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EFFECT OF ABATTOIR WASTES ON SELECTED SOIL PROPERTIES IN ABAKALIKI AND EZZAMGBO SOUTHEASTERN NIGERIA

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ABSTRACT
This research was conducted in 2015 and 2016 at Abakaliki and Ezzamgbo Southeasern Nigeria to evaluate the effect of abattoir wastes on soil properties in Abakaliki Southeastern Nigeria. Four replicate auger and core soil samples were collected as follwos: 1m-donkey = 1 m away from donkey abattoir waste dumpsite at Ezzamgbo; 10m-donkey = 10 m away from donkey abattoir waste dumpsite at Ezzamgbo; 1m-cow = 1 m away from cow abattoir waste dumpsite at Abakaliki and 10m-cow = 10 m away from donkey abattoir waste dumpsite at Abakaliki while non-dumpsite at Mile – 4, Ishieke was used as Control. The data obtained was analysed using analysis of variance based on CRD and difference between treatments means were dictated using F-LSD. The result obtained showed significant higher improvement in soil bulk density, total porosity, mean weight diameter, aggregate stability, pH, available P, total N, organic C, exchangeable bases & acidity, effective cation exchange capacity and base saturation in soil near abattoir sites than control. Generally, the order of improvement in soil properties studied was 1m-donkey > 1m-cow > 10m-donkey > 10m-cow. Also, the improvement of soil properties was higher in the second year of the study when compared to the first year of the study. From, the results we can understand that the improvement in soil properties is directly depended on the type of animal slaughter in an abattoir, that is why at distance of 1 m away from abattoir and 10 m away from abattoir, donkey abattoir showed higher improvement in soil properties when compared to cow abattoir.Therefore, the study recommended the use of abattoir wastes as soil amendment to increase soil productivity and as means of waste disposal and nutrient recycle.

Keywords: Abattoir, Butcher, Improvement, Sanitation and Wastes

Introduction

An abattoir is an area/building that houses the butchering of animals (Hornby, 2006). Slaughter house also can be seen as an enclosure certified and endorsed by the law enforcement agencies for sound and proper butchering, inspections, production, preservation and safe guiding of the animal products for marketing (Alorge, 1992). The main events carried in the operations of a slaughter house are intake and keeping of animal; killing and preserving of carcass; freezing of animal products; wastes treatment and transportation of processed substances. Nearly all abattoir houses in Nigeria are sources of wastes that need to be properly disposed to abate the menace these wastes poses to the environment (Adesemoye et al., 2006). These wastes generated may be beneficial or pose a threat in soil when discharged into the soil medium. Butchering of animals in Nigeria is done in inappropriate vicinities and by unskilled staff without the knowledge of the sanitary regulations (Olanike, 2002). Slaughter events are targeted at improving the regeneration of portable parts of the meat processing cycle for human intake. Also, much amount of tertiary wastes contents; fluid, fatty contents, decomposed and undecomposed materials, solids, salty contents with chemical materials were likely to be generated at the course of the cycle (Red Meat Abattoir Association, 2010). The livestock dung is made up of rejected food materials, basically decomposed and undecomposed material contents; unwanted materials and some chemical components such as potassium, zinc, calcium and manganese etc (Ezeoha et al., 2011). The characteristics of abattoir waste and effluent discharge varies based on the amount, forms of supply executed and the mechanism adopted (Tove, 1985). However, abattoir waste generation are made up of hard and soft rejected materials from the butchered animals (Sangodoyin et al., 1992). Moreover, those unwanted materials from slaughter houses are of solidifying, water and fatty origins. They are full of organic materials. The non-liquid wastes are strong meat, bones, animal tissues and removed intestines. The waste water contains diluted materials, blood, belly, urinary make-ups and water (Bull et al., 1982). The unsatisfactory conditions in which in wastes are collected and disposed off contribute to environmental degradation in Abakaliki, Ebonyi State Nigeria. Waste disposal and poor management have been the major cause of environmental degradation, pollution and natural resources depletion with adverse social and health consequences on Nigerian urban environment (Madu, 2001). According to Omaka (2004) the presence of pollutant threatens natural systems (land, water, air, plants and animals). Soil is one of earth's essential natural resources, yet they are often taken for granted (Njoku et al., 2017). Soil productivity of tropical soils is hindered by soil fertility constraints and deteriorating nutrient status (Olatun and Ayuba, 2011; Njoku et al., 2015a). Many interrelated factors, both natural and managerial cause soil fertility decline. This decline in soil fertility may occur through leaching, crop removal and soil erosion (Donovan and Casey, 1998). Unless these lost nutrients are replenished through the use of organic or mineral fertilisers, or partially through crop residues, or through traditional fallow system that allows restoration of nutrients and reconstruction of organic matter, soil nutrients will decline continuously (Mbah and Onweremadu (2009). Njoku et al. (2011) showed the beneficial effect of organic wastes in improving soil properties. Land application of organic wastes such as animal wastes, sewage sludge and municipal solid wastes is an excellent way of recycling both the nutrients and the organic matter contained in them (Shima et al., 2010). Also, the addition of wastes to soil can improve the soil fertility by acting directly on its physical and chemical properties thereby increasing the activities of microbial biomass, improve soil structure, moisture content and aggregate stability (Costas et al., 1991).Therefore, the main objective of this research was to evaluate the effect of abattoir wastes on selected soil properties in Abakaliki Southeastern Nigeria.

