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Assessment of the effect of abattoir effluent on soil properties cultivated with flint maize

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ABSTRACT

The assessment of abattoir effluent on the physicochemical and microbiological properties of the soil cultivated with flint maize was conducted in the Teaching and Research Farm of Ambrose Alli University, Ekpoma. The experiment was a randomized complete block design (RCBD) with five levels of abattoir effluent (0, 32 x 10^3, 64 x 10^3, 96 x 10^3, 128 x 10^3L/ha) and each was replicated three times. The effluent was collected and analyzed for its chemical properties, the number and types of bacteria and fungi before and at the end of the experiment. Soil samples were collected before planting and at the end of the experiment and analyzed for physicochemical properties as well as the number and types of bacteria and fungi. Maize variety; Samma – 38 was used as a test crop. Results showed that more bacteria and fungi counts were found in the abattoir effluent than in the soil. At 15 weeks after application, the plot treated with 64 x 10^3 L/ha of abattoir effluent had more bacteria isolated and the least bacteria count. The plot that received the 32 x 10^3L/ha had the least fungi count. The soil was slightly acidic except for the strongly acidic control. The soil after the applications of abattoir effluent was high in organic matter. Abattoir effluent increased the total N, K, Mg, and Ca with the highest recorded at the applications of 96 x 10^3L/ha and 128 x 10^3L/ha. Organisms such as *Penicillium and Aspergillus spp* were isolated, and these enhanced nitrogen and phosphorous fixation, thereby increasing soil fertility for suitable crop production.

1.0 Introduction

Abattoir or slaughterhouse is a facility where animals are killed and prepared fresh for traders and consumers to buy for various types of food products (Eze*et al.,* 2013). The abattoir industry is an essential component of the livestock industry in Nigeria, providing domestic meat supplies to over 150 million people (Nebo*het al.,* 2013) and it's usually associated with some pollution problems (Hinton *et al.*, 2000). They pollute the environment either directly or indirectly from their various processes, if not handled properly (Kosamu*et al.,* 2011). Wastewater from an abattoir is a concentrated source of oxygen-consuming waste (Girards, 2005) containing high levels of organic matter due to the presence of faeces, blood, fats, grease, hair, grit, and undigested feeds. It can also contain a high level of salts, phosphate, and nitrates. In ruminant animals, the excreta contains undigested feed, mostly cellulose-fiber, undigested protein, excess nitrogen from digested protein, residues from digested fluids, waste minerals, worn-out cells from intestinal linings, mucus, bacteria, and foreign matter such as dirt consumed, calcium (Ca), magnesium (Mg), iron (Fe), phosphorus (P), sodium (Na) *et cetera* (Robinson *et al.*, 1971). These could increase the levels of nitrogen (N), phosphorus (P), and total solids in receiving environments considerably (Omole and Longe, 2008) or introduce certain elements such as iron (Fe), lead (Pb), zinc (Zn), and calcium (Ca) present in minute quantity, and make them the leading chemicals, thus, altering the physicochemical nature of the soil (Tortora *et al.*, 2007). Some of these chemicals may be toxic to the microbial, floral, and faunal communities of the soil (Rabah*et al.*, 2010).

The resultant consequences could be the degradation of soil fertility due to the accumulation of certain nutrients

and heavy metals that may lead to low productivity in the surrounding farmlands, in addition to the damages and destruction of aquatic lives (Rabah*et al.*, 2010).

In Nigeria, many abattoirs dispose of their effluents directly into streams and rivers without any form of treatment, and the slaughtered meat is washed by the same water (Adelegan, 2002). The inventory of urban and industrial wastes in Nigeria as compiled by Sridar (2006) showed that millions of tons of industrial, domestic, and animal wastes are produced annually in the country, and these wastes can be utilized effectively for agriculture.

