Microbial Impact Assessment of a Municipal Abattoir Operations on Adjoining Soils of its Receiving Water Milieu

Ayeni T. O.* Olusola-Makinde O. O. and Arotupin D. J.
Department of Microbiology, Federal University of Technology, Akure, Nigeria
* Corresponding author: ayenitope01@gmail.com

Abstract: Wastewater from abattoirs have been documented to have harmful impact on the surrounding soil environments. This study therefore, assessed soil samples for possible abattoir wastewater contamination of physicochemical parameters and microbial composition from a mini abattoir in South Local Government Area of Ondo State, Nigeria. Soil samples were collected from the soil 2 m away from abattoir site and 50 m upstream and 50 m downstream. The pH, soil moisture, organic matter, organic carbon, total organic nitrogen, phosphorus and cation exchange capacity were analysed using standard methods. The microbial load of the samples were determined using standard microbiological methods. Abattoir contaminated soils were acidic between 4.8 – 6.4 while the non – abattoir contaminated soil was neutral 7.01. There was significant difference in moisture content, phosphorus, organic carbon, organic matter, total organic nitrogen and cation exchange capacity in abattoir contaminated soil and non – abattoir contaminated soil. In the contaminated soil samples, mean bacterial counts was 15.4 x 10^4 cfu/ml compared to the 43.01x10^3 cfu/ml of the uncontaminated soil sample. The mean fungal counts was 39.42 x 10^2 sfu/ml and 15.2 x 10^2 sfu/ml respectively. Bacteria such as *Bacillus cereus, Enterobacter cloacae, Escherichia coli, Shigella dysenteriae, Citrobacter koseri, Providencia rettgeri, Salmonella typhi, Proteus mirabilis, Pseudomonas aeruginosa, Klebsiella pneumoniae, Lactobacillus plantarum, Actinobacter baumanni* and *Serratia mascescens,* while fungi such as *Aspergillus niger, Saccharomyces cerevisiae, Aspergillus flavus, Candida albicans, Penicillium italicum,* and *Rhizopus stolonifer* were isolated from adjoining soils of sampled abattoir. High microbial population and physicochemical parameters of contaminated soil, in this study, further confirmed the need to treat wastewater rather than discharging it directly into the environment.

Key word: Abattoir contaminated soil, wastewater, bacteria, fungi

INTRODUCTION

Abattoirs, also known as slaughterhouses, play a crucial role in the processing of animals for human consumption. According to the report of Acumen and consulting research (2022) the global protein ingredients market size is projected to be around $103,747 million by 2030. Meat is a major source of protein that is in high demand all over the world. This demand is felt more acutely in developing countries such as Nigeria. In Nigeria, over 1.3 million cows are slaughtered yearly, as cattle alone provide about 30 percent of the meat consumed in the country (Akinfenwa, 2022). Abattoirs can vary from large industrial facilities to small operations and are equipped with services like cold storage and waste recycling activities (Gadisa *et al.,* 2019). The logistics chain of abattoir operations involves loading, transporting, and unloading animals, as well as the slaughter process from lairage box to cooling room for carcasses (Gadisa *et al.,* 2019). Environmental concerns related to abattoir operations include odours from cooking and rendering processes, effluent salinity, dust emissions, fuel burning emissions, greenhouse gases, disease transmission risks, and noise pollution (Praveen *et al.,* 2017).

Abattoir operations in Nigeria face significant challenges related to waste management, environmental quality, and public health. The poor state of national abattoirs, meat processing plants, and ineffective meat inspection services pose risks of consuming unwholesome meat, raising concerns for public health and environmental quality. The establishment, operations, and management of abattoirs in Nigeria are crucial for ensuring food safety, quality of life, and environmental sustainability. However, many abattoirs in Nigeria operate below international standards, lacking essential facilities like hanging rails, potable water, and proper waste disposal systems (Ovuru *et al.*, 2024).

Studies have highlighted the inadequate waste management practices in Nigerian

abattoirs, leading to environmental pollution and health hazards (Ekpunobi *et al.*, 2024). Abattoir waste contains various contaminants and microbial organisms that can pollute the environment, posing serious threats to human health and quality of life (Obidegwe *et al.,* 2019). The challenges posed by poor waste disposal from abattoirs include air pollution, contamination of soil and water sources, and adverse effects on aquatic life. These issues are exacerbated by factors such as obsolete facilities, inadequate clean water supplies, and the location of abattoirs in residential areas (Jerie and Matunhira, 2022).

