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The Impacts of Abattoir Wastes on Soil Quality at Ukwunwangwu, Uturu, Abia State, Nigeria

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

This study investigated the impact of abattoir waste on the soil quality in Ukwunwangwu, Uturu, Abia State. The aim of this study was to assess the impact of abattoir wastes on soil quality at Ukwunwangwu, Uturu, Abia State. Experimental research design was used and it was carried out at Uturu, Abia State, Nigeria. Three sampling locations were chosen, the bone, dung and slurry sections respectively and two control points labeled A and B respectively. The first set of samples were collected in the morning to ensure freshness and the second set of samples were collected after two weeks making it a total of eight samples used for this study. These samples were collected at different sections so as to know the variations in concentrations of the following important physico-chemical parameters: p^H, Temperature, Moisture Content, Soil Organic Carbon, Cation Exchangeable Capacity and Soil Exchangeable Acidity. The temperature was taken in-situ using a mercury-in-glass thermometer. Results of analyses revealed that UK3A had the highest temperature of 35.0^0C in the first week and also 35.2^0C after two weeks, control A had the highest p^H value of 8.2mg/l in the first week while UK2B had the highest p^H of 8.5mg/l after two weeks.

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Control A had the higher moisture content value of 58.08% in the first week while UK3B had the highest value of 54.81% after two weeks. UK1A had the highest soil organic carbon 30.5 in the first week and also after two weeks. UK3A had the highest soil exchangeable capacity of 0.6 in the first week while UK3B had the highest value of 0.5 after two weeks. UK3A had the highest cation exchangeable capacity of 5.0 in the first week while UK2B had the highest value of 4.8 after two weeks. The correlation between the results was done using the Pearsons Correlation Moment. The experiment will help reduce the impact of abattoir waste on the environment by reducing the effect of global Climate Change and other environmental hazards. The study therefore recommended that strict environmental laws that can help curb the effects of abattoir wastes on the environment be enforced.

Keywords: Soil quality; abattoir wastes; temperature; moisture content; cation exchangeable capacity.

1. INTRODUCTION

The issues of environmental pollution on land, air and water qualities are worse now than before. There are a lot of facts ranging from soil fertility loss, depletion of biodiversity, several health problems (mostly those leading to metabolic disorder), ecological effect and others [1]. These types of pollution are caused from the indiscriminate discharge of wastes into these natural habitats thereby affecting the natural workings of the environment. The solid and liquid wastes generated are mostly disposed off on open landfills, waterways, rivers and streams indiscriminately by most industries and the entire populace. These practices are mostly seen in Nigeria where there are no properly managed disposal sites for solid waste [1].

Human activities create vast amounts of various wastes and pollutants. These lead to the release of materials that cause serious health problems within the environment. The problems are found in the air, water, food and soil pollution [2]. One type of waste that is of great concern to both urban and rural areas in Nigeria is the abattoir or slaughterhouse [2]. The continuous drive to meet the protein needs of the population is usually associated with some pollution problems because of overuse of an existing facility [3].

The Abattoir Act [4] defined abattoir as any premises used for the slaughter of animals intended for human consumption. The abattoir must include a slaughter house that does not operate on a farm [5]. A lot of activities are involved in the operation including receiving and holding of livestock, slaughter carcass, dressing of animals, chilling of carcass products, carcass boning, packaging and drying of animal skins [6]. Abattoirs directly or indirectly pollute the environment through these numerous processes [7]. This is because less than 1% of the world's fresh water, about 0.007% of the overall water on earth is readily accessible for direct human use [8]. Moreover, in Nigeria, meat processing activities are usually carried out in unsuitable places or buildings by butchers who have little or no idea of sanitary principles. These activities are usually done by the generation of large amount of wastes like blood, fat, organic and inorganic solids, salts which are discharged into soils and water bodies around the abattoir premises [9]. Abattoir waste is the residual material generated from the abattoir after the slaughter of animals like cattle, sheep, goats. These wastes comprise materials like blood, urine, faeces, water, bones [10]. Organs of cattle such as the muscle, blood, liver, kidney, viscera and hair have been found to contain heavy metals [11].