Materials and Methods

Study area

The study was carried out in Abakaliki and Ezzamgbo of Ebonyi State, South Eastern Nigeria. The area lies approximately between latitude 06^0 $14'$ and 06^0 $30'$ N with longitude 08^0 $0'$ and 08^0 $15'$ E. The rainfall pattern is bimodal (April to July and September to November), with a quick dry spell in August normally referred to as "August Break". It has annual rainfall of 1700 to 2000mm and annual mean of 1800mm. Abakaliki and Ezzamgbo have high temperature of 27ºC and the topmost mean daily temperature of 31ºC that is within the year. Humidity is high (80%) during rainy season and low (60%) during dry season. Geologically, the research site is sedimentary rock which is obtained from straight seawater retainer of the cretaceous periods and quaternary periods. As stated by Federal Department of Agriculture and Land Resources (1987), agricultural zone of areas remains within 'Asu River group' and made up of olive brown sandy shale, small particles of mudstones and sandstone. The soil is not very deep with unconsolidated parent substances within 1 m of the sand uppermost layer.

Field method

A reconnaissance survey of the study area was carried out and the following sampling locations were selected:

Control – Non-dumpsite at Mile-4

1m-donkey = 1m away from donkey abattoir wastes dumpsite at Ezzamgbo

10m-donkey = 10 m away from donkey abattoir wastes dumpsite at Ezzamgbo

1m-cow = 1 m away from donkey abattoir wastes dumpsite at Abakaliki

10m-cow = 10 m away from donkey abattoir wastes dumpsite at Abakaliki

Soil sampling and analysis

Soil samples were collected at the depths of 0 – 20 cm using soil auger in January, April, July and October of 2015 and 2016. Also undisturbed core soil samples were also collected using a core of 167.28cm^3 in January, April, July and October of 2015 and 2016 study years. Thus, the total auger and core soil samples collected for each location per a year were four replicate auger and four replicate core soil samples, respectively. These soil samples were taken to laboratory for analyses immediately after collection.

Laboratory determination of physical properties of the soil

The following soil physical properties were determined:

Bulk density: The bulk density was determined using the method described by Landon (1991).

Total porosity: Total porosity was determined as describe by Obi (2000).

Aggregate stability: Aggregate stability was determined by the wet technique for Kemper and Rosenau (1986).