The impact of a municipal abattoir operation on adjoining soil can be significant due to the microbial contamination associated with abattoir waste (Obidegwe *et al.,* 2019). Studies have shown that abattoir wastewater can lead to soil contamination, affecting soil fertility and productivity (Okwakpam *et al.*, 2022). The microbial content of abattoir wastewater and its contaminated soil has been found to be high, with bacterial and fungal populations exceeding safe levels (Awari *et al.,* 2020). This contamination can disrupt the ecological balance of the soil, reducing microbial species diversity and potentially increasing the population of a few surviving species (Geisen *et al.*, 2019). In addition, abattoir operations have a significant impact on the physicochemical properties of adjoining soil. Studies have shown that activities at abattoir sites can deplete certain parameters in the soil due to increased microbial activities from animal waste deposits (Ebong *et al.*, 2020; Useh *et al.,* 2022). The constant washing at abattoirs can also wash off nutrients into water bodies, further affecting soil quality (Gutu *et al.,* 2021).

Research has indicated that abattoir wastewater can lead to changes in the physicochemical properties, high microbial counts and varieties of microorganisms of contaminated soil. The contaminated soil may contain various chemicals, indicating high microbial activities and potential pollution risks (Ariyo and Obire, 2021). Furthermore, the discharge of abattoir wastewater into surrounding soils negatively impact soil quality by introducing pollutants such as heavy metals, organic compounds, and pathogens. This pollution disrupts the ecological balance of the soil, reduce microbial species diversity, and increase the population of surviving species, leading to potential environmental and health risks (Ogun *et al.,* 2023).

Research has shown that abattoir wastewater can lead to changes in soil properties, with notable effects on pH, available phosphorus (P), and micronutrients such as zinc (Zn), manganese (Mn), and iron (Fe). Specifically, abattoir effluent has been found to increase soil pH, available P, and micronutrients significantly while reducing exchangeable cations compared to control conditions (Gorfie *et al.,* 2022). Studies have reported higher levels of total organic matter, total organic carbon, cation exchange capacity, total petroleum hydrocarbons, nitrogen, and phosphorus in abattoir-contaminated soils compared to control soils (Alabi *et al.,* 2019; Ariyo and Obire, 2021). Additionally, essential elements like potassium (K), sodium (Na), calcium (Ca), magnesium (Mg), and trace metals such as iron (Fe), zinc (Zn), cadmium (Cd), copper (Cu), lead (Pb), chromium (Cr), and nickel (Ni) were found to be higher in abattoir-contaminated soils (Abd and Omar, 2021).

MATERIALS AND METHODS

Study Area: This research was carried out in the Department of Microbiology, School of Life sciences, Federal University of Technology, Akure. Akure is the capital of Ondo State, and it is located in South Western Nigeria. Ondo – State has eighteen (18) local government areas and a land area of 13,595km^2. Ondo State lies between longitudes 4^O 30' and 6^O East of the Greenwich meridian 5^O, 45' and 8°15' North of the Equator. The State lies entirely in the tropics. Most live in rural areas with a rural/urban population ratio of 61/39. The State abattoirs selected for the study are under the supervision of Ministry of

Agriculture, Veterinary Services, Ondo State.

Collection of abattoir soil samples: Ten grams (10 g) of wastewater adjoining soil samples were taken from a depth of 10 cm with the aid of soil auger into sterile sample bottles. Samples were immediately transported in ice chest to the Department of Microbiology laboratory, Federal University of Technology, Akure, Nigeria for analysis within 30 minutes of sample collection.

Determination of pH: Five grams (5 g) of soil sample was mixed with distilled water in ratio 1:2 and allowed to stand for 30 minutes. The pH of the mixture was determined by Jenway 3510 pH electrode which has been calibrated with buffer 7, 4 and 9.

