THE IMPACT ASSESSMENT OF ABATTOIR ACTIVITIES ON SURROUNDING SOIL IN A RESIDENTIAL AREA OF AYETORO, OGUN STATE, NIGERIA

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Abstract: Abattoir activities have become a major source of income in recent times with less concern about its negative impact on residential areas. This study is therefore aimed at assessing the impact of abattoir activities on the adjoining soils of a residential area in Ayetoro, Ogun State Nigeria. Three locations around a selected abattoir site were identified for sample collection based on their proximity. The control site is located at about 200 m from the abattoir. The twelve collected soil samples were analyzed for pH, electrical conductivity, chromium, lead, nickel, copper, zinc, nitrate, chloride, iron, and sulphate. The result showed that the pH of the soils were acidic while the values of the electrical conductivity, nitrate, chloride, sulphate, iron and zinc varied significantly ($p< 0.05$) across all the selected locations. The highest concentration of Iron (2780.33±20.50 mg/kg) was at S_1. Heavy metals (Chromium, lead and nickel) were not detected in all the sample locations. Chloride concentrations were within permissible limits allowed by National Environmental Standards and Regulations Enforcement Agency (NESREA). The result also showed higher levels of copper at S_1, S_2 and S_3 (8.22±0.40, 8.41±0.50, and 4.31±0.40 mg/kg), respectively. The activities of the abattoir impact negatively on the soils of adjoining residential areas. This calls for stricter control measures that should be aimed at reducing soil pollution and ensuring conformity with laid down operating procedures especially when they are within residential areas.

Keywords: Abattoir, heavy metals, residential area, Ayetoro, soil pollution

Introduction

The importance of livestock farming cannot be over-emphasized in modern day agricultural. Different products are derived from livestock farming; some of these are: egg, skin, milk, gelatin, etc. Due to the importance of their health and nutritional benefits, their demand is driving the huge economic activities around livestock farming and processing in Nigeria. However, several wastes generated from livestock slaughtering and processing have been reported as a major source of pollution in the country (Magaji and Chup, 2012). The infiltration of these wastes into adjoining watercourses located close to abattoirs has resulted in various degrees of groundwater contamination.

The wastes generated from abattoir activities are classified into fats; which is often high in organic content, high organic solids and liquid. The liquid often contain urine, dissolved solids, water, gut contents and blood. The solids include hairs, damaged fetus, undigested swallowed foods, condensed meats, and blood, while fats and oil are the components of fat waste (Dan *et al.*, 2018). The result of discharging these wastes into water bodies often create imbalance in aquatic ecosystems, which reduces aquatic species and in some cases, cause them to go into extinction (Elemile *et al.*, 2019).

These generated wastes have also affected the soil media through the disposal of high volume effluents into the soil. These in turn percolates into the soil mass causing serious soil and water pollution. Soil contamination often results in metalloids build-up, accumulation of heavy metals in the soil and sludge cake. Other sources of soil contamination include: oil spillage, animal droppings, firewood firing filths, fertilizers application, pesticides, deposition of waste with high metallic content, mine tailings, and pollutants released from different manufacturing industries (Aires *et al.*, 2013). Various body parts of animals have been reported as being capable of releasing heavy metals into the soil and tend to increase soil pH (Rabah *et al.*, 2010).

Several researches have been conducted to show the effects of activities of abattoirs on soil physicochemical properties. Malik *et al.* (2010) investigated the level and sources of heavy metals contamination on soil surfaces in Sialkot city, in Pakistan which is popularly known for the production of tanneries and pharmaceutical industries, with the use of a multivariate and GIS approach. The results revealed an increase in the level of heavy metal concentration measured in urban soil and also indicated that the concentration exceeded the permissible limit for soil surfaces. The authors advocated for an imperative need for a detailed baseline when investigating the spatial distribution of heavy metals in soils. Onyeike *et al.* (2002) investigated the level of concentration of inorganic ions available in soils and streams from three different locations in Ogoni land, Nigeria which is adversely affected by spillage from crude oil. The results showed that there was a significant variation in the concentrations of the polluted soils and streams in the three locations. Although the analyzed anions and cations of the soils and streams were within the permissible limit by NESREA, however, since inorganic ions also contribute to soil and stream pollution, this renders the soil and stream less productive for domestic, industrial, and agricultural purposes. Adegoke *et al.* (2020) studied the effect of cassava wastewater from wet *fufu* paste processors on surrounding soils in Ayetoro, Ogun State, Nigeria. The results showed that this activity contributed to the increased level of heavy metals available in the soil.