Abattoir effluent is the residual material obtained from the abattoir after the slaughter of animals like cattle, sheep, goats, etc. The effluent comprises materials like the blood, urine, faeces, water, etc., of such slaughtered animals (Osemwota, 2010). Masse and Masse (2000) reported that abattoir effluent is high in organic content, biological nutrient, adequate alkalinity, and free toxic materials.

Effluent application at high rates causes retardation in the nitrification process, a massive accumulation of salts in soils, partial sterilization of soil microbes, and loss of nitrogen through leaching, volatilization and denitrification, and low recovery of added nitrogen (Osemwota, 2010).

Crops like maize grow very rapidly in soils rich in organic matter. Flint maize (*Zea mays* indurata) is also known as Indian corn in most countries. The flint maize is yellowish with less soft starch than dent (Lincoln, 2009). Flint corn is also the type of corn preferred for making hominy, a staple food in the Americas since pre-Columbian times.

The flint corn cultivars that have large proportions of kernels with hues outside the yellow range are primarily used ornamentally by Euro-Americans, notably as part of Thanksgiving decorations in the United States. They are often called either "ornamental corn" or "Indian corn". These varieties can be popped and eaten like popcorn.

Abhanzioya (2013) observed that abattoir effluent could be a good source of nutrients for maize growth as well as other crops. The application of abattoir effluent to soils has significant effects on soil microorganisms and soil physicochemical properties (Ogboghodo *et al*., 2001). Osemwota (2010) investigated the effects of abattoir effluent on soil physicochemical properties and reported that abattoir effluent increased soil pH, available P and Zn, Mn and Fe significantly, but observed that exchangeable cations were reduced significantly compared to the control.

Akinnibosun and Ayejuyoni (2015) determined the effects of abattoir effluent on the microbiological and physicochemical characteristics of the soil. They reported that the microorganisms isolated from the contaminated soil were *Escherichia coli, Pseudomonas aeruginosa, Bacillus sp, Staphylococcus epidermidis, Staphylococcus aureus, Alcaligenessp, Klebsiellasp, Aspergillus flavus, Aspergillus niger, Penicillium sp, Geotrichumsp, and Mucor sp.* The microbial counts were higher in the contaminated samples than in the control, having 2.35 x 104 ± 0.1 cfu/g, 1.15 x 102 ± 0.1 cfu/g and 1.25 x 103 ± 0.1 cfu/g for bacteria, coliform and fungal counts, respectively. (*Aspergillus and Penicillium*) species.

However, actual knowledge of the soil properties is not sufficient for making predictions involved in the use of abattoir effluent in agriculture. Hence, the objective of this study was to determine the effects of abattoir effluent on; growth parameters, soil physical and chemical properties; types and number of bacteria and fungi in the soil.

2.0 Materials and methods

This experiment was carried out in the Teaching and Research Farm of Ambrose Alli University, Emaudo Annex, Ekpoma.

Abattoir effluent that was used for the experiment was collected from the slaughterhouse along Benin/Auchi Road, Ekpoma. The maize used in planting was obtained from the International Institute of Tropical Agriculture (IITA), Ibadan.

2.1 Field Experiment

The experimental site measuring 12.25 m x 10.75 m was cleared, packed, and marked into plot sizes of 1.25 m x 2.25 m. The experiment was a randomized complete block design (RCBD) with five treatments, and each was replicated three times. Abattoir effluent levels (0, $32x10^3$, $64x10^3$, $96x10^3$, $128x10^3$ L/ha) were applied to the plots and allowed to equilibrate for two weeks before planting. Maize variety (Sammaz- 38) was used as a test crop and planted at a spacing of 25 cm x 75 cm. Three seeds were planted per hole and later thinned to one per stand at two weeks after planting. Manual weeding with the aid of cutlass and hoe was carried out. Growth parameters determined include plant height, stem girth, leaf area, and number of leaves at 2, 6, and 10 weeks after planting.