Determination of organic matter: Ten grams (10 g) of soil sample was weighed into a 250 ml conical flask after which 10 ml of 0.167 M $K_2Cr_2O_7$ was added. Twenty milliliters (20 mls) of concentrated sulphuric acid were also added and swirled until the reagents were properly mixed. The flask was rotated and allowed to stand on asbestors sheet for 30 minutes. One hundred millilitres (100 mls) of distilled water were added, three drops of ferroin indicator and titrated against 0.5 M ferrous ammonium sulphate. The blank was also prepared using the same procedure as the sample (Carter, 1992).

$$\% \text{ Organic carbon} = \frac{(B - T) \times M \times 0.003 \times 1.33 \times 100}{\text{Weight of sample}}$$

Where, B = Blank titre value

T = Sample titre value

M = Molarity of ferrous ammonium sulphate

W = Weight of sample

% Organic matter = % Organic carbon x 1.724

$$\% \text{ Organic nitrogen} = \frac{\% \text{ Total carbon}}{20}$$

Phosphorus determination: The available phosphorus was determined by weighing 5 g of soil sample and 35 ml of extracting solution (NH_4F and HCl). The mixture was swirled for one minute and filtered with Wattman filter paper. Five milliliters from the filtrate were pipetted into 50 ml volumetric flask and 8ml of ascorbic acid solution was added and made up to 50 ml with distilled water. The solution was allowed to stand for 30 minutes and the absorbance read at 660 nm using Hach DR 5000 UV spectrophotometer (Murphy and Riley, 1962).

Cation exchange capacity (CEC) determination:Two grams of soil sample was weighed into a clean centrifuge tube and 15ml of 1 M sodium acetate trihydrate solution was added and mixed for 5 minutes. The tube was centrifuged at 300 rpm until the supernatant was clear. The supernatant was decanted and discarded. This process was repeated four times with 15 ml 1M sodium acetate. Then, 15 ml of 95% ethanol was added and centrifuged until the supernatant was clear and decanted. The process, with ethanol, was repeated until the electrical conductivity of the supernatant was less than 400 microcentimeter. The absorbed sodium was replaced by extracting with 15 ml portions of 1 M ammonium acetate solution, mixed for 5 minutes and centrifuged until the supernatant was clear. This process was repeated three times and the supernatants were up to mark in 100 ml standard flask with 1 M ammonium acetate solution. The concentration of sodium in the sample was analysed using flame photometer (Ibitoye, 2006). Values were determined with the following formular.

$$\text{Soil sample concentration (ppm)} = \frac{\text{Concentration of solution}}{\text{Weight of sample}} X\ 100$$

Isolation of microorganisms from soil samples: Commercially prepared nutrient agar was used for bacterial isolation while potato dextrose agar was used for fungal isolation. The recommended quantity of all culture media was weighed into a conical flask and the appropriate quantity of distilled water was added according to manufacturer's instruction. One gram of soil sample was dissolved in 9 ml sterile distilled water, successive decimal dilutions were obtained with 1 ml of the sample added to 9 ml of sterile distilled water resulting to a dilution of 10^{-1}. One ml was aseptically poured into sterile Petri dishes and 15 ml of

prepared medium was poured aseptically into the sterile Petri dishes and allowed to solidify. The petri dishes were appropriately labeled.

Colonial and morphological characteristics of microbial isolates of the samples: The colonial and morphological characteristics of the colonies such as colour, elevation, texture and opacity were used as the presumptive test for the identification of the bacterial isolates. The biochemical tests were carried out according to Cheesbrough (2006).

Identification of bacterial isolates of samples: Bacterial isolates were presumptively identified using standard methods for colonial morphology, microscopy and biochemical tests (Cheesbrough, 2006).

Identification of fungal isolates of samples: The identification of fungi was based on macroscopic and microscopic examination. Macroscopic examination was based on colour, texture, topography, and nature of hyphae. In microscopic examination, the technique of James and Natalie (2001) was adopted for identification of unknown isolated fungi using cotton blue in lactophenol stain. The identification was achieved by placing a drop of the stain on clean slide, where a small portion of the mycelium was spread very well on the slide with the aid of a needle. A cover slip was gently applied with little pressure to eliminate air bubbles. The slide was then mounted and observed with x10 and x40 objective lenses. The species encountered was identified in accordance with (Cheesebrough, 2006).

Statistical Analysis*:* Data obtained from analysis were subjected to statistical analysis of variance (ANOVA) to determine the level of variations. The statistical package for social sciences (SPSS) version 20 software was used for this study. $P \leq 0.05$.

