

# Effects of Abattoir Waste Discharges on the Soil Quality of Kwata, Awka South L.G.A, Anambra State, Nigeria

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**Abstract:** Abattoir waste discharged on soil is of great concern to environmentalists. It has been adjudged to have a negative impact on the soil medium; hence, this study was carried out to assess the effects of abattoir waste discharges on soil quality at the Kwata abattoir in Awka, Anambra State. Heavy metal concentrations were determined using an atomic absorption spectrophotometer (AAS). Physicochemical Parameters were determined using standard methods. All data obtained were subjected to statistical analysis using a paired sample t-test. A total of 10 soil samples were collected randomly at three depths (0-10 cm, 10-15 cm, and 15-20 cm) at the abattoir and a control site to assess physicochemical properties and heavy metal parameters of the soil. Three (3) wastewater samples were collected at three (3) different points, and a control sample was collected at the abattoir, to analyse their physicochemical parameters. The pH mean value of soil from sample A (4.11) is below the set limit, while samples 2 and 3 were within the permissible limit for soil. The Total Dissolved Solid (T.D.S) and Total Suspended Solid (T.S.S) values were above the control and the minimum permissible limit. The Electrical conductivity values were within the maximum permissible limit set by WHO, which recommends EC levels of <400  $\mu\text{S}/\text{cm}$ . The sampled sulphate value indicated that “Sample A is below the set limit, while “Sample B and Sample C” were within the acceptable limit of the World Health Organisation standard. The analysis further revealed that all values of Nitrate and Phosphate are within the set limits for soil as set by W.H.O. The levels of all tested heavy metals were within the maximum permissible limits, with zinc ranging from 3.29-3.98 mg/L, lead from 8.23-10.50 mg/kg, iron from 600.07 to 614.7 mg/kg, chromium from 4.80-5.28 mg/kg, and copper from 4.98-5.39 mg/kg. The heavy metal levels in soils were within the FEPA minimum permissible limit of 0.0-1.00 for soil standards, except for chromium (Cr), which showed high concentrations in sample A (5.28), sample B (5.08), sample C (4.80), and the control sample (4.54). The significance level of the hypothesis is >1%; therefore, the null hypothesis was rejected and the alternative accepted. The study therefore views the abattoir effluent discharge as having a significant influence on the levels of physicochemical parameters and heavy metals in the abattoir soil. The study recommends composting biodegradable solid waste in pits; thus, there is no need for wastewater treatment plants to treat wastewater before disposal.

**Keywords:** Soil quality assessment, Heavy metal contamination, Physicochemical parameters, Environmental pollution

Conflicts of interest: None

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## 1. Introduction

As animal protein is a major source of protein globally, the continuous drive to increase meat production to meet the protein needs of the ever-increasing world population has some pollution problems attached (Chukwu, Adeoye, Chidiebere, 2011). Humans depend on the environment for their daily activities; the quality of the topsoil in any environment is very important to them. As such, health is our wealth, and we must be concerned about the food we

eat and where it comes from (Verla, E.N., Verla, A.W., and Enyoh, 2017). Over the past few decades, the environmental quality of urban soil has been closely related to human health, prompting greater concern about soil pollution around them (Verla, Horsfall, and Spiff, 2015). Soil pollution arising from man's socio-economic activities may threaten human health if not properly controlled. It is also a natural reservoir of metals whose

concentrations are associated with several factors, such as biological and biogeochemical cycling, parent material and mineralogy, soil age, organic matter, soil pH, redox conditions, and microbial activity (Obasi, Akubugwo, Ugbogu and Otuchristian, 2012). One type of waste of great concern in both urban and rural areas of Nigeria is abattoir (slaughterhouse) waste (Ezeoha and Ungwuishiwu, 2011).

Abattoir Act (1988) defined abattoir as “any premises used for, or in connection with the slaughter of animals whose meat is intended for human consumption and includes a slaughter house, but does not include a place situated on a farm”. Animals in this case include cattle, sheep, pigs, goats, and other equines. It is an approved facility registered by the regulatory agency for the hygiene of slaughtering and animal inspection, and for the processing, effective preservation, and storage of meat products for human consumption (Tamenech and Tamirat, 2017). Due to the attendant environmental impacts arising from abattoir operations, including the failure of abattoir operators to adhere to environmentally friendly and good hygiene practices, abattoir or slaughterhouse wastes have become a major cause for concern in Nigeria (Falodun and Rabi, 2017). The indiscriminate activities of these abattoirs pose a significant challenge to the proper management of the environment, particularly in the areas where they are located. Furthermore, they encourage the transfer of infectious agents which can be pathogenic to humans (Solomon, Wudu, Biruk, Tesfay and Aklilu, 2016; Onuoha, Eluu and Okata, 2016).