In ruminant animals, the first stomach or paunch contains undigested materials called paunch manure, which comprises long hairs, whole grains and large fragments [12]. The excreta is usually made up of undigested feed, mainly cellulose-fibre, 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) among others. These could increase the levels of nitrogen (N), phosphorus (P) and total solids in receiving environments considerably [12] or introduce certain elements such as iron (Fe), lead (Pb), zinc (Zn) and calcium (Ca). When found present in minute quantities, the leading chemical alter the physicochemical nature of the soil [13]. Some of these chemicals may be toxic to the microbial, floral and faunal community of the soil [14].

Additional reports have been made on the effect of abattoir wastes on soil including increased concentration of trace metals, increased population of decomposers, loss of aesthetic value, excessive soil nutrient enrichment and increased toxin accumulation, as well as large accumulation of sulphides, mercaptans, amines and organic acids [15].

1.1 Statement of Problem

Wastes generated by abattoirs are potential environmental problems. Olawuni et al. submitted that the environmental effects of abattoir come through abattoir operation and waste disposal. The processes of the operation include bleeding, dressing, hide removal, evisceration or removal of internal organs, carcasses, cutting and boning In Nigeria, a cow brought for slaughtering produces on the average, 328.4Kg of waste in the form of dung, bone, blood, horn and hoof.

Bello and Oyedemi, further reported that the disposal of waste products is a problem that has always dominated the slaughter sector and on the average, 45 per cent of each live cow, 53 per cent of each sheep, and 34 per cent of each pig consist of non-meat substances.

The characteristics of slaughter house waste and effluent vary from day to day depending on the number, types of stock being processed and the method. Waste generated by abattoirs include solid waste, made up of paunch content, bones, horns, and faecal components, slurry of suspended solids, fat, blood and soluble material, bacteria, viruses, other microorganisms and sediment [16]. The waste from animals can also be washed into streams if not protected, thereby endangering aquatic life. According to (19), abattoir effluents could considerably increase levels of nitrogen, phosphorous, and total solids in the receiving water body.

Bello and Oyedemi, [14] also posited that improper animal waste disposal can lead to animal diseases being transmitted to the human through contact with animal faeces.

Medical experts reported in 2011 that abattoir activities cause diseases, which include; pneumonia, diarrhea, typhoid fever, asthma, Wool Sorter disease, respiratory and chest disease. E. coli infection source was reported to be undercooked beef which had been contaminated; often in an abattoir with faces containing the bacterium. These diseases can spread from the abattoir to the neighborhood via vectors. However, a growing population with an increase in demand for meat has resulted in increased abattoir related pollution and has attracted intervention in many developed countries [17,18].

Despite the fact that the growing population with increased demand for meat has led to an increase in abattoir related pollution which also has attracted intervention in many developed countries. There is also high level of awareness on pollution from animal waste (including abattoir) whether in the farm or in the city and over the years, several measures have been put in place to protect public health and the environment [17]. It is also stated that the European Commission introduced a Pan-European fresh-meat directive designed to standardize structural and hygiene regulations for abattoirs in all EU countries. The requirement was said to have a profound impact on slaughter industry structures in the United Kingdom. Similar intervention was recorded in the United States of America with the introduction of Abattoir Act in 1998. On the contrary, little intervention or response had been made in the developing nations [19].

2. METHODOLOGY

2.1 Study Area

This research was carried out at Uturu, Abia State, Nigeria. Abia state is one of Nigeria's 36 states. It is surrounded to the North and Northeast by the states of Enugu and Ebonyi, Rivers State is to the South, Cross River State to the East and Akwa Ibom State to the South-east. It is located in Southern Nigeria. Uturu is located in Northern part of Abia State, Nigeria, between the latitudes of 05.33°N and 06.03°N. It is well known for being the location of several schools such as Abia State University, Uturu, and Gregory University.

2.2 Research Design

The experimental research design was used for this study**.** Soil samples for this study were collected randomly from five different locations from the Ukwunwangwu abattoir in Ukwunwangwu, Uturu, Abia State. Samples from the bone section, labelled UK1, samples from the dung section labelled UK2, samples from the

slurry section labelled UK3 and control points labelled A and B respectively.

All the samples were collected on the same day in the morning for various physicochemical analyses.

Soil samples were collected in five clean dry plastic containers in a way that the samples won't mix with each other. The plastic containers were labeled appropriately using a marker and transported to the laboratory for further analysis.

2.3 Sampling Technique

Random sampling technique was employed for the study and a total of eight samples were used for the study.