Mean weight diameter: This was calculated thus;

Mean weight diameter (MWD) =

$$\sum_{I=1}^{n} XiWi$$

where;

MWD = mean weight diameter (mm)

Xi = mean diameter of each size fraction (mm)

Wi = proportion of all the sample weight

Laboratory determination of chemical properties of the soil

Soil pH: Soil pH was determined by using a suspension of soil and distilled water in the ratio of 2:5 – soil: water (Mclean, 1982).

Organic carbon: This was determined by the method of Olsen and Sommers (1982).

Total nitrogen: Total nitrogen was determined using modified kjeldahl digestion procedure (Bremmer and Mulvaey 1982).

Available phosphorous: Available phosphorous was determined by Bray 11 method (Olsen and Sommers 1982).

Exchangeable bases: Exchangeable base was determined using Chapman method (Chapman, 1982).

Exchangeable acidity: Exchangeable base was determined by the titration method (Jou, 1979).

Effective cation exchangeable capacity: This was determined by the summation and calculation (Njoku and Mbah, 2012).

Base saturation: Base saturation was calculated as follows: TEB/ECEC $\times$ 100,

Where;

TEB = Total exchangeable bases,

ECEC = Effective Cation Exchangeable Capacity.

Data Analysis

The data obtained from this research was analysed using analysis of variance (ANOVA) based on CRD and difference between treatment means were dictated using F-LSD at P=0.05 according to the method described by SAS Institute Inc. (1999).

Results and Discussion

Effect of abattoir wastes on soil physical properties

Table 1 shows the effect of abattoir wastes on selected physical properties of the soil studied. Bulk density, total porosity, aggregate stability and mean weight diameter showed significant ($p < 0.05$) differences among different locations studied. The highest bulk density values of 1.34 gcm^3 and 1.27 gcm^3 were observed in control in the first and second two years of the study, respectively. On the other hand, the bulk density of soil near abattoir wastes ranged between 1.19 – 1.02 gcm^3 and 1.09 – 0.92 gcm^3 in the first and second years, respectively. The order of increase in total porosity in first and second year was Control < 1m-donkey < 10m-donkey < 1m-cow < 10m-cow . The lowest mean weight diameter of 1.36% was observed in control in the first year. This observed mean weight diameter in control was lower than the mean weight diameter in 1m-donkey, 10m-donkey, 1m-cow and 10m-cow by 63, 65, 100 and 89%, respectively. The order of increase in mean weight diameter in the first year was 10m-donkey < control < 1m-donkey < 10m-cow < 1m-cow. The lowest aggregate stability values of 18.07 and 25.12% were recorded in control in both first and second year of studied, respectively. Also, the aggregate stability in soils near abattoir sites ranged 30.62 – 38.71% and 35.99 – 56.74% in first and second years, respectively.

Table 1: Effect of Abattoir Wastes on Bulk Density (BD), Total Porosity (TP), Mean Weight Diameter (MWD) and Aggregate Stability (AS)

Location		BD (gcm^{-3})		TP (%)		MWD (%)		AS (%)	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
Control		1.34	1.27	48.85	52.08	1.36	1.34	18.07	25.12
1m-donkey		1.19	1.09	55.09	58.87	2.21	1.48	38.71	42.66
10m-donkey		1.13	0.96	57.35	63.77	2.24	1.31	30.42	35.99
1m-cow		1.10	0.94	58.49	64.53	2.72	2.38	28.42	56.74
10m-cow		1.02	0.92	61.51	65.28	2.57	2.36	30.62	54.43
F-LSD	($P < 0.05$)	0.12	0.02	13.51	3.68	0.10	0.02	9.59	0.34

Note: Control; 1m-donkey = 1 m away from donkey abattoir waste dumpsite at Ezzamgbo; 10m-donkey = 10 m away from donkey abattoir waste dumpsite at Ezzamgbo abattoir; 1m-cow = 1m away from cow abattoir waste dumpsite at Abakaliki; 10m-cow = 10 m away from cow abattoir waste dumpsite at Abakaliki; 1st = 1st year and 2nd = 2nd year.