Also, Khan and Kathi (2014) researched heavy metal and petroleum hydrocarbon contamination at the roadside soil close to an automobile workshop and an agricultural field. Their findings revealed that the sampling sites located very close to an agricultural field had low contamination with little pollution levels while sites located very close to the automobile workshop along the highway had high pollution levels with high levels of contamination; suggesting that the impact of anthropogenic activities on the contamination level is on the high side. Elemile *et al*. (2019) conducted a similar study in Omu-Aran, Kwara State, Nigeria. The authors reported average values for Ni, Cr and Pb which are slightly higher than the control site. These values were above permissible limits and impacts negatively on the surrounding arable soils. They recommended sustainable pollution control measures for abattoirs situated in residential areas.

Abattoir available in Ayetoro lack basic waste treatment facilities, and farmers often plant crops around the abattoir area due to the high yield obtained not minding the cumulative effects and hazards posed on the crop and human health. This stems from the fact that when polluted soils are planted with crops, the harvested crops are also polluted which has negative effects on human health as a result of consumption of such crops.

Despite having some research works carried out on soil contamination resulting from abattoir activities, little has been documented on the pollution of soil media by abattoir activities in Ayetoro. This research work aims to investigate the effect of abattoir activities on the surrounding soils of a residential area in Ayetoro, Ogun State, Nigeria. It will further assess the soil quality at the selected locations to establish the level of contamination and make some recommendations to forestall further contaminations.

Materials and Methods

Study area

Ayetoro is a town in Yewa North Local Government Area (Fig. 1) about 35 km northwest of Abeokuta Ogun State Nigeria, and lies on longitude 3^o 03'E and latitude 7^o 12'N, with an average annual rainfall of 1,909.30 mm. The town lies between 90 and 120 m above sea level, with a population of 120, 000. Farming is the dominant occupation. The study was conducted in an area within 3 km radius of a selected abattoir. All sample collection points are located within this radius with control at 200 m away from the abattoir.

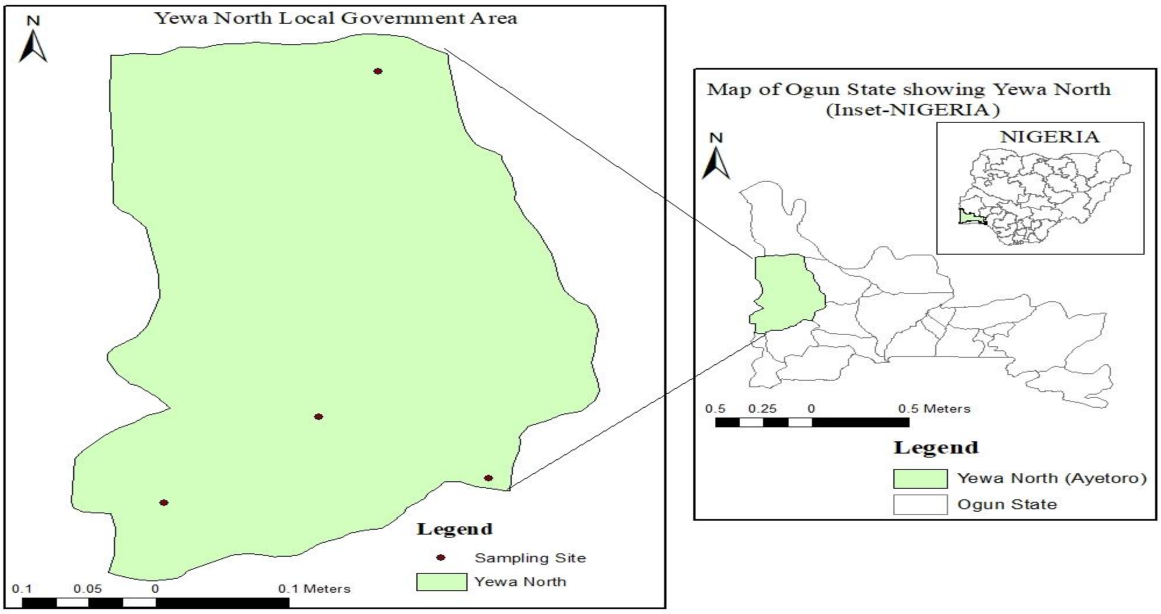

Fig. 1: Map showing the study area

Sample collection

Soil samples were collected from three different locations. A total of twelve soil samples were collected, which consist of three soil samples each, collected from three residential areas available within the abattoir area. Three other soil samples were collected at a distance of 200 m away from the abattoir which served as the control. The soil samples collected were air-dried and pulverized using agate mortar and pestle before they were sieved with a mesh of 2 mm diameter, and then labelled in an air-tight polythene bags before they were taken to the laboratory for analysis. A disinfected auger was used for the collection of the soil samples at different locations. Samples were collected in three replicates to validate the results. Samples collection was done during the dry season between January and February 2021.