2.2 Soil Sample Collection and Analysis

Soil analysis was carried out in the Agronomy laboratory of Ambrose Alli University, Main campus, Ekpoma, and Dollybee laboratory, Ibadan. Soil samples were taken at a depth of 0-15 cm randomly from 12 points before the application of abattoir effluent and bulked together to form a composite sample. This was taken to the laboratory for physicochemical and microbiological analyses before planting. At the end of the experiment (15 WAP), soil samples were also collected from each plot with an auger and taken to the laboratory for physicochemical and microbiological analysis.

The samples were air-dried at room temperature (25^{o}C) then, sieved with a 2.0 mm mesh sieve. Particle size distribution was determined by the hydrometer method (Okalabo*et al.,* 2002), soil pH was measured in a 1:1 (soil: water) by glass electrode pH meter (MaClean, 1982), organic carbon was done by wet dichromate acid oxidation method (Nelson and Sommers, 1996). Total nitrogen was determined by the micro Kjeldahl method (Bremner, 1982). Available phosphorus was extracted with Bray II solution and determined by the molybdenum blue method on the Technicon auto-analyzer as modified by Olsen and Sommers (1992), Al^{3+} and H^+wereextracted with 1N KCl (Thomas, 1982), Ca, Mg, Na and K were extracted with 1N NH4OAC pH 7.0 (Ammonium acetate). Potassium and sodium were determined with flame emission photometer, while calcium and magnesium were determined with automatic adsorption spectrophotometer (Anderson and Ingram, 1993). CEC was calculated by the summation of exchangeable bases and exchangeable acidity (Anderson and Ingram, 1993).

2.3 Determination of Bacteria and Fungi Populations

The bacteria and fungi populations of the samples were determined using the pour plate method of serially diluted samples and the direct plate method (Cheesebrough, 2006).

2.4 Biochemical Test for Identification of Isolates

Observed colonies were subjected to several biochemical tests to identify the specific microorganisms present in the samples. These tests include gram stain, starch hydrolysis, catalase, oxidase, casein hydrolysis, gelatin hydrolysis, methyl reduction, Voges Proskauer, nitrate reduction, motility, indole, citrate, and sugar fermentation.

2.5 Isolation of Fungi

This was determined using the standard methods of Robert *et al*. (2004) and Cheese brough (2006). In identifying fungi, microscopic and macroscopic examinations were carried out on fungal isolates as well as wet mount, and confirmation were made using Atlas of Mycology (Robert *et al.,* 2004).

3.0 Results and Discussion

The result of the soil analysis carried out before the commencement of the experiment is presented in Table 1. The result of the soil analysis showed that the soil texture was loamy sand. The soil was slightly acidic (pH 5.8). Based on the established critical level of 1% for organic carbon, 3% for organic matter, 0.15% for Total N, 0.20cmol/kg for K, 2.0 cmol/kg for exchangeable Ca, and 0.26 cmol/kg for exchangeable Mg as recommended by Adebusuyi (1985), Sobulo and Osiname (1987), the soil at the beginning of the experiment was deficient in organic carbon (8.6 g/kg) and organic matter (14.8 g/kg) and adequate in total N (3.78 g/kg), K (0.23 cmol/kg) and Mg (0.71 cmol/kg) and deficient in Ca (1.37 cmol/kg).

Table 1. Physical and chemical properties of the soil used for the experiment before abattoir application.

Parameter	Value
pH	5.8
Organic Carbon (g/kg)	8.6
Organic Matter (g/kg)	14.8
Total Nitrogen (g/kg)	3.78
Available P (mg/L)	3.34
Exchangeable cations (cmol/kg)	
Ca^{2+}	1.37
Mg^{2+}	0.71
K^{+}	0.23
Na^{+}	2.05
H^{+}	1.27
Al^{3+}	0.13
EA	1.40
CEC	4.36
ECEC	5.76
Particle size (g/kg)	
Clay	140.00
Silt	10.00
Sand	850.00
Textural Class	Loamy Sand

Table 2. Chemical properties of the effluent used for the experiment.