Effect of abattoir wastes on soil chemical properties

Effect of abattoir wastes on soil pH, phosphorus, total nitrogen, organic carbon, C/N ratio showed significant ($p < 0.05$) changes in the different locations studied (Table 2). The order of increase in soil pH in first and second year was control < 1m-donkey < 10m-donkey < 10m-cow < 1m-cow abattoir. Control recorded the lowest available P value of 20.72 $mgkg^{-1}$ in the first year of study. This observed available P in control was lower than available P in 1m-donkey, 10m-donkey, 1m-cow and 10m-cow by 308, 52, 290 and 211%, respectively. On the second year of study, control also recorded the lowest available P value of 28.90 $mgkg^{-1}$ while available P in soils near abattoir wastes ranged between 35.30 – 44.56 $mgkg^{-1}$. The orders of increase of total N in the first and second years of study were control < 10m-cow < 1m-cow < 10m-donkey < 1m-donkey and control < 10m-cow < 10m-donkey < 1m-donkey < 1m-cow, respectively. In first year of study, control had lowest organic C value of 1.10% was while organic C in soils near abattoir wastes ranged between 2.19 – 3.19%. Similarly, in the second year of the study control recorded lowest organic C of 1.2% whereas organic C in soils near abattoir wastes ranged between 2.36 – 3.70%. The orders of increase in C/N ratio in first and second years were 10m-donkey < 1m-donkey < control < 10m-cow abattoir < 1m-cow and 1m-donkey < 10m-donkey < control < 1m-cow < 10 m-cow, respectively.

Table 3 shows the effect of abattoir waste on soil exchangeable bases. There was a significant ($P < 0.05$) change in Ca, Mg, K and Na among the different locations studied. In the first and second years of study control recorded the lowest Ca value of 2.80 $cmol_{(+)}kg^{-1}$ and 3.60 $cmol_{(+)}kg^{-1}$ while Ca in soils near abattoir wastes ranged 3.20 – 8.00 $cmol_{(+)}kg^{-1}$ and 4.00 and 5.60 $cmol_{(+)}kg^{-1}$, respectively. The order of increase of Mg in the first year of study was control < 10m-donkey < 1m-donkey < 1m-cow < 1m-cow whereas the order of increase in the second year of study was control < 10m-cow < 1m-cow < 1m-donkey < 10m-donkey. The lowest K value of 0.02 $cmol_{(+)}kg^{-1}$ was observed in control in the first year of study. This observed K in control was higher than K in soil near to abattoir wastes by 29, 100, 14 and 114%, respectively. Similarly, control had the lowest K of 0.08 $cmol_{(+)}kg^{-1}$ in second year of study while K in the soils near abattoir wastes ranged between 0.16 – 0.20 $cmol_{(+)}kg^{-1}$. The order of increase of Mg in the first year of study was control < 1m-cow < 1m-donkey = 10m-cow < 10m-donkey whereas that of second year of study was control < 10m-cow < 1m-cow < 10m-donkey < 1m-donkey.

Table 4 shows significant ($P < 0.05$) changes in TEB, EA, ECEC and BS among the different locations studied. The order of increase in TEB for the two years of the study was control < 1m-donkey < 10m-donkey < 10m-cow < 1m-cow and control < 10m-cow < 1m-donkey < 1m-cow < 10m-donkey for first and second years of study, respectively. The highest EA value of 2.96 $cmol_{(+)}kg^{-1}$ was observed in B in the first year of study. This observed EA in B was higher than EA in control, 10m-donkey, 1m-cow and 10m-cow by 38, 16, 640 and 1750%, respectively. On the other hand, the control recorded the lowest EA value of 0.23 $cmol_{(+)}kg^{-1}$ in the second year of study. This observed EA in control was lower than EA in 1m-donkey, 10m-donkey, 1m-cow, 10m-cow by 283, 248, 109 and 196%, respectively. Control had the lowest ECEC value of 6.75 $cmol_{(+)}kg^{-1}$ and 5.72 $cmol_{(+)}kg^{-1}$ while ECEC in the soils near abattoir wastes ranged between 8.98 – 13.22 $cmol_{(+)}kg^{-1}$ and 7.43 – 9.63 $cmol_{(+)}kg^{-1}$ for first and second years of study. The order of increase in BS in the first year of study was 1m-donkey < control < 10m-donkey < 1m-cow < 10m-cow while the order of BS increase in the second year of study was 1m-donkey < 10m-cow < 10m-donkey < 1m-cow < control.