Abattoir waste originates from slaughtering, hide removal or dehairing, paunch handling, rendering, trimming, processing and cleanup operations. Abattoir waste is raising public health concerns emerging from the poor environmental management practices (Ogbuene, Ezeile, Oroke, Eze, Ede and Arcilla Jr, 2020). Wastewaters from abattoirs mostly seep into the surrounding soil, while the remainder is channelled through abattoir drainages into connecting rivers (Kazzah et al., 2020). Physicochemical and microbiological qualities of soil and water samples contaminated with faecal matter from cattle have been reported to exhibit high turbidity and pathogenic bacteria, including *E. coli*, respectively, posing a high risk to environmental health. Hence, this research was conducted to ascertain whether abattoir wastes generated from abattoir activities contain harmful substances that can affect the soil, and to suggest environmentally friendly strategies to improve soil quality within the study area.

Abattoir wastes contain several pollutants, most of which have growth-limiting effects on soil microbes, plants, animals, and the entire ecosystem. A larger fraction of these wastes contains heavy metals, which are present in plants through bioaccumulation, bio-magnification, and bioconcentration and remain persistent in the food chain in the ecosystem (Ogun, Anagun, Awole, Oluwole, Kappo and Alonge 2023). According to Adeniji, Osifeso, Ogundairo and Abiodun (2021) there is pollution as well as contaminants from the abattoir sites. On the impact of abattoir activities on the physicochemical properties of

soils within a residential area of Omu-Aran, Kwara state, Nigeria, the mean values of parameters in the soil samples collected around the studied wells ranged from  $31.00 \pm 2.00 - 110.03 \pm 8.72$  mg/L and  $7.21 \pm 0.02 - 7.83 \pm 0.02$  for electrical conductivity and pH, respectively (Elemile, Raphael, Omole, Oluwatuyi, Ajayi, Umukoro and Elemile 2019). However, there is a significant difference in pollutant concentrations across different sample points (Oladipo, Ilesanmi and Olaleye 2022).

Heavy metal is a major environmental pollutant with deleterious health effects on man, flora and fauna, high toxicity and diseases in humans and animals through consumption of food crops from contaminated soil. (Sangodoyin and Ajayi-Banji, 2017; Abdullahi, Lawal and Salisu, 2021). Moreover, Kazzah, Kutman, Michael, Obaje, Fodeke, Feka, Tanko and Bammai (2020) conducted a preliminary investigation into the elemental and bacterial profiles of soils contaminated by effluent from the Zangon Shanu abattoir using an experimental method. High bacterial loads, isolated pathogenic bacteria, and elevated heavy metal levels found in the sampled soils indicate that these may easily be transferred or deposited onto crops grown on the vast irrigation farms that span the riverbank.

Chikwendu, Uchendu, and Ochor (2019) studied the spatiotemporal variation in abattoir operations and their effects on soil quality dynamics in Umuahia South, Abia State, and revealed that the possible source of contaminants is the unhygienic manner of handling meat in abattoirs. The results indicated that the quality of the soil is adversely affected by the abattoir's activities. Chukwu and Anuchi (2016) studied the impact of abattoir waste on the physicochemical properties of soils in Port Harcourt using an experimental approach. The results after possible contamination and comparison with the WHO and FEPA standards showed that the values for heavy metals, including Chromium, were higher than both control points and the standards. This indicates possible contamination and pollution from abattoir activities.

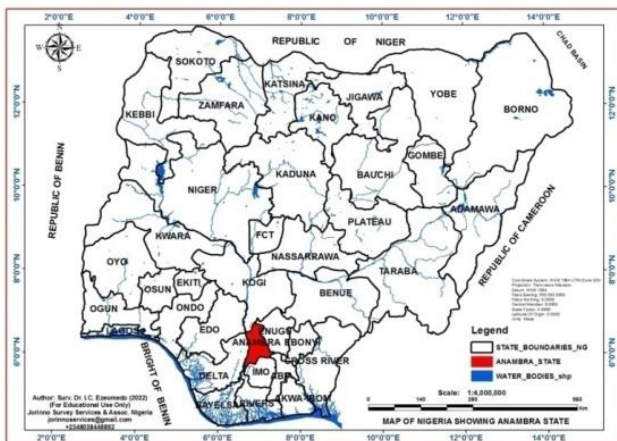
This study is based on the concepts of soil quality and soil health. The multidimensionality of the soil-health concept allows soil management goals to be aligned with sustainability goals and provides the foundation to consider a large number of stakeholders, functions, and spatial and temporal scales. The health of a soil reflects its capacity to function and provide desirable ecosystem services, such as sustaining crop productivity. Soil health and soil quality are terms used interchangeably to describe soils that are not only fertile but also possess beneficial physical and biological properties. According to the USDA Natural Resource Conservation Service (2019), soil quality is how well the soil does what we want it to do. A healthy, high-quality soil is fertile, has good soil structure, and is biologically active. Soil quality is the capacity of a specific kind of soil to function to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation. Soil health globally has become an overarching challenge of the agricultural production system, threatening global

food security and social, environmental, and economic sustainability.