Parameter	Value
pH	7.85
Nitrogen (mg/L)	2.70
Available P (mg/L)	550.00
Exchangeable cations (mg/L)	
Ca^{2+}	130.00
Mg^{2+}	20.00
K^{+}	140.00
Na^{+}	13.75
Available micronutrient and heavy metals (mg/L)	
Mn	54.00
Fe	1.83
Zn	23.20
Cu	6.75
Pb	2.70
Ni	3.45
Cr	0.65
Cd	0.50
Co	0.95

The chemical properties of the effluent are shown in Table 2. The pH of the abattoir effluent was slightly alkaline. The heavy metal concentrations in the abattoir effluent were within the permissible ranges, given by the European Community Regulation (Lacatusu *et al.,* 2011).

Table 3 shows the bacteria and fungi populations that were present in the effluent and soil before application of abattoir effluent. It was observed that more organisms were found in the effluent before it was applied to the soil. Fewer fungi but more bacteria were found in the effluent. This finding is in agreement with Abhanzioya (2016), who reported that more organisms were found in the effluent before it was applied to the soil. At 15 weeks after application of abattoir effluent to the soil (Table 4), it was observed that the plots treated with $96x10^3$ L/ha of abattoir

effluent had more bacteria isolates (coliform) compared to $128x10^3$ L/ha and other treatments. The least bacteria count was observed in plots treated with $64x10^3$ L/ha while $32x10^3$ L/ha had the least fungi count. This finding was not in agreement with the report of Abhanzioya, (2016) who observed that the number of the different mi-

Table 3. Bacteria and fungi populations/identification on effluent and soil before application of abattoir effluent

Sample	Bacteria Identification	Bacteria Counts (Cfu/ml)	Fungi Identification	Fungal Counts (Cfu/ml)
Abattoir	Bacillus spp Pseudomonas spp AeromonassppEnterobacterspp Proteus spp	10.9×10^5	Penicillumspp Aspergillus spp Mucorspp	1.2×10^4
Soil	Bacillus spp Pseudomonas spp AeromonassppEnterobacterspp	9.2×10^4	Penicillumspp Aspergillus spp Mucorspp	1.0×10^4

Table 4. Effects of abattoir effluent (ABAE) on bacteria, coliform, and fungi population/identification at 15 weeks after application

Treatment (L/ha)	Bacteria Identification	Bacteria Counts (Cfu/g)	Fungi Identification	Fungal Counts (Cfu/g)
ABAE 0	Bacillus spp Pseudomonas spp AeromonasspEnterobacterspp Klebsiella Proteus spp	7.3×10^4	PenicillumsppGeotricu-imspp Aspergillus spp Mucorspp	3.5×10^4
32×10^3	Bacillus spp Pseudomonas spp Flavobacteriumspp Aeromonasspp Proteus spp	5.3×10^4	PenicillumsppGeotricu-imspp Aspergillus spp Mucorspp	1.1×10^4
64×10^3	Bacillus spp Pseudomonas spp Flavobacteriumspp AeromonasspEnterobacterspp E. coli spp	5.0×10^4	PenicillumsppGeotricu-imspp Aspergillus spp Mucorspp	2.6×10^4
96×10^3	Bacillus spp Pseudomonas spp Flavobacteriumspp AeromonassppEnterobacterspp E. coli spp Proteus spp	5.1×10^4	PenicillumsppGeotricu-imspp Aspergillus spp Mucorspp	1.6×10^4
128×10^3	Bacillus spp Pseudomonas spp Enterobacterspp Proteus spp	7.0×10^4	Penicillumspp Aspergillus spp Mucorspp	1.3×10^4

Table 5. Effects of abattoir effluent (ABAE) on soil properties after application