RESULTS

The physicochemical properties of the soil samples are presented in Table 1. The findings revealed the mean pH value of 4.8 – 6.5 except for unpolluted soil which is 7.01. Percentage moisture content ranges from 0.5 – 2.3%, phosphorus from 22.7 – 32 mg/kg, organic carbon (7.7 – 24.5 g/kg). organic matter (13.3 – 42.3 g/kg), total organic nitrogen (0.4 – 1.22 g/kg) and cation exchange capacity ranges between 21.3 – 28.3. The pH value indicated an acidic nature of polluted soil samples in this study. There was no significant difference among temperature range in samples. The organic matter, organic carbon and total organic nitrogen were relatively higher in wastewater contaminated soil sample with cation exchange capacity highest in wastewater contaminated soil (28.3±0.15 meq/kg) than non – abattoir contaminated soil (22.21±0.01 meq/kg).

Table 2 shows the mean aerobic total bacterial count (TBC) and total fungal count (TFC) from each of the sampling points. The aerobic TBC of the samples ranged from $83.2 \times 10^3 \pm 0.10$ to $25.1 \times 10^4 \pm 0.03$ cfu/ml. The bacterial counts from the abattoir soil had the highest number followed by downstream soil and the least counts was upstream soil. The findings show very high bacterial counts for all samples when compared with the FEPA standard of 4.0×10^2 cfu/ml standard.

Table 1: Physicochemical properties of adjoining soils

Physicochemical parameters	Wastewater adjoining soil	Upstream adjoining soil (50 m)	Downstream adjoining soil (50 m)	Non – abattoir polluted soil
pH	4.8±0.36[a]	6.5±0.06[a]	6.4±0.4[a]	7.01±0.01[b]
Moisture Content (%)	0.5±0.05[a]	2.3±0.2[c]	2.2±0.05[c]	0.52±0.01[b]
Phosphorus (mg/kg)	33±0.02[a]	22.7±0.6[c]	31.7±0.5[a]	32.52±0.01[a]
Organic Carbon (g/kg)	24.5±0.17[b]	16.2±0.9[a]	18.97±0.23[b]	10.44±0.01[d]
Organic Matter (g/kg)	42.3±0.58[b]	28.3±0.5[a]	32.7±0.25[b]	18.19±0.01[d]
Total Organic Nitrogen (g/kg)	1.22±0.01[b]	0.81±0.06[a]	0.9±0.2[a]	0.52±0.01[a]
Cation Exchange Capacity (meq/kg)	28.3±0.15[c]	20.3±0.5[a]	21.3±0.15[a]	22.21±0.01[c]

Key: Values are means ± standard error means in the same column with different superscripts are significantly different ($p \leq 0.05$)

Table 2: Total bacterial and fungal count of adjoining abattoir wastewater soils

Sample Source	Total bacterial count (cfu/ml) TBC x 10^3	Total fungal count (sfu/ml) TFC x 10^2
Abattoir Waste water Soil	250.7±0.03[a]	58.2±0.13[b]
Upstream Adjoining Soil	83.2±0.10[c]	13.02±0.03[c]
Downstream Adjoining Soil	127.3±0.05[b]	47.05±0.07[b]
Non – abattoir Polluted Soil	43.01±0.03[d]	15.2±0.23[c]

Key: values are means ± standard error means in the same row with different superscripts are significantly different ($p \leq 0.05$)

Analysis of variance on the data obtained showed that there was significant difference ($P \leq 0.05$) in the total bacterial counts among samples. The TFC ranged from 13.02 x 10^2 ± 0.03 to 37.05 x 10^2 ± 0.07. The highest fungal was observed in downstream soil followed by wastewater soil and the least was upstream soil. Fungal count in downstream and abattoir soil samples was statistically not different from each other.

Tables 3 and 4 show the gram reaction and biochemical test reaction of bacterial isolates from soil samples. The bacteria were presumptively identified as *Bacillus cereus, Enterobacter cloacae, Escherichia coli, Shigella dysenteriae, Citrobacter koseri, Providencia rettgeri, Salmonella typhi, Proteus mirabilis, Pseudomonas aeruginosa, Klebsiella pneumoniae, Lactobacillus plantarum, Actinobacter baumanni and Serratia mascescens*. Table 6 shows the cultural identification of fungal isolates from soils. The fungi were identified as *Aspergillus niger, Saccharomyces cerevisiae, Aspergillus flavus, Candida albicans, Penicillium italicum, and Rhizopus stolonifer*.