Laboratory analysis

The parameters analyzed include pH, Electrical Conductivity, chromium, lead, nickel, copper, zinc, nitrate, chloride, iron and sulphate. The physicochemical parameters of the soil samples analyzed were temperature, pH, electrical conductivity, sulphate, nitrate and chloride. The mercury-in-glass thermometer (B60770-1800, SP Science ware, USA) was used to determine the temperature, the pH was determined using an AD14 pH meter (Adwa Instrument, Hungary).

The electrical conductivity was measured using Sension1 portable conductivity meter (Hach Company, USA). Digested soil samples were analyzed for sulphate, nitrate, chloride and other heavy metals using SP-AA 3000 Atomic Absorption Spectrometer, (Shanghai Yanhe, China). The statistical analysis was done using the SPSS software Version 21.0 and ANOVA was used for comparing the soil samples parameters at different locations. Also, the significant difference between the mean values of the parameters considered around the areas were determined by applying Duncan's multiple range comparison tests, using a 5% significance level (p<0.05). The results obtained were compared with NESREA permissible limits.

Results and Discussion

The physicochemical parameters of the soil samples

From Table 1, the pH of the soil was slightly acidic. The pH content reduced to (6.4±0.08) at sampling point 2 which indicates the presence of acidic content in that particular region. There is a significant difference at sampling point 2 when compared with other collection points. The control which was at a distance of 200 m from the abattoir site had similar pH content with other sampling points. The pH of the soil which ranges between 6.3 and 6.7 indicates that the abattoir effluent did not alter the pH of the soil. Also, the concentration of the soil was acidic in all the sampling points and these are within NESREA permissible limits for soil pH (6.5-8.5) except the pH of S_2 (6.4±0.08). This corresponds with what was obtained by Rabah *et al* (2010). The electrical conductivity increased at the different sampling points compared to the control (116.84±1.07) uS/cm. There is a significant difference across all the sampling points considered.

The high concentration of conductivity in the soils could be attributed to the presence of abattoir wastes such as blood, bones, furs, flesh, blood, and salts in abattoir effluents between the soil openings (Elemile *et al*., 2019).

The highest EC level of the soil (222.30±1.13 μS/cm) at S_1 is an indication that crops planted on it will have low yield and nutrient deficiency. Table 1 revealed that there is a significant difference across all the sampling points for nitrate content, nitrate had high concentration in all the locations considered with the highest level at S_2 (67.09±2.55 mg/kg). The nitrate concentration at S_1 and S_2 (222.30±1.13 mg/kg) and (54.09±3.13 mg/kg) do not fall within the NESREA permissible standard of 50 mg/kg, which makes the soils at this collection points not good for agriculture or consumption. The nitrate concentration values of abattoir soil at the control and the S3 soil (25.82±4.45) mg/kg and (42.72±2.64) mg/kg are low and fall within the NESREA permissible limits. The result also showed the high residual amount of nitrate in the soil despite irrespective of activities of the abattoir. The high concentration of nitrate in the soil will result in the lowering of the nitrite which associates with the amine to produce N-nitro so that causes cancer of the stomach (Aires *et al*., 2013).

Furthermore, a statistically significant difference was observed in the chloride contents of the soil samples across the locations with S_1 having the highest level of concentration (38.13±1.11 mg/kg). The chloride concentration values are lower and within NESREA permissible limits of 250 mg/kg for chloride. This makes the soil safe for agricultural purposes. Higher values results in poor yield of crops. The sulphate content in all the locations was high (1060.47±49.45 mg/kg) (936.13±5.36 mg/kg), and (734.13±22.28 mg/kg), respectively. A lower trend of concentration at the control and high concentration values at the sampling points, were observed. This showed that the presence of abattoir activities increased the sulphate content of the soil. Table 1 also indicated that S_1 had the highest sulphate concentration (1060.47±49.45 mg/kg). The increased value of the sulphate concentration at the locations of the abattoir could be as a result of the increase in the microbial activities which was due to the deposition of animal wastes in large volumes (Magaji and Chup, 2012). The result obtained does not conform to NESREA recommendation limits and implies a need for soil treatment before agricultural usage. Excess concentration of sulphate in soil affects plant development.