Treatment (L/ha)	pH	Organic Carbon g/kg	Organic Matter g/kg	N g/ kg	Na^{+}	K^{+}	Ca^{2+}	Mg^{2+}	EA	Al^{3+}	H^{+}	CEC	ECEC	Available P	Sand	Clay	Silt	Texture
ABAE						Cmol/kg								Mg/L	g/kg			
0	5.3	12.4	21.3	2.0	1.86	0.11	1.91	1.00	1.50	0.12	1.38	4.83	6.38	3.71	840	150	10	Sandy Loam
32 x 10^3	5.7	10.2	17.5	3.5	1.93	0.16	1.58	0.83	1.00	0.06	0.94	4.50	5.50	3.65	860	130	10	Loamy Sand
64 x 10^3	5.7	11.4	19.6	3.2	1.98	0.39	1.91	1.00	2.10	0.13	1.97	5.28	7.38	3.52	840	140	20	Sandy Loam
96 x 10^3	5.8	11.6	20.0	2.2	2.00	0.27	2.46	1.29	1.20	0.08	1.12	6.01	7.21	4.21	820	170	10	Sandy Loam
128 x 10^3	5.7	11.0	18.9	2.8	2.05	0.41	1.91	1.00	0.80	0.04	0.76	5.37	6.17	22.17	830	160	10	Sandy Loam

croorganisms increased as the levels of application of abattoir effluent to soil increased.

The effect of abattoir effluent on soil physical and chemical properties after the application is presented in Table 5. The result of the soil analysis showed that the texture of soil was sandy loam for 0 L/ha, $64x10^3$ L/ha, $96x10^3$ L/ha, and $128x10^3$ L/ha of effluent applied while it was loamy sand for $32x10^3$ L/ha of effluent applied. The soil pH were slightly acidic (pH 5.7 - 5.8) at the application of $32x10^3$ L/ha, $64x10^3$ L/ha, $96x10^3$ L/ha and $128x10^3$ L/ha.

Based on the established critical level of 1% for organic carbon, 3% for organic matter, 0.15% for total N, 0.20 cmol/kg for K, 2.0 cmol/kg for exchangeable Ca, and 0.26 cmol/kg for exchangeable Mg recommended by Adebusuyi (1985), Sobulo and Osiname (1987), the soils after the application of abattoir effluent were high in organic carbon when compared to the critical level of 1% and low organic matter when compared to the critical level of 3%. Although the organic matter content of the soils treated with abattoir effluent was low when compared with the initial soil before application of abattoir effluent, there was an increase in the organic matter content. Abattoir effluent increased the OC, total N, and P.This result corroborates with Osemwota, (2010). K, Mg, and Ca of the soil also increased with the highest recorded at the application of $96x10^3$ L/ha and $128x10^3$ L/ha.

The effect of abattoir effluent on mean vegetative traits of maize at 2, 6, and 10weeks after planting are shown in Tables 6. At 2WAP, abattoir effluent had significant effects on plant height, leaf area, and the number of leaves. Application of $96x10^3$ L/ha had the highest plant height of 7.43 and leaf area of 77.23cm^2 and also highest stem girth of 2.20 though there was no significant increase. In contrast, the application of $32x10^3$L/ha had the highest number of leaves of 5.00.

At 6weeks, after planting (Table 6), abattoir effluent had significant effects on all the growth parameters when compared with control. Application of $96x10^3$ L/ha had the highest plant height of 39.00cm, leaf area of 467.4cm^2, stem girth of 6.73. Application of $32x10^3$L/ha and $64x10^3$L/ha had the highest number of leaves of 6.67. At 10 WAP, abattoir effluent significantly increased stem girth. The application of

Table 6: Effects of abattoir effluent on (ABAE) mean vegetative traits at 2, 6, and 10 weeks after planting (WAP)