Table 3: Biochemical characteristics of bacterial isolates from the abattoir wastewater samples

Shape	Arrangement	Gram Reaction	Spore Staining	Motility	Oxidase	Urease	Citrate	Catalase	Coagulase	Indole	MR	VP	Lactose	Maltose	Glucose	Mannitol	Sucrose	Hydrogen Sulpide	Endo	Haemolysis	Isolate
rod	chain	+ve	+ve	+ve	+ve	+ve	+ve	+ve	ND	-ve	-ve	+ve	-ve	+ve	+ve	-ve	+ve	-ve	ND	beta	*Bacillus cereus*
rod	chain	-ve	-ve	+ve	-ve	-ve	+ve	+ve	ND	+ve	-ve	-ve	+ve	+ve	+ve	-ve	+ve	-ve	P	beta	*Enterobacter cloacae*
rod	chain	-ve	-ve	+ve	-ve	-ve	-ve	+ve	ND	-ve	+ve	+ve	+ve	+ve	+ve	+ve	+ve	-ve	GMS	beta	*Escherichia coli*
rod	chain	-ve	-ve	-ve	-ve	-ve	-ve	+ve	ND	-ve	+ve	-ve	-ve	+ve	+ve	+ve	-ve	-ve	C	gamma	*Shigella dysenteriae*
rod	chain	-ve	-ve	+ve	-ve	-ve	+ve	+ve	ND	-ve	+ve	-ve	+ve	+ve	+ve	+ve	+ve	+ve	P	alpha	*Citrobacter koseri*
rod	chain	-ve	-ve	+ve	-ve	+ve	-ve	+ve	ND	+ve	+ve	-ve	-ve	+ve	+ve	+ve	+ve	+ve	C	gamma	*Providencia rettgeri*
rod	chain	-ve	-ve	+ve	-ve	-ve	-ve	+ve	ND	-ve	+ve	-ve	-ve	+ve	+ve	+ve	-ve	+ve	C	gamma	*Salmonella typhi*
rod	chain	-ve	-ve	+ve	-ve	+ve	+ve	+ve	ND	-ve	+ve	-ve	-ve	-ve	+ve	-ve	-ve	+ve	C	gamma	*Proteus mirabilis*
rod	chain	-ve	-ve	-ve	-ve	+ve	+ve	+ve	ND	-ve	-ve	+ve	+ve	+ve	+ve	+ve	+ve	-ve	P	gamma	*Klebsiella pneumoniae*
rod	chain	+ve	-ve	-ve	-ve	-ve	-ve	-ve	ND	-ve	-ve	-ve	+ve	+ve	+ve	-ve	+ve	-ve	ND	alpha	*Lactobacillus plantarum*

Key: +ve: positive, -ve: negative, ND: not done, GMS: green metallic sheen, P: pink, C: colourless

Table 4: Biochemical characteristics of bacterial isolates from abattoir wastewater soil samples

Shape	Arrangement	Gram Reaction	Spore Staining	Motility	Oxidase	Urease	Citrate	Catalase	Coagulase	Indole	MR	VP	Lactose	Maltose	Glucose	Mannitol	Sucrose	Hydrogen Sulphide	Endo	Haemolysis	Isolate
rod	chain	-ve	-ve	+ve	+ve	-ve	+ve	+ve	-ve	-ve	-ve	+ve	-ve	-ve	+ve	-ve	-ve	-ve	ND	beta	*Pseudomonas aeruginosa*
rod	chain	-ve	-ve	-ve	-ve	-ve	+ve	+ve	ND	-ve	-ve	-ve	-ve	+ve	+ve	-ve	-ve	-ve	C	beta	*Acinetobacter baumanni*
rod	chain	-ve	-ve	+ve	-ve	+ve	+ve	+ve	ND	-ve	-ve	+ve	-ve	+ve	+ve	+ve	+ve	-ve	C	alpha	*Serratia marcescens*

Key: +ve: positive, -ve: negative, ND: not done, GMS: green metallic sheen, P: pink, C: colourless

Table 5: Cultural characteristics and microscopic examination of fungal isolates from abattoir wastewater soil samples