Table 1: Physicochemical properties of soil samples at various points

Parameters	Sampling Position			Control	NESREA Standard
	S_1	S_2	S_3		
pH	6.7033±0.15[a]	6.3767±0.08[b]	6.7567±0.01[a]	6.7467±0.13[a]	6.5-8.5
Electrical Conductivity (μS/cm)	222.30±1.13[a]	123.01±0.94[b]	144.00±2.51[c]	116.84±1.07[d]	< 100
Nitrate (mg/kg)	67.09±2.55[a]	54.09±3.13[b]	42.72±2.64[d]	25.82±4.45[c]	50
Chloride (mg/kg)	38.13±1.11[a]	26.86±1.62[b]	30.59±0.95[d]	21.67±0.69[c]	250
Sulphate (mg/kg)	1060.47±49.45[a]	936.13±5.36[b]	734.13±22.28[d]	288.35±11.22[c]	100

In each of the parameters, means with the different letters (superscripts) indicates significantly different at $p < 0.05$

Table 2: Heavy metal properties of soil samples at various points

Parameters	Sampling Position			Control	NESREA Standard
	S_1	S_2	S_3		
Iron (mg/kg)	2780.33±20.50[a]	2356.00±48.38[b]	2049.67±61.45[d]	1076.00±117.09[c]	400
Nickel (mg/kg)	-	-	-	-	0.02
Copper (mg/kg)	8.22±0.40[a]	8.41±0.50[a]	4.31±0.40[c]	2.35±0.33[b]	1.5
Lead (mg/kg)	-	-	-	-	0.05
Zinc (mg/kg)	109.80±1.60[a]	130.28±0.38[b]	126.84±0.79[d]	14.42±0.43[c]	15
Chromium (mg/kg)	-	-	-	-	0.05

In each of the parameters, means with the different letters (superscripts) indicates significantly different at $p < 0.05$

The heavy metal content of the soil samples

The results for heavy metals on Table 2 showed that the iron values for the abattoir sites are high (2780.33±20.50 mg/kg), (2356.00±48.38 mg/kg), and (2049.67±61.45 mg/kg) respectively. The control also recorded a high concentration value (1076.00±117.09 mg/kg) which could be as a result of some activities which could have been carried out on the land in the time past.

The concentration of heavy metals in the samples and the control as indicated in Table 2 revealed that the iron values range between 1076.00±117.09 mg/kg to 2780.33±20.50 mg/kg indicating that iron concentration in the environment is very high which is similar to what was obtained by Yahaya *et al.* (2009). The values reported do not conform to NESREA permissible limit of 400 mg/kg. A significant difference in all the locations was observed. Despite this, the soil is not safe for agricultural use. The result also showed that Nickel was below detection limits. Nickel has been reported to be a major cause of cancer in human beings (Ediene and Iren, 2017).

Table also showed that values of copper concentration ranged between 8.22±0.40, 8.41±0.50, 4.31±0.40 mg/kg for samples S_1, S_2 and S_3 respectively, while (2.35±0.33 mg/kg) for the control soil. The highest value was at S_2, while the lowest concentration was at the control. There is a significant difference between S_3 and the control. The level of the copper at the control could be as a result of activities that could have taken place around the soil environment long before the experiment was conducted. Although copper at the permissible level assists in blood synthesis (Garba *et al.*, 2010), the result also showed that the level of copper concentration at the different soil locations is high which differs from the report of Sumayya *et al*. (2013). The concentration is not within the NESREA permissible limit which if consumed, could result in a gastric problem, liver disease, kidney failure and also blood deformation (Ediene and Iren, 2017). The result revealed that lead concentration was not detectable in any of the samples analyzed, even though the required permissible NESREA standard is 0.05 mg/kg. Zinc concentrations ranged between 109.80±1.60 mg/kg, 130.28±0.38 mg/kg and 126.84±0.79 mg/kg for S_1, S_2 and S_3 respectively, and 14.42±0.43 mg/kg for the control soil. The control soil had the lowest concentration of zinc (14.42±0.43 mg/kg), with the results varying significantly from each other with only the control soil meeting the NESREA permissible limit (15 mg/kg). This is similar to what was reported by (Hanlon, 2015). Zinc has been reported to be beneficial to man as its deficiency can result in congenital abnormality in children, but an excess of zinc intake can cause health disorder (Morgan *et al*., 2008). No chromium concentration was detected in the soil samples and the NESREA permissible concentration is 0.05 mg/kg. This is an indication that the soil free from pollution with chromium.