Treatment ABAE(L/ha)	Plant Height (cm)			Stem Girth (cm)			Number of Leaves/plant			Leaf Area (cm^2)		
	2	6	10	2	6	10	2	6	10	2	6	10
0	3.87b	21.00c	95.50	1.53	3.87c	4.33b	4.00b	5.00b	6.00	38.60b	161.90c	281.60
$32x10^3$	6.00ab	25.43bc	109.60	1.77	4.53bc	4.87b	5.00a	6.67a	7.33	48.29ab	223.1bc	369.60
$64x10^3$	5.80ab	33.67ab	135.60	1.87	5.67ab	5.77ab	4.67ab	6.67a	6.67	54.67ab	458.7a	525.8
$96x10^3$	7.43a	39.00a	121.10	2.20	6.73a	7.23a	4.67ab	6.33	7.67	77.23a	467.4a	480.4
$128x10^3$	6.83a	29.53bc	124.20	1.93	5.53bc	5.33b	4.33ab	6.00a	8.00	69.31a	381.7ab	480.4
LSD (0.05)	2.65	10.92	NS	NS	1.37	1.79	0.91	0.91	NS	28.29	194.4	NS

NS: Not Significant

Means within the same vertical column followed by the same letters are not significantly different at the 5% level

Table 7. Biochemical Characteristics of Isolates

Isolates	Gram Rx	Cell Morph	Catalase	Oxidase	Casein Hyd	Gelatin Hdy	Methyl Red	VP	Nitrate Redn	Citrate Utiliza	Motility	Indole test	Glucose	Fructose	Maltose	IDENTIFY
A	_	R	+	+	+	+	+	+	_	+	+	_	+	_	_	Pseudomonas fluorescens
B	+	R	+	+	_	_	_	_	+	+	(+)	_	+G	+	+	Enterobacteraerogenes
C	_	R	+	_	+	+	+	+	_	_	+	+	+	+	+	Aeromonashydrophilia
D	+	R	+	+	+	+	_	_	+	+	+	_	+G	+	+	Bacillus megaterium
E	_	R	+	_	_	_	+	+	_	_	+	+	+	+	+	Escherichia coli
F	+	R	+	+	+	+	+	+	+	D	+	_	+	+	+	Bacillus cereus
G	+	R	+	+	+	+	+	_	+	_	+	_	+G	_	+	Bacillus polymyxa
H	_	R	+	_	+	+	+	+	+	+	+	_	+G	+	_	Proteus mirabilis
I	_	R	+	_	+	+	_	_	_	+	_	_	+	+	+	Flavobacteriumaquatite
J	+	R	+	+	+	+	_	_	_	+	+	_	+G	_	_	Bacillus substilis
K	+	R	+	+	+	+	_	_	_	_	+	+	+G	_	+	Bacillus alvai
L	+	R	+	+	+	+	+	_	+	+	+	+	+G	+	+	Proteus vulgaris
M	_	+	+	+	_	+	+	_	+	+	+	_	+	_	+	Pseudomonas cepacia
N	+	_	_	_	(+)	_	_	+	+	+G	+	(+)	_	_	+	Bacillus brevis
O	_	R	+	_	+	_	+	+	+	+	+	+	+G	+	_	Proteus morganii
P	_	R	+	+	+	+	_	_	+	_	+	_	+G	_	+	Bacillus licheniformis
Q	_	R	+	_	_	_	+	_	+	+	+	_	+	+	+	Klebsiella pneumonia

$96X10^3$L/ha had the highest stem girth of 7.23cm (Table 6). There were no significant effects in plant height, leaf area, and a number of leaves with the treatment applied. Application of $64x10^3$L/ha had the highest plant height of 135.60cm and leaf area of 525.8cm^2.

In comparison, the application of $128x10^3$L/ha had the highest number of leaves of 8.00. Generally, abattoir effluent has a significant influence on the growth of maize. This finding is in agreement with what was earlier reported by Osemwota*et al.* (2010) and Abhanzioya (2016).