Cultural characteristics (on plate)	Microscopic examination of slide culture	isolate
Cottony appearance, dark – brownish The reverse is pale yellow	Hyphae are septate. Smooth conidophores and conidia. Conidia head appear radial	*Aspergillus niger*
Flat, smooth, moist and whitish-cream	Blastoconidia (cells budding out) oval in shape	*Saccharomyces cerevisiae*
Greyish fluffy mass. Visible elevated black spore.	Non – septate hyphae	*Rhizopus stolonifer*
Yellowish-green spores	Conidiophores are long and rough protruded from a septate hyphae	*Aspergillus flavus*
Blue – green spores. Reverse is yellowish.	Brushed – shaped unicellular, ovoid conidia. Multinucleated septate hyphae	*Penicillium italicum*
Flat, smooth, dry and whitish cream	Blasto conidia. Oval shaped cells	*Candida albicans*

DISCUSSION

The discharge of untreated abattoir wastewater into the environment, coupled with the challenges of having sustainable conventional wastewater treatment options is a major environmental concern. Studies have reported that polluted water bodies from abattoir wastes could constitute significant environmental hazards (Nafarnda *et al.,* 2012; Akankali *et al.,* 2022). The low pH values observed in abattoir polluted soil indicated that abattoir wastewater has the ability to alter the pH value of soils. This is in line with the findings of Chikwendu *et al.* (2019), whose findings revealed lower pH of abattoir effluent contaminated soil, and high pH on uncontaminated soil. The findings revealed that there was significant difference between the pH values of the soil samples.

Organic carbon and organic matter were higher in abattoir polluted soils than non – abattoir polluted soil (Ibeaja, and Njoku, 2024). Soils from wastewater discharging area samples were statistically similar, but were different from the control samples (non – abattoir polluted soil). These findings also conform with that of Ogunlade *et al.* (2021). They found out high percentage organic carbon and organic matter values on wastewater contaminated soil than on uncontaminated soil. This is because of the fact that waste from abattoir typically contains compounds that are characterized by high organic level (Ng *et al.,* 2022).

There are significant high mean values of total nitrogen observed on soil samples from the wastewater discharging areas. This is attributed to the washing away of faeces that is known to contain undigested protein, excess nitrogen from digested protein (Baniasad *et al.,* 2022), high microbial activities such as decomposition of organic residues. High total nitrogen content of the soil enhances microbial proliferation and promotes plant growth (Zhang *et al.,* 2019).

Soil contaminated with abattoir wastewater samples had higher available phosphorus content than the non – abattoir contaminated soil samples. This is consistent to the findings of Rabah *et al*. (2010), who reported similar high mean available phosphorus value of 5.60 mgg-1 for abattoir wastewater contaminated soil and 5.20 mgg-1 for uncontaminated soil.

A total of five hundred and three (503) bacteria and one hundred and thirty-three (133) fungi colonies were isolated from the abattoir polluted sampled soils by standard plate count technique. This may be as a result of the high organic carbon and organic content of the abattoir polluted site soils. In addition, it could be as a result of the increased availability of biodegradable organic and inorganic substrates from the consistent abattoir operations over time. This is similar to the finding of Ibe and Nzenwa, (2023) who reported a high microbial count while assessing the physicochemical and selected heavy metal contents of wastewater in the vicinity of an abattoir within Owerri municipal, Imo State. The bacterial counts of sample taken from 5 different sampling points reveled varied loads and composition of bacteria. The counts relatively varied with different locations at the abattoir sites. The total bacterial counts were relatively high compared to the FEPA standards of 4.0 $x10^2$ cfu/ml. The bacteria in the abattoir samples were identified as *Bacillus cereus*, *Serratia marscescens*, *Escherichia coli*, *Enterobacter claocae*, *Shigella dysenteriae*, *Citrobacter koseri*, *Providencia rettgeri*, *Actinobacter baumanni*, *Salmonella typhi*, *Proteus mirabilis*, *Klebsiella pneumoniae*, *Lactobacillus plantarum*, and *Pseudomonas aeruginosa.* This is similar to the findings of Anele *et al.* (2023) who identified *Micrococcus* sp., *Bacillus* sp., *Staphylococcus* sp., *Streptococcus* sp., and *E. coli*, in their report on the environmental impact assessment of abattoir in River – State, Nigeria. Also, in thesame study, the fungi isolated included *Aspergillus niger, Saccharomyces cerevisiae, Aspergillus flavus, Candida albicans, Penicillium italicum*, and *Rhizopus stolonifer*. This finding agrees with the report of Olusola – Makinde *et al.* (2018) who reported the presence of *Aspergillus niger, Saccharomyces cerevisiae, Aspergillus*

flavus in abattoir wastewater