This study provides a platform for scientists wishing to undertake further research into the effects of abattoir waste discharges on the environment and the health of local communities in Anambra State and across Nigeria. Scholars in environmental management, agriculture, chemistry and food sciences will find this study resourceful. The Study is capable of attracting the attention of State Ministry of Environment, the State Ministry of Agriculture to tackle the problem of soil pollution due to the unhealthy abattoir practices associated

## 2. Materials and method

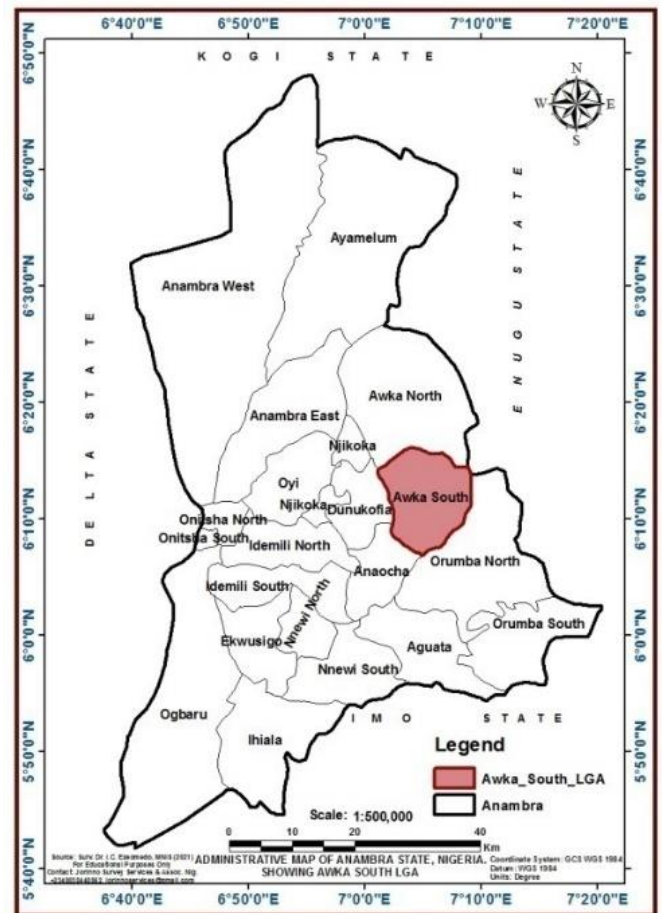
The study area includes nine (9) communities under Awka South Local Government Area in Anambra State, Nigeria, figures 2.1 to 2.3. It lies within the latitudes  $06^{\circ} 06'N$  and  $06^{\circ} 15'N$  and longitudes  $07^{\circ} 05'E$  and  $07^{\circ} 15'E$ , and covers a land area of about 120 km<sup>2</sup>. The headquarters of the Awka South Local Government Area is in Amawbia, while the area comprises autonomous communities such as Awka, Amawbia, Mbaukwu, Umuawulu, Okpuno, Nise, Nibo, and Ezinato. The study area is reasonably accessible, with the Enugu-Onitsha expressway as the primary route facilitating mobility within it.



**Figure 1:** The Administrative Map of Nigeria Showing Anambra State

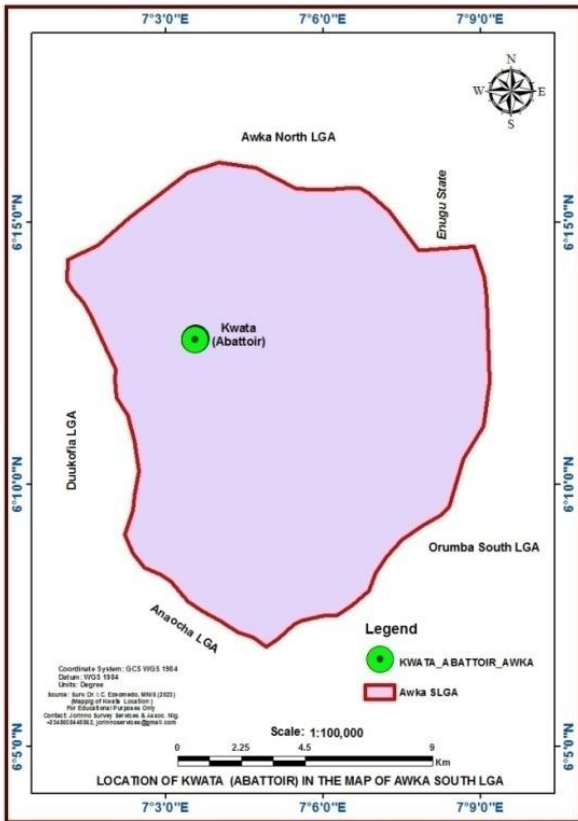
Source: Ejikeme, J. O. Adeboboye, A. J. and Ezeomodo, I. C. (2023).