4.0 Summary

This research work was carried out to investigate the effect of abattoir effluent on the soil physical and chemical properties and microbiological properties of a soil cultivated with flint maize. Results showed that more bacteria and fungi count were found in the abattoir affluent than the soil. At 15 weeks after application, the plots treated with $96x10^3$L/ha of abattoir effluent had more bacteria isolate (coliform isolates) compared to $128x10^3$ L/ha which had the least bacteria isolates while the plot that received the $32x10^3$ L/ha had the least fungi count. The bacteria present were *Bacillus spp* and *Pseudomonas spp*, *Enterobacter*spp, and *Proteus spp* while the fungi present were *Penicilliumspp, Aspergillus spp, Geotricuimspp,* and *Mucor spp*. The texture of soil was loamy sand for $32x10^3$ L/ha of effluent applied. The soil pH was slightly acidic (pH 5.7 - 5.8) at the application of $32x10^3$ L/ha, $64x10^3$ L/ha, $96x10^3$ L/ha, and $128x10^3$ L/ha while the control was 5.3 (strongly acidic). The organic matter content of the soils treated with abattoir effluent was low, but when compared with the initial soil before application, an increase in the organic matter content was observed. Abattoir effluent increased the total N, K, Mg, and Ca of the soil with the highest recorded at the application of $96x10^3$ L/ha and $128x10^3$ L/ha.

Conclusively, it was observed that at fifteen (15) weeks after application, organisms such as *Penicillium* and *Aspergillus* were isolated, and these organisms can enhance nitrogen fixation thereby increasing soil fertility for sustainable crop production.

References

Abhanzioya, M.I. (2013). Effects of abattoir effluent on the yield and yield components of maize (*Zea mays*) in forest transitional zone of Edo State, Nigeria. *Nigerian Journal of Soil Science* 26(16): 171-180.

Adebusuyi, B. A. (1985). Soil testing and Nitrogen, Phosphorus requirement for maize in southwestern Nigeria. Ph.D. thesis, Obafemi Awolowo University, Ile-Ife, Nigeria. 225 pp.

Adelegan, J.A. (2002). Environmental policy and slaughterhouse waste in Nigeria. *Proceedings of the 28th WEDC Conference,* November 18 – 22, 2002, Calcutta, India, pp:3-6.

Akinnibosun, F.I., and Ayejuyoni, T.P. (2015). Assessment of Microbial Population and Physico-Chemical Properties of Abattoir Effluent-Contaminated Soils In Benin City, Nigeria. *Journal of Tropical Agriculture, Food, Environment and Extension* 14(3):1-6.

Anderson, J.M., and Ingram, J.S. (1993). Tropical soil biology and fertility. *A handbook of methods*. Information and Press Eynsham.

Bremner, J.M. (1982). Inorganic nitrogen. In: Page, A.L., Miller, R.H. and Keeney, D.R. (eds.) *Methods of Soil Analysis,* Part 2. Second Edition. American Society of Agronomy, Madison, Wisconsin USA.

Cheesebrough, M. (2006). *District Laboratory Practice in tropical countries.* Part 2. Low Price Edition. Cambridge University Press, London pp 79-201.

Eze C. N., Ogbonna, J.C., Anyanwu, C.U., Eze, EA,2013. Determination of the relative abundance and distribution of bacteria and fungi in Bonny light crude oil-contaminated sandy loam soil. *Scientific Research and Essays*8(9), 375-381.

Girards J (2005). Principle of Environment Chemistry, Jones & Bartlett, USA.

Hinton, M.H., G.C. Mead, and Rowlings, C. (2000). Microbiological control in the meat industry. Flair flows Europe technical manual. F-Fe 339A/00. Available from www.exp-ie/flair.html.

Kosamu, I. B. M., J. Mawenda and H. W. T. Mapoma (2011) Water quality changes due to abattoir effluent: A case on Mchesa Stream in Blantyre, Malawi African Journal of Environmental Science and Technology Vol. 5(8), pp. 589-594

Lacatusu, R. Lundu, M., and Teodorescu, S. (2011). Heavy metals abundance in the soil of the PantelinumBranseti area: Fe, Mn, Ni, Pb, and Zn. *Present Environment Sustainable Development* 5 (2): 55-65.