Table 2: Effect of Abattoir Wastes on Soil pH, Available Phosphorus ($Mgkg^{-1}$), Total Nitrogen (%), Organic Carbon (%) and C/N Ratio

Location	pH		Available P		Total N		Organic C		C/N Ratio	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Control	4.80	5.20	20.72	28.90	0.11	0.10	1.10	1.20	10.00	12.00
1m-donkey	5.40	5.80	84.60	35.30	0.30	0.24	2.62	2.67	8.73	11.13
10m-donkey	5.80	6.90	31.50	38.60	0.28	0.21	2.24	2.36	8.00	11.23
1m-cow	6.20	7.10	80.90	44.50	0.21	0.28	3.19	3.70	15.19	13.21
10m-cow	6.00	7.00	64.50	43.70	0.18	0.19	2.19	3.19	12.16	16.78
F-LSD (P < 0.05)	0.06	0.52	20.14	0.91	0.20	0.03	0.21	0.14	1.54	3.63

Note: Control; 1m-donkey = 1 m away from donkey abattoir waste dumpsite at Ezzamgbo; 10m-donkey = 10 m away from donkey abattoir waste dumpsite at Ezzamgbo abattoir; 1m-cow = 1m away from cow abattoir waste dumpsite at Abakaliki; 10m-cow = 10 m away from cow abattoir waste dumpsite at Abakaliki; 1st = 1st year and 2nd = 2nd year.

Table 3: Effect of Abattoir Wastes on Soil Exchangeable Bases ($cmol_{(+)}kg^{-1}$)

Location		Ca		Mg		K		Na	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
Control		2.80	3.60	1.60	1.70	0.07	0.08	0.14	0.11
1m-donkey		3.20	4.00	2.40	2.60	0.09	0.20	0.33	0.31
10m-donkey		4.10	5.60	2.00	2.80	0.14	0.19	0.40	0.24
1m-cow		8.00	4.80	4.40	2.40	0.08	0.17	0.30	0.23
10m-cow		7.60	4.40	4.00	2.00	0.15	0.16	0.33	0.19
F-LSD	(P < 0.05)	0.63	0.55	0.31	0.21	0.01	0.06	0.08	0.03

Note: Control; 1m-donkey = 1 m away from donkey abattoir waste dumpsite at Ezzamgbo; 10m-donkey = 10 m away from donkey abattoir waste dumpsite at Ezzamgbo abattoir; 1m-cow = 1m away from cow abattoir waste dumpsite at Abakaliki; 10m-cow = 10 m away from cow abattoir waste dumpsite at Abakaliki; 1st = 1st year and 2nd = 2nd year.