with meat production and consumption in Anambra state, consumers, abattoir operators, food nutritionist, the agricultural sector, health sector and other stakeholders and legal authorities working for food and environmental safety because they will gain more knowledge on the sources and health hazard associated with abattoir waste discharges on soils. There is therefore a need to investigate the effects of abattoir waste generation on soil quality in Awka, Anambra state and to recommend the best management practices to be applied for sustainable environmental protection.



**Figure 2:** Awka South Local Government Area (LGA)

Figure 2 is the administrative map of Anambra State showing Awka South L.G.A



**Figure 3:** Location of Kwata Abattoir

Figure 3 is a Map of Awka South L.G.A showing the location of Kwata Abattoir.

The geology consists of a lithostratigraphic unit of Imo Formation. The Imo Formation underlies Awka and environs. (Short and Stauble 1967) and (Ekwenye et al., 2014) stated that the unit is extensively distributed across southeastern Nigeria and dates from the Palaeocene to the Lower Eocene. (Nwajide 2013) identified that large-scale cross-beds and well-sorted sandstone primarily characterise the Ebenebe Sandstone member of the Imo Formation, which serves as the aquifer package for most of Awka metropolis. The shales of the Imo Formation are fissile and are occasionally interbedded with sandstone intercalations, giving rise to prominent aquifer aquitard systems (Ezeigbo 1987).

Topography is predominantly a low-lying region on the western plain of the Mamu River, with almost all parts at 333 meters above sea level. The major topographic feature in the region is two celestas (asymmetric ridges) with east-facing escarpments, each trending southward outside Awka urban to form part of Awka-Orlu upland. (Adeboboye et al., 2012). The soil is suitable for root and tuber crops such as yams, cassava, and maize. The two main types of soil found in the area are ferruginous and hydromorphic soil. Ferruginous soil is rich in iron and is derived from marine complexes of sandstone, clay and shales. The climate of Awka is tropical wet and dry, according to the Köppen classification, with a distinct seasonal cycle. The mean daily maximum temperature is usually 27°C throughout the year, although it can reach

34°C in March, and is lowest during the hamattan months of December and January. (UN-HABITAT, 2013).

The vegetation of Awka ranges from light rainforest to savannah. Dense vegetation with tall trees is prominent around streams, river courses, and the shaley lowlands, while savannah vegetation and isolated trees are prominent on sandy highlands; extensive man-made vegetation exists within the city and environs (Ezeabasili et al., 2015). The area is characterised by the annual double maxima of rainfall with a slight drop in either July or August, known as a dry spell or (August break). The annual total rainfall is above 1,450mm, concentrated mainly in eight months of the year, with a few months of relative drought. Climatological records since 1978 show that the study area has a mean annual rainfall of about 1,524mm (UN-HABITAT, 2009). According to Iloeje, Odumodu and Ekenta, (2012), the area has a relative humidity of 80% at dawn (Adah et al., 2014). The relative humidity ranges from 85% to 100% during the rainy season and below 70% during the dry season. According to the 1991 and 2006 population censuses, the population of the Awka South Local Government Area was 130,664 and 197,721, respectively.

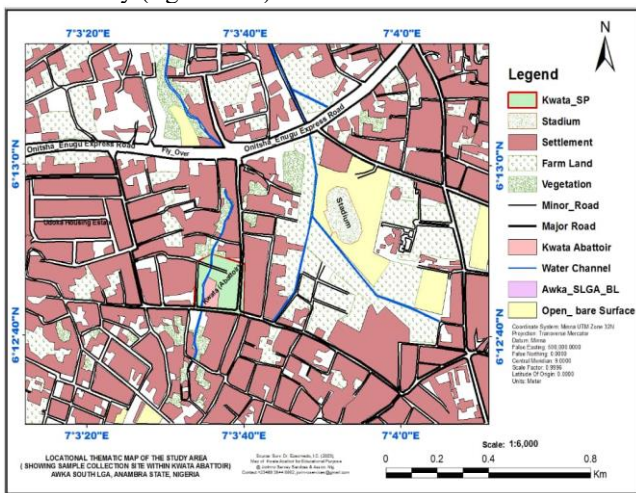
Using Dudley Kirk's (1996) formulae for population projection, with a 3.2% approved annual population growth rate by the National Population Commission in 2006, the population of Awka South Local Government Area is projected at 337,767 in 2023 by the researchers.