2.4 Variables

2.4.1 The experimental method

Each of the soil samples was collected from the different sampling locations, that is, the bone, dung and slurry at a depth of 15cm from the surface and transferred into well labeled plastic containers of UK1A, UK2A, UK3A, control A and Control B. They were transported to the laboratory in five clean plastic containers for the physico-chemical analysis. For the analysis, the collected samples were air dried for three days using a 2mm mesh. They were sieved to remove particles. The sieved samples were pound in a mortar to form a uniform size.

The sieved samples were used to determine the following physico-chemical parameters: p^H, Temperature, Soil Organic Carbon, Cation Exchangeable Capacity, Soil Exchangeable Acidity using the volumetric analysis method.

The collection of samples was repeated after an interval of two weeks from the first sampling date and the containers labeled UK1B, UK2B, UK3B. The same procedure was carried out in the laboratory to check for their physico-chemical characteristics. A total of eight soil samples were used for this study.

Determination of (p^H): Hydrogen ION concentration:

Procedure: 10g of each soil sample was collected in a beaker and 20g of distilled water was added to each of them. They were shook for 30mins using a mechanical shaker. The samples were removed and a p^H meter was dipped into each of them to determine the p^H.

Determination of Temperature:

Procedure: The temperature was determined from source (*in-situ*) using a mercury-in-glass thermometer. It was dipped into the various soil samples at the sampling location and left for about 5mins before reading was taken.

Determination of Moisture Content:

Procedure: Petri dishes were washed and put in an oven to dry. They were transferred to a dessicator to cool and eventually weighed (W_1). 10g of each of the soil samples were put in each petri dish and weighed (W_2). The petri dishes containing the various soil samples were kept in an oven, maintaining a temperature of 105^0C for 3hours and the final weight taken (W_3). The process was repeated ater two weeks from first sampling. The moisture content is usually measured in percentage.

The formula used to determine the moisture content is shown in equation 2.1.

$$\text{Moisture content} = \frac{W_2 - W_3}{W_2 - W_1} \; x \; \frac{100}{1} \quad (2.1)$$

Where W_1 = weight of empty petri dish
W_2 = weight of petri dish + sample
W_3 = final weight of petri dish + sample after drying

Determination of Cation Exchangeable Capacity:

Procedure: 2.5g was taken from each of the soil samples and weighed. 50 ml of 1N ammonium acetate (p^H 7.0) was added to each of them and shook for 2hours with a mechanical shaker. The solution generated was filtered into a 50ml volumetric flask. The residue was washed with 30ml of 96% ethanol. 50ml of 2.5N potassium chloride was added to the residue and shaken vigorously for 1hour.

10ml of the soil extract gotten was transferred into a volumetric flask, 2ml of 45% NaOH was added to it and distilled with steam into 20ml of 0.25% mixed indicator placed under a condenser.

25.30ml of the distillate was collected and titrated with 0.02N H_2SO_4 until colour changed from blue to yellow. Titre values were recorded. This procedure was repeated after two weeks for the second set of samples.

Determination of Soil Organic Carbon:

Procedure: According to Walkley-black method (1934), 1g of each of the samples was put into a 500ml conical flask and 10ml of 1N Potassium Heptaoxodichromate (VI) was added to each of them. 10ml of concentrated H_2SO_4 was added carefully and mixed thoroughly. The mixture was left to cool for 35mins before adding 200ml of distilled water and 10ml of Phosphoric acid (H_3PO_4) slowly.

The solution was titrated against 0.5N Ferrous Ammonium Sulphate until end points reacted with a colour change to green. This procedure was repeated after two weeks for the second set of samples.

Determination of the Soil Exchangeable Acidity:

Procedure: 10g of each of the samples was put into a 250ml conical flask and 10m of Potassium Chloride was added to each of them. Every 13minutes another 10ml of Potassium chloride was added to it for 10mins. 0.5m of Phenolphthalein powder was measured and absolute ethanol was added to it and mixed thoroughly.

3. RESULTS AND DISCUSSION

3.1 Determination of (P^H): hydrogen Ion Concentration

The p^H of the soil samples was determined by using a p^H meter. The p^H levels of the soil samples was presented in Table 1 with the control and UK2B having the highest p^H values of 8.2 mg/l and 8.5mg/l for the first week and after the two week interval while UK1A and UK3B had the lowest values of 6.9mg/l and 6.5mg/l for first week and after two weeks respectively. Table 1 shows the results obtained while Figs. 1 and 2 shows the p^H in the first week and after two weeks interval respectively.