Lincoln, N.E. (2009). Roy's Calais flint corn. University of Nebraska Press 1965. Reprint 1977, pp 4-8 accessed 16 December.

MaClean, E.O., (1982). Soil pH and lime requirement in Black, C.A. (Ed): *Methods in soil analysis, chemical, and microbiological properties* Part II-American Society of Agronomy, Madison, Wisconsin USA pp 927-932.

Masse, D., and Masse, L. (2000). Characterization of water from hog slaughterhouse in Eastern Canada. And evaluation of their plant wastewater treatment system. *Canada Agricultural Engineer* 42 (3): pp 139 -146.

Neboh, H.A., O.A. Ilusanya, C.C. Ezekoye, and Orj, F.A. (2013). Assessment of Ijebu-Igbo abattoir effluent and its impact on the ecology of the receiving soil and river. *Journal of Science, Toxicology and Food Technology*, 7(5): 2319-2402.

Nelson, D.W., and Sommers, L.E. (1996). Total carbon, organic carbon, and organic matter. In: *Methods of Soil Analysis*, Part 2, 2nd ed., A.L. Page et al., Ed. Agronomy. 9:961-1010. America Society of Agronomy, Inc. Madison, Wisconsin.

Ogboghodo, I. A., Osemwota, I. O., Eke, S. O. and Iribhogbe, A.E. (2001). Effect of cassava (*Manihotesculenta*Crantz) mill granting effluent on textural chemical and biological properties of surrounding soils. *World Journal Biotechnology*. (2):292-301.

Olsen, G.J, and Sommers, L.E. (1992). Phosphorus in Page A.L. Miller R.H. and Keeney, D.R. (eds.) *Methods of Soil Analysis,* Part 2. Second Edition. *American Society of Agronomy*, Madison, Wisconsin USA. Pp 402-403.

Okalebo J.R., Gathua K.W., and Woomer P.L., (2002). Laboratory Methods of Soil and Plant Analysis. A Working Manual. 2nd edn. TSBFCIAT, SACRED Africa, KARI, Soil Science Society of East Africa, Nairobi, Kenya, p. 128Omole, DO and Longe, E.O. (2008). An assessment of the impact of abattoir ef-

fluents on river Illo, Ota, Nigeria. *Journal of Environmental Science and Technology,* 1(2): 56-64.

Osewmota, I.O. (2010). Effect of abattoir effluent on the physical and chemical proportion of soils. *Environmental Monitoring Assessment* 67(1-4):399-404.

Rabah, AB, S.B. Oyeleke, SB Manga, L.G. Hassan and Ijah, U.J. (2010). Microbiological and physicochemical assessment of soil contaminated with abattoir effluents in Sokoto metropolis, Nigeria. *Science World Journal*, 5 (3): 1-4.

Robert, A.S.; Ellen, S.H. and Jens, C.F. (2004). Introduction to Food and Airborne Fungi. Seventh Edition, CentraalbureauVoorschimmkultures. *The Netherlands* pp 23-306.

Sobulo, R. A., and Osiname, O. A. (1987). Soil and fertilizer in western Nigeria. Resource Bulletin No. 11, IAR&T, Unife, Ile-Ife. Pp.20-26.

Sridar, M. K. C. (2006). Solid waste management in the twenty-first century in Nigeria. In *Proceedings of the fourth Annual Conference of Senate on the NigerianEnvironment, organized at Port Harcourt by SenateCommittee on Environment and Ecology, National Assembly, July 5–7* (pp. 1–11). Abuja.

Tortora, G.J., B.R. Funke, and Case, CL (2007). *Microbiology: An introduction*. 9th Edn., California: Benjamin/ Cummings Publishing Company Inc.