Awka is the traditional home of the Igbo (Ibo) blacksmiths; early bronze artefacts have been discovered in the vicinity, and the town's artisans are still noted for their metalworking and wood carving. They are known for producing guns (Egbe). The Imo-Oka festival is a two-week-long festival of masquerades and dances held in May at the beginning of the farming season in honour of a female deity who, it is hoped, would make the land fertile and yield bountiful crops. The festival starts with the Awka people visiting the community of Umuokpu with masquerades, and it ends with a visit to the Imo-Oka stream on the final day, heralded by heavy rain in the late afternoon. There are four major events performed during the festival: the ede-mmuo, ogwuoghugha, egwuOpu-Eke and Egwu Imo-Oka. Egwu Opu Eke is a rich cultural dance performed by female worshipers of Imo-Oka shrine, which includes priestesses and ordinary women alike, decorated in colourful costumes, dancing in the market square in honour of the deity controlling the shrine, and culture prohibits the killing of monkeys (Enwe) because it is regarded as a sacred animal. (Ezenagu, 2016).

Field survey and experimental design were selected in order to achieve the research aim and objectives. In terms of the field survey design, personal observation and oral interviews were used to collect information on the major animals, slaughter methods, meat preservation, and general practices of abattoir operators in the study area. The experimental design involves a step-by-step laboratory procedure for generating quantitative data for the study area. This experimental design focused on soil and wastewater sampling and analysis to determine the heavy metal concentrations in the soil and the

physicochemical parameters of both soil and wastewater from the abattoir. The data needs include analysis of heavy metals (Pb, Fe, Zn, Cr, and Cu) in soil samples, the analysis of physicochemical parameters in soil and wastewater such as pH, EC, sulphate, nitrate, phosphate, temperature, TSS and TDS, field observations on the activities going on in Kwata abattoir Awka, oral interview administered to abattoirs operators, field measurement using GIS to determine the coordinates of samples locations.

Primary data were obtained from field observations, interviews, and laboratory analyses of soil and wastewater samples. Measurements and equipment were also used to generate data. The secondary data were derived from publications, academic articles, textbooks, bulletins, internet materials, news articles, research projects, magazines, journal articles, conference/seminar papers, and other research records. It also includes maps produced for the study (figures 2.1).



**Figure 2.4:** Locational Map Showing Kwata Abattoir and its Environs

Simple random sampling technique was chosen for the study. According to Lance and Hattori (2016), simple random sampling is the most basic form of probability sampling because it ensures that every member of the population has an equal chance of being selected, thereby avoiding bias. For this study, the respondents selected were in the sampling frame for interview administration. Soil samples were collected from the abattoir in Awka, Awka South Local Government Area, Anambra State. The soil samples contaminated with abattoir waste were collected using a trowel and a meter rule and placed in sterile polyethene bags. Three (3) sampling points (A, B and C) were identified around the abattoir at depths 0-10 cm, 10-15 cm and 15-20 cm. one other soil sample was collected from a distance of 50m away from the abattoir as the control, giving a total of 10. The location 50m away was chosen as a control, with a similar ferruginous and hydromorphic soil type but lacking such abattoir activities. The control sample was labelled 'X'.

Moreover, the bottles were rinsed with slaughterhouse wastewater to reduce the effects of external contaminants. A total of three (3) samples were collected at the point of

effluent discharge from the abattoir drainage channel: Sample A (10 meters), Sample B (20 meters), and Sample C (away from the drainage channel). A control water sample was collected from the borehole located in the abattoir vicinity. All the samples collected were transported to the laboratories for analysis (Plates 1 and 2).



Plate 1. Researcher collecting soil sample



Plate 2. Researcher collecting wastewater sample

Additionally, a Handheld Global Positioning System (GPS) was used to take coordinates of the selected sites in the study. Table 3.1 shows the list of Geographical Coordinates (GC) of sampled stations obtained using Global Positioning System (GPS). The coordinate system is World Geodetic System (WGS) 84 Universal Transverse Mercator (UTM) zone 32 and Minna Datum, UTM zone 32.