Table 1. P^H of Various Samples at the first week and after two weeks interval

1st week	Reading	After 2weeks	Reading
UK1A	6.9 mg/l	UK1B	7.5mg/l
UK2A	7.9mg/l	UK2B	8.5mg/l
Uk3A	8.1mg/l	Uk3B	6.5mg/l
Control A	8.2mg/l	Control B	7.8mg/l

Scale 1-6 Acidic, 7 Neutral, 8-14 Alkaline

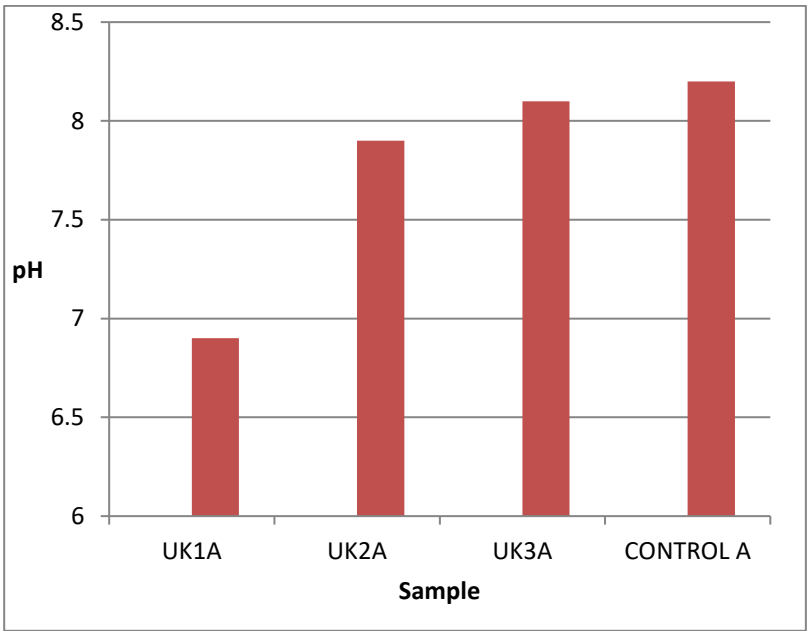

Fig. 1. p^H at the first week

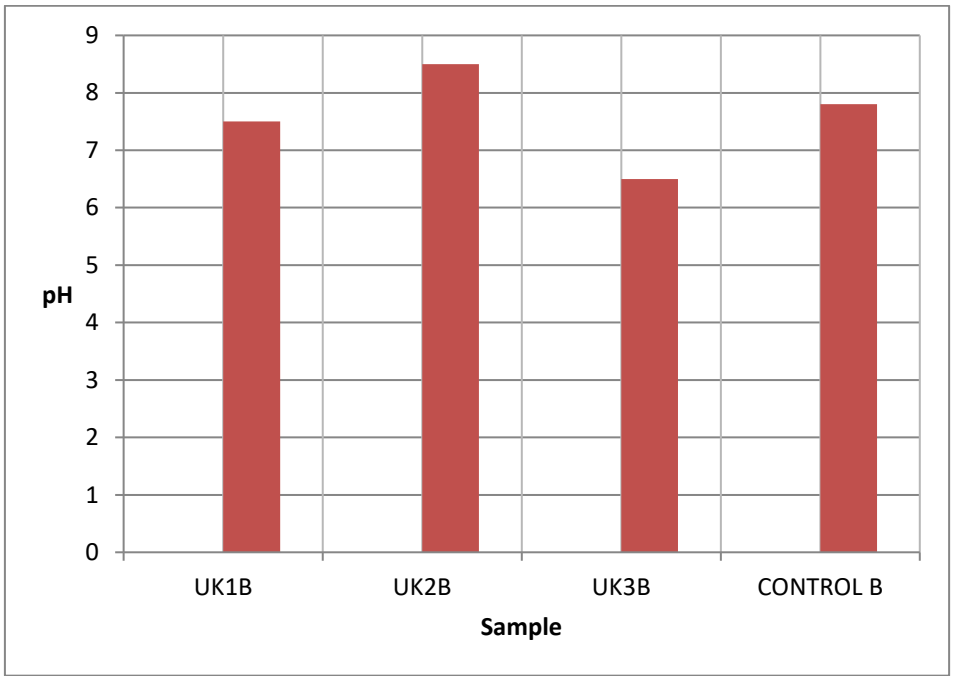

Fig. 2. p^{H} after two weeks interval

Table 2. Shows the Temperature of the Various Samples

1st week	Reading	After 2weeks	Reading
UK1A	30.2^{0}c	UK1B	32.4^{0}c
UK2A	33.5^{0}c	UK2B	32.6^{0}c
Uk3A	35.0^{0}c	Uk3B	35.2^{0}c
Control A	31.2^{0}c	Control B	30.4^{0}c

