effect of Activities at the Gboko Abattoir on some Physical Properties and Heavy mMetals Levels of Surrounding Soil. *International Journal ofChemistry*, 5(1): 49 – 57.

[16] Alekseenko, V., and Alekseenko, A. (2014). The Abundances of Chemical Elements in Urban Soils. *Journal of Geochemical Exploration 147: 245 – 249.*

[17] Rayment, G. E and Higginson, F. R. (1992). Electrical Conductivity. In 'Australian Laboratory Handbook of Soil and Water Chemical Methods' Inkata Press: Melbourne.

[18] Dara, S. S. (1993). A Textbook of Environmental Chemistry and Pollution Control. *Schand and Company Limited*. Newa Delhi. 167-223.

[19] World Health Organization. (2011) Training Package for the Health Sector: Adverse Health Effects of Heavy Metals in Children. World Health Organization. Retrieve from http://www.who.int/ceh/capacity/heavy_metals.pdf.

[20] Njoku, C., Agwu P. N., Uguru, B. N., and Agwu, J. O. (2017). Physioco-chemical Properties of Erosion Site in AbakalikiSoutheastern Nigeria. I*OSR Journal of Environmental Science, Toxicology and Food Technology* 11 (7): 69 – 72.