A 5g portion of the air-dried soil sample was digested in aqua-regia prior to heavy metal analysis. The filtrate was made up to 100 mL with deionised water, and the concentrations of the heavy metals, Fe, Pb, Cu, Zn and Cr were determined using an atomic absorption Spectrophotometer (AAS) (Perkin Elmer Analyst 200) following the standard procedures as given in APHA (1995). pH was measured by the electrometric method using a laboratory pH meter, Hanna model HI991300 (APHA, 1998). The pH and Temperature were determined using a pH meter (Setra pHS-25). The levels of total dissolved solids (TDS) and conductivity were determined by using a C0150 conductivity meter. For Total Suspended Solids (TSS), 100 mL of the wastewater samples was filtered through a pre-weighed filter paper.

Using observation as an important data collection method, the researchers compared what was observed in the field with what people said during the interviews. The result of this method gave an in-depth understanding of the nature and extent of the impacts of abattoir activities in the area, especially on the soil. This method was also used to cross-validate certain interview responses. The unstructured interview is open-ended and allows for freedom of both questions and answers. This type of interview was chosen because of its flexibility; Plate 3 shows the researcher administering an interview to an abattoir operator selling goat meat.



Plate 3: Researcher administering interview

The data were statistically analysed using a paired-samples t-test at the significant level of  $\alpha = 0.01$  to test the

research hypothesis. This is because it will be used to compare the means of two samples when each observation in one sample can be paired with an observation in the other sample. A paired-samples t-test was used to test the hypothesis at the  $\alpha = 0.01$  significance level. The results obtained were compared with the recommended standards by the Federal Environmental Protection Agency (FEPA) and the World Health Organisation (WHO). The results of laboratory analysis, responses to the interviews and results of the field observation were interpreted and presented using tables. Table 1 displays the list of Geographical Coordinates (GC) of sampled stations.

### 3. Results and Discussion

#### 3.1 Results

##### Physicochemical parameters of the abattoir wastewater sample and their percentage compliance with World Health Organisation (WHO) standard.

Physicochemical parameters of the water samples in Table 2 show that pH and electrical conductivity are within the permissible limits for effluent discharge set by WHO, while most temperature, TDS, and TSS values were above the minimum permissible limits. This indicates that the effluent water must be treated before discharge into the environment.

Table 1: List of Geographical Coordinates (GC) of sampled stations

POINT ID	LATITUD E (LAT.)	LONGITUD E (LONG.)	NORTHI NG (Nm)	EASTING (Em)	ELEVATIO N (Zm)	HEIGHT (MSL, m)	
1	Soil Sample A	6.21273569	7.05915426	511196.796	244767.32	82.85	61.96
2	Soil Sample B	6.21274306	7.05909329	511190.051	244768.15	77.92	57.03
3	Soil Sample C	6.21263267	7.05919219	511200.964	244755.91	77.63	56.74
4	Soil Sample Control 1	6.21288386	7.05953073	511238.508	244783.59	78.68	57.78
5	Soil Sample Control 2	6.21303678	7.05954361	511239.979	244800.50	77.83	56.93
6	Effluent Sample A	6.21272830	7.05912458	511193.509	244766.51	79.03	58.14
7	Effluent Sample B	6.21280500	7.05921167	511203.171	244774.96	78.20	57.31
8	Effluent Sample C	6.21277833	7.05914167	511195.416	244772.04	79.50	58.61
9	Effluent Control 1	6.21271155	7.05919027	511200.775	244764.64	77.42	56.53
10	Effluent Control 2	6.21275170	7.05919667	511201.495	244769.07	77.81	56.91

##### Physicochemical Parameters of the Soil Arising from the Discharge of Abattoir Effluent and Their Percentage Compliance with WHO Standard.

Physicochemical parameters of sampled soil from the Kwata abattoir, Awka, Awka South Local Government Area, Anambra State, are presented in Table 2.

**Table 2:** Abattoir Effluent and Their Percentage Compliance with WHO Standard

Parameter	Sample A	Sample B	Sample C	Control	WHO (2004)
Temperature(°C)	28	27	26	25	25
pH	7.12	7.2	6.9	6.8	6.5-8.5
Conductivity (µS/cm)	547.00 + 17.00c	511.67 + 69.03bc	469.00 + 19.16ab	433.33 + 38.27a	<1000
TDS	2000	1600	1000	450	<500
TSS	1000	800	700	200	<500

Source: Docchy Laboratories Awka (2023).

**Heavy Metal Concentration in the Soil and its Percentage Compliance with FEPA Standard.**

Table 3 shows the distribution of heavy metals in soil sampled from the Kwata abattoir, Awka. The levels of all tested parameters were within the maximum permissible

limits, with zinc ranging from 3.29 to 3.98 mg/kg. For Lead, which ranges between 8.23-10.50 mgkg; Iron, 600.07-614.7 mgkg; Chromium, 4.80-5.28 mgkg; and Copper, 4.98-5.39 mgkg.