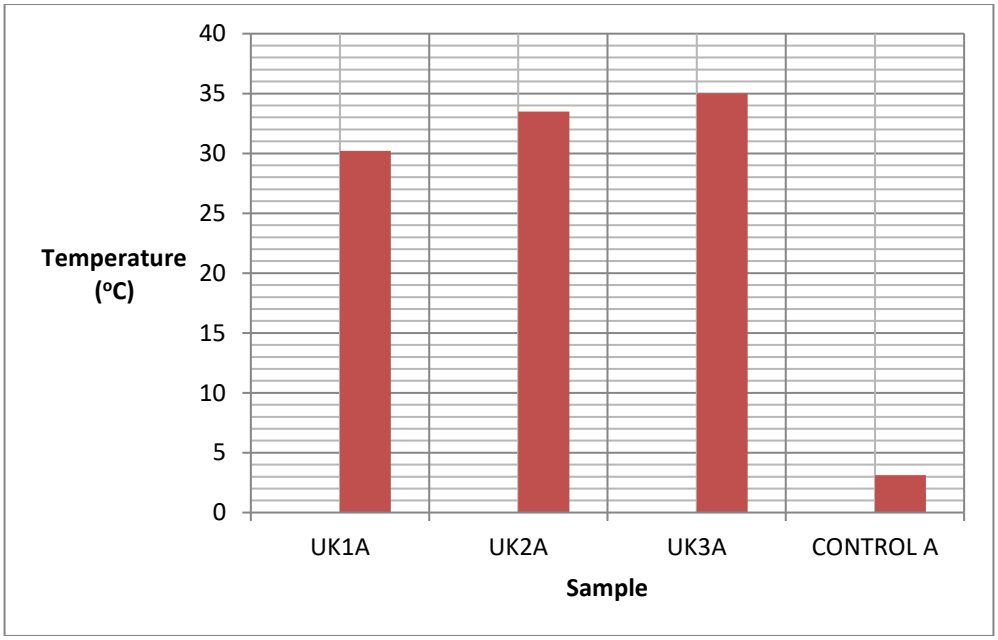

Fig. 3. Temperature after the first week

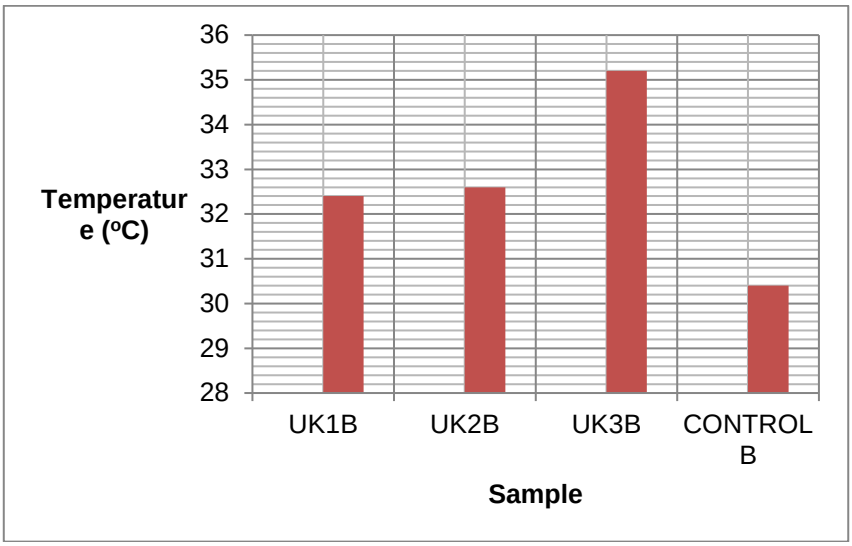

Fig. 4. Temperature after the two weeks interval

3.2 Determination of Temperature

The temperature of the samples ranged between 30.2^0C – 35.2^0C with UK1A having the least temperature of 30.2^oC and UK3A had the highest for the first week while UK3B had the highest temperature of 35.2^0C while control B had the lowest temperature of 30.4^0C

The result is presented on Table 2 and graphically in Figs. 3 and 4 respectively.