Table 4: Effect of Abattoir Wastes on Soil Total Exchangeable Bases (TEB), Exchangeable Acidity (EA), Effective Cation Exchange Capacity (ECEC) and Base Saturation (BS)

Location	TEB ($cmol_{(+)}kg^{-1}$)		EA ($cmol_{(+)}kg^{-1}$)		ECEC ($cmol_{(+)}kg^{-1}$)		BS (%)	
	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Control	4.61	5.49	0.12	0.23	6.75	5.72	68.30	95.97
1m-donkey	6.02	7.11	2.96	0.88	8.98	7.99	67.04	88.99
10m-donkey	6.64	8.83	2.56	0.80	9.20	9.63	72.17	91.69
1m-cow	12.82	7.60	0.40	0.48	13.22	8.08	96.97	94.06
10m-cow	12.08	6.75	0.16	0.68	12.24	7.43	98.69	90.85
F-LSD (P < 0.05)	0.14	0.12	0.11	0.13	0.36	0.06	4.91	3.58

Note: Control; 1m-donkey = 1 m away from donkey abattoir waste dumpsite at Ezzamgbo; 10m-donkey = 10 m away from donkey abattoir waste dumpsite at Ezzamgbo abattoir; 1m-cow = 1m away from cow abattoir waste dumpsite at Abakaliki; 10m-cow = 10 m away from cow abattoir waste dumpsite at Abakaliki; 1st = 1st year and 2nd = 2nd year.

Improper management and supervision of the activities of abattoir operators in Nigeria is a source of great risk to soil physical properties such as bulk density, total porosity, mean weight diameter and aggregate stability (Adelegan, 2002). Management practices such as burning animal residues increase bulk density, while practices such as addition of abattoir wastes to the soil decreases soil bulk density (Njoku et al., 2015b) . According to Adelegan (2002), bulk density and total porosity of a soil gives an indication of soil health and strength, and thus the resistance the soil gives to the root of the crop penetration. Table 1 showed that soil bulk density was higher in control in both 2015 and 2016 relative to other locations. This may be as a result of dumping activities in the site which had reduced bulk density and increase total porosity of soils near abattoir waste dumpsites. According to Adelegan (2002), low bulk density and higher total porosity can translate to better crop yield through increase in water transmissivity and root penetration. Table 1 also showed higher value of mean weight diameter (MWD) in soils near abattoir wastes relative to control. Soil mean weight diameter is a good index for measuring water transmission and reduction in water logging in soils (Tritt *et al.,* 1992). Results of the study (Table 1) also showed significant higher values of aggregate stability (AS) in soil near abattoir wastes relative to control. This could be due to the binding power of organic matter in abattoir wastes in soil particles to form stable aggregates.

Table 2 showed lower pH in control than the pH in soils near abattoir waste locations. Rabah *et al.,* (2010), indicated reduction and increase in soil pH due to increase and decrease in organic matter content, respectively. Similarly, soils near abattoir sites recorded higher available P when compared to control. Neboh *et al.,* (2013) showed that abattoir soil had higher content of available P which is supporting this study. Organic C, total N were higher in soils near abattoir wastes. This is because abattoir wastes are full of organic materials which comprised of non-liquid wastes (strong meat, bones, animal tissues and removed intestines) and waste water (diluted materials, blood, belly, urinary make-ups and water) (Bull *et al.,* 1982). Exchangeable bases were higher in soils near abattoir sites than control. These higher exchangeable bases in abattoir sites mighty have come from decomposed and mineralised abattoir wastes. Magnesium, sodium, calcium and potassium ions in soil are needed for the activation of many enzymes required in cell metabolic reactions in plants, whereas in excess, sodium ion for example can disperse fine materials via small holes by reducing water penetration and blocking plant root access and low levels of calcium salt in increases risk of soil erosion (Norton *et al.,* 2002).

Conclusion

The study was done to ascertain the effect of abattoir wastes on soil properties in Abakaliki. In order to accomplish the objectives of this study, soil samples from abattoir sites were analyzed and compared with soil sample from non-abattoir site (control). However, the results of the soils studied showed that abattoir wastes improved soil properties of Ezzamgbo and Abakaliki soils. Similarly, results showed that donkey abattoir wastes have higher positive effect than cow abattoir wastes. Similarly, the nearer the abattoir wastes dumpsites the higher the effect. Thus, the need to adopt abattoir wastes as soil amendment to improve soil productivity and as means of waste disposal and recycle.

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