**Table 3:** Physicochemical Parameters of the Sampled Abattoir Soil Compared With WHO

Parameter	Sample A				Sample B				Sample C				Control			WHO	
	0-10 c m	10-15 c m	15-20 c m	Mean	0-10 c m	10-15 c m	15-20 c m	Mean	0-10 c m	10-15 c m	15-20 c m	Mean	0-10 c m	1015 cm	15-20 c m		Mean
pH	4.24	4.20	3.90	4.11	6.40	6.20	7	6.5	7.02	7	6.82	6.94	6.9	6.7	6.79	6.8	7
EC µs/cm	110	100	93	101	96	92	90	93	80	76	73	76	65	60	50	58	<400
Sulphate mg/L	242.16	238.94	230.87	237.32	265.62	263.05	261.12	263.26	342.86	340.05	333.97	338.96	582.86	600.05	605.33	596.08	>250
Nitrate mg/L	24.08	23.30	23.13	23.50	28.58	27.89	27.00	27.83	35.96	32.66	31.73	33.45	41.92	40.15	39.58	40.55	>40
Phosphate mg/L	1.78 ±0.16	1.76 ±0.21	1.73 ±0.21	1.42 ±0.21	1.61 ±0.21	1.60 ±0.21	1.55 ±0.21	1.59 ±0.21	1.58 ±0.11ab	1.57 ±0.15 <sup>a</sup>	1.46 ±0.15 <sup>a</sup>	1.54 ±0.15 <sup>a</sup>	1.73 ±0.05	1.70 ±0.21	1.55 ±0.11	1.66 ±0.15 <sup>a</sup>	5.00

**Testing of Hypothesis**

Ho: There is no significant relationship between the concentration of heavy metals in the Abattoir’s effluent and the quality of soil of kwata abattoir.

H1: There is a significant relationship between the concentration of heavy metals in the Abattoir’s effluent and the quality of the soil of kwata abattoir.

**Table 4:** Heavy Metal Concentration in the Soil Compared With FEPA Limit

Parameter	Sample A in cm				Sample B in cm				Sample C in cm				Control in cm				FEPA LIMIT
	0-10	10-15	15-20	Mean	0-10	10-15	15-20	Mean	0-10	10-15	15-20	Mean	0-10	10-15	15-20	Mean	
Pb(mgKg1)	8.30	8.33	12.50	9.71	7.17	8.33	9.33	8.28	8.60	9.43	10.50	9.51	4.17	4.22	5.03	4.47	15.0-25.00
Zn (mgKg1)	3.71	3.93	4.31	3.98	3.50	3.67	4.01	3.73	3.20	3.30	3.37	3.29	1.40	1.49	1.55	1.44	<15
Fe (mgKg1)	571.11	580.10	656.60	602.60	574.10	581.50	644.60	600.07	586.30	611.60	646.20	614.7	274.10	281.10	286.10	282.10	1000-5000
Cr (mgKg1)	4.68	5.56	5.61	5.28	4.25	5.32	5.67	5.08	4.56	4.67	5.18	4.80	4.01	4.67	4.96	4.54	0.0-100
Cu (mgKg1)	3.45	4.14	7.54	5.04	4.07	4.74	6.14	4.98	4.14	5.59	6.45	5.39	2.07	2.11	2.30	2.16	7.0-80.00

Source: Docchy Laboratories Awka (2023).

The result of the correlation analysis of Physicochemical Parameters of the Sample Abattoir

Wastewater and Heavy Metal Concentration in the Soil of the Study Area is presented in Table 5.

**Table 5:** Paired Samples Correlations

	N	Correlation	Sig.
Pair 1 Concentration of pb & Concentration of Temp	3	-.351	.772
Pair 2 Concentration of Zn & Concentration of pH	3	.777	.433

Pair 3	Concentration of Fe & Conductivity ( $\mu\text{S}/\text{cm}$ )	3	-.807	.402
Pair 4	Concentration of Cr & Concentration of TDS	3	-.488	.675
Pair 5	Concentration of Cu & Concentration of TSS	3	-.660	.541

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

Source Output from SPSS version 22 Computer software

Correlation Coefficient ( $r$ ) = 1.000

Significance value = 0.000 ( $p < 0.01$ , that is, significant)

The correlation is statistically significant. However, the correlation coefficient is modest, indicating a positive relationship between the concentration of heavy metals in the Abattoir's effluent and the quality of the soil at the