3.3 Determination of Moisture Content

The Control A had the highest value of Moisture Content of 58.08% while UK2A had the lowest 46.60%. The result showed a positive correlation between the moisture contents in the first week and after the two weeks. The result is presented in Table 3 and the graphical representation in Figs. 5 and 6 respectively.

3.4 Determination of Cation Exchangeable Capacity

Cation Exchangeable Capacity for each sample was analyzed and titre values were obtained. UK1B had the highest value of 1.5 while UK3A had the lowest value of 0.2. The result is shown in Table 4.

3.5 Determination of Soil Organic Carbon

From the result presented in Table 5, Control A had the highest value of 30.5 while UK3B had the lowest value of 2.6.

3.6 Determination of the Soil Exchangeable Acidity

From Table 6, the soil exchangeable capacity showed that UK3A had the highest value of 0.6 while Control A had the lowest value of 0.1 as shown in Table 6.

3.7 Statistical Analysis

Statistical analysis of data obtained in this research was generated using the IBM SPSS statistic as shown in Table 7. The Pearsons Correlation Moment was perfomed at 0.01% level. The result showed that values obtained were statistically significant.

Table 3. Shows the moisture content of the samples

FIRST WEEK				AFTER TWO WEEKS		
SAMPLES	**W_1**	**W_2**	**W_3**	**W_1**	**W_2**	**W_3**
UK1A	$38.92^0/_0$	48.92%	48.76%	41.23%	51.23%	51.05%
UK2A	36.76%	46.98%	46.60%	40.36%	50.36%	50.23%
Uk3A	43.03%	53.03%	52.68%	45.26%	55.26%	54.81%
Control A	48.13%	58.13%	58.08%	40.69%	50.69%	50.68%