Conclusions

The study investigated the effect of abattoir activities on the soil. The result obtained showed that the activities of abattoir slightly contributed to the soil pollution due to increase in the concentrations of Fe, Cu, Zn, nitrate and sulphate in the soil samples. The pH of the soils was slightly acidic but within the permissible limit. Ni, Pb and Cr were not detected in the soils which makes the soils conform the NESREA recommended limit. The study also revealed that indiscriminate animal waste dumping has detrimental effects on soils and should be controlled by the Ogun State Waste Management Authority. An adequate means of soil remediation is recommended were higher levels of pollution and contamination have been established.

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Conflicts of Interest

There are no conflicts of interest.

References

Adegoke AT, Lawal NS, Odusanya OA, Idowu OT & Oyetunji OT 2020. The effects of natural coagulants using *Moringa oleifera* and Aluminium sulphate in restaurant wastewater treatment. *Journal Kejuruteraan,* 32(4): 693 – 698.

Aires I, Carvalho R, Eduardo AS, Rosa, EA & Saavedra MJ 2013. Effects of agriculture production systems on nitrate and nitrite accumulation on baby-leaf salads. *Food Science and Nutrition,* 1(1): 3–7.

Dan E, Fatunla K & Shuaibu S 2018. Influence of abattoir wastes on soil microbial and physicochemical properties. *Int. J. Adv. Res. and Innov.,* 6(4): 253-261.

Ediene VF & Iren OB 2017. Impact of abattoir effluents on the pH, organic matter, heavy metal levels and microbial composition of surrounding soils in Calabar Municipality *Asian J. Envt. and Techn.,* 2(3): 1-10.

Elemile OO, Raphael OD, Omole DO, Oluwatuyi OE, Ajayi EO, Umukoro U & Elemile MG 2019. Assessment of the impact of abattoir activities on the physic chemical properties of soils within a residential area of Omu-Aran, Nigeria. *Materials Science and Engineering,* 640(31): 1-10.

Garba ZN, Hamza SA & Galadima A 2010. Arsenic level speciation in fresh water from Karaye, Local Government Area, Kano State, Nigeria. *International Journal of Chemistry,* 20(2): 113-117.

Hanlon EA 2015. Soil pH and Electrical Conductivity: A County Extension Soil Laboratory Manual http://edis.ifas.ufl.edu. Assessed on the 11th March, 2021.

Khan AB & Kathi S 2014. Evaluation of heavy metal and total petroleum hydrocarbon contamination of roadside surface soil. *Int. J. Envtal. Sci. and Techn.,* 11: 2259–2270.

Magaji JY & Chup CD 2012. The effects of abattoir waste on water quality in Gwagwalada-Abuja, Nigeria. *Ethiopian J. Envtal. Stud. Mgt*., 54: 542 – 549.

Malik RN, Husain SZ & Nazir I 2010. Heavy metal contamination and accumulation in soil and wild plant species from industrial area of Islamabad, Pakistan. *Pakistan Journal of Botany* 42: 123–127.

Morgan SC, Relaix F, Sandell LL & Loeken MR 2008. Oxidative stress during diabetic pregnancy disrupts cardiac neural crest migration and causes outflow tract defects. *Clinical Molecular Teratology,* 82(6): 453–463.

NESREA 1999. National Guidelines and Standards for Soil Quality in Nigeria. *National Environmental Standards and Regulations Enforcement Agency* (NESREA), Rivers State Ministry of Environment and Natural Resources, Port-Harcourt, Nigeria.

Onyeike EN, Ogbuja SI & Nwinuka, NM 2002. Inorganic ion levels of soils and streams in some areas of Ogoniland, Nigeria as affected by crude oil spillage. *Environmental Monitoring and Assessment,* 73(2): 191–204.

Rabah AB, Oyeleke SB, Manga SB Hassan LG & Ijah UJ 2010. Microbiological and physicochemical Assessment of soil contaminated with Abattoir effluents in Sokoto metropolis, Nigeria. *Science World Journal,* 5(3): 1 – 4.

Sumayya BU, Usman BU Aisha U, Shahida A, Mohammad A, Yakubu MS & Zainab M 2013. Determination of physiochemical qualities of abattoir effluent on soil and water in Gandu, Sokoto. *J. Envtal. Sci. Toxicol. and Food Techn.,* 4: 47-50.

Yahaya MI, Mohammad S & Abdullahi BK 2009. Seasonal variations of heavy metals concentration in abattoir dumping site soil in Nigeria. *J. Appl. Sci. Envt. Mgt*., 13: 9-13.