### 3.2 Discussion

Based on the analysis results, pH and electrical conductivity were within the permissible limits for effluent discharge set by WHO, while TDS and TSS were above the minimum permissible limits. This indicates that the effluent water needs to be treated before discharging into the environment. pH mean value from the three (3) sample points is within the permissible limit for soil set by WHO. Electrical conductivity values were within the maximum permissible limit as set by WHO, which recommends EC levels of  $< 400 \mu\text{S}/\text{cm}$ . The sampled sulphate value indicated that "Sample A is below the set limit, while "Sample B and Sample C" were within the acceptable limit of the WHO standard. The analysis further revealed that all Nitrate and Phosphate values are within the soil limits set by WHO. The levels of all the tested heavy metals were all within the maximum permissible limit, with zinc levels ranging from 3.29-3.98 mg/kg. For Lead, which ranges between 8.23-10.50 mg/kg; Iron, 600.07-614.7 mg/kg; Chromium, 4.80-5.28 mg/kg; and Copper, 4.98-5.39 mg/kg. This result thus supports the idea of Dan, Fatunla and Shuaibu (2018).

The findings from the analysis further revealed that the heavy metal levels in soils were moderately within the FEPA minimum permissible limit for soil standards except chromium (Cr), which shows high concentration in sample A (5.28), sample B (5.08), sample C (4.80) and control sample (4.54) respectively, which are above 0.0-1.00 FEPA limit. This undoubtedly indicated the possibility of contamination and pollution from abattoir activities at the Kwata abattoir, which poses a serious danger to agricultural safety and, indirectly, to human health and safety. It thus suggests that the quality of the soil with regard to chromium concentration is negatively affected by abattoir activities, causing higher values, including in the control soil. This thus corroborates the assertion of Chukwu and Anuchi (2016).

From the observations made, there are other activities in the abattoir vicinity, such as the sale of food, footwear,

Kwata Abattoir. However, the correlation is significant at the 1% level. Thus, we reject the null hypothesis of no significant relationship between the concentration of heavy metals in the abattoir and soil quality. The study therefore accepts the alternative hypothesis and concludes that there is a significant relationship between the concentration of heavy metals in the Abattoir's effluent and the quality of the soil of the Kwata abattoir.

fresh fish, vegetables, and soft drinks. There is drainage where the wastewater flows through when animals are being washed, and animal faeces are not disposed of properly. Wastewater from animal washing remained stagnant in the drainage systems, and animal faeces/excrement were seen heaped openly, causing odour. An individual was seen, barefoot and without gloves, packing excrement into a wheelbarrow with a shovel. This method exposes the individual to ill-health.

The oral interview indicates that cows and goats are the most commonly slaughtered animals in the abattoir. These animals are obtained from Ugwuoba, a community in the Oji River Local Government Area of Enugu State. Tires were previously used to roast the animals, but due to complaints from people living in the area, bamboo was used instead. The abattoir workers do not worry about water because there is already a borehole located in the abattoir slaughter area for washing the animals. About 40-45 cows are slaughtered on Saturdays and 35-37 cows on other days while about 100 goats are slaughtered on Saturdays and 50 on other days. Through the interview, their preservation method was revealed. The remaining meat is taken to the cold room to avoid spoilage. However, they do not go to the cold room often because they sell everything daily. Doctors buy animal bones because they serve as a source of calcium; restaurants and hotels buy animal intestines to make pepper soup. Animal faeces are also bought and used for generating electricity and for agricultural purposes.

### 4. Conclusion

The present experimental study clearly indicates that direct disposal of abattoir waste alters the physicochemical properties of the soil. The study, therefore, views the abattoir effluent discharge as having a significant influence on the levels of physicochemical

parameters and heavy metals in the abattoir soil, particularly chromium. Wastewaters from the study area are highly variable in their physicochemical properties. The mean pH of 4.11 from sample A is below the WHO set standards for effluent discharge into the environment. The discharge, if unchecked and continues unabatedly, could pose a serious negative effect on crop yield and a health challenge to man and his environment.

This study therefore recommends that slaughterhouse activities should be effectively monitored through efficient enforcement of environmental sanitation laws by the relevant authorities. Also, abattoir waste recycling methods should be explored to create a hygienic facility, increase job opportunities for 'waste to wealth' creation, and improve economic growth, for environmental and sanitation reasons. Moreover, biodegradable solid wastes are recommended for composting, which can be done in pits. Wastewater treatment plants are needed to treat wastewater before disposal, and, based on the outcome of this study, public education and enlightenment regarding the risks associated with non-compliance with abattoir laws, particularly for abattoir workers, should be routinely practised through mass media.

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