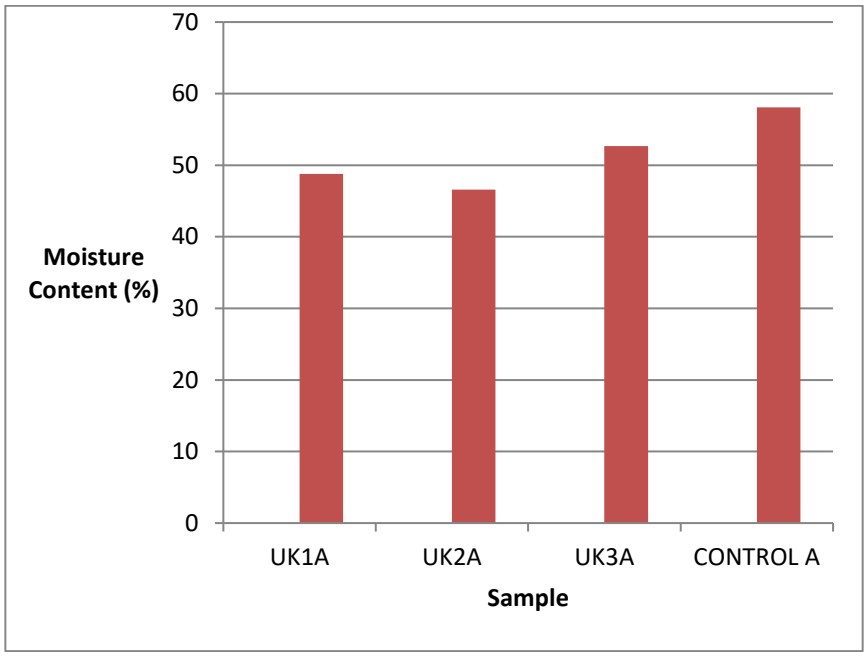

Fig. 5. Moisture Content after the first week

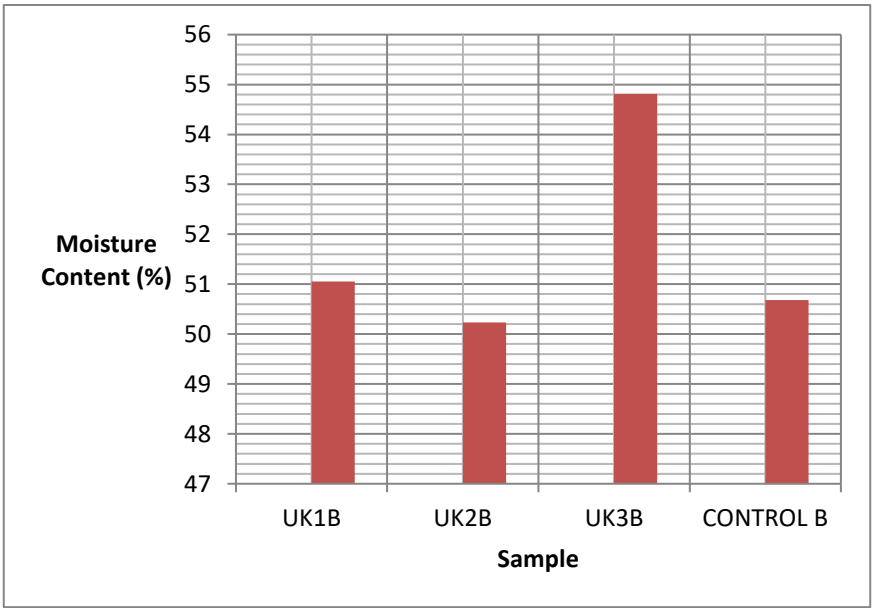

Fig. 6. Moisture Content after the two weeks interval

Table 4. Cation Exchangeable Capacity of the samples

Sample	Initial	Final	SAMPLE	Titre Value
UK1B	0.00	1.5	UK1B	1.5
Control B	1.5	2.2	Control B	0.7
UK3B	2.2	3.1	UK3B	0.9
Control A	3.1	3.5	Control A	0.4
UK1A	3.5	4.0	UK1A	0.5
UK2B	4.0	4.5	UK2B	0.5
UK2A	4.5	4.8	UK2A	0.3
UK3A	4.8	5.0	UK3A	0.2

Table 5. Soil organic carbon

Sample	Initial	Final	Titre Value
Control B	0.00	30.5	30.5
Control A	30.5	40.6	10.1
UK3A	2.50	7.0	4.5
UK3B	7.0	9.6	2.6
UK2A	9.6	38.0	28.4
UK1B	0.00	25.9	25.9
UK1A	25.9	30.5	4.6
UK2B	2.4	14.5	12.1

Table 6. Soil exchangeable acidity

Samples	Initial	Final	Titre value
Control A	4.9	5.0	0.1
B	5.0	5.4	0.4
UK1B	5.4	5.7	0.3
UK2B	5.7	6.1	0.4
Uk3B	6.1	6.6	0.5
UK1A	6.6	6.4	0.2
Uk2A	6.4	6.7	0.3
Uk3A	6.7	7.3	0.6

Table 7. Correlations between the samples using the Pearsons Correlation Moment

		MOIST A1	MOIST A2	MOISTB1	MOIST B2
MOIST A1	Pearson Correlation	1	-1.000**	.107	.045
	Sig. (2-tailed)		.000	.893	.955
	N	4	4	4	4
MOIST A2	Pearson Correlation	-1.000**	1	-.107	-.045
	Sig. (2-tailed)	.000		.893	.955
	N	4	4	4	4
MOISTB1	Pearson Correlation	.107	-.107	1	.993**
	Sig. (2-tailed)	.893	.893		.007
	N	4	4	4	4
MOIST B2	Pearson Correlation	.045	-.045	.993**	1
	Sig. (2-tailed)	.955	.955	.007	
	N	4	4	4	4

***. Correlation is significant at the 0.01 level (2-tailed).*

4. CONCLUSION AND RECOMMENDATION

With the way untreated abattoir wastes are being discharged into the environment, there will be severe threat to it. The toxic level of harmful materials can increase due to the continuous generation of the wastes. This has to be looked into, as most of the analyzed values were way too high, which signals danger to human health, that of plant life and aquatic animals.

People living in such areas where abattoirs are located may in no distant time begin to experience severe consequences of pollutants generated from there. There should be need to educate the people on the dangers associated with improper management of abattoir wastes.

Following the findings of this research, the following recommendations were made:

- There should be adequate awareness to the users of abattoir facility in the community.
- The Federal government through the state government and local government can provide financial assistance to the butchers.
- Waste treatment facilities within the abattoir facilities should be provided.
- Enacting laws – The government should make sure that environmental laws are enforced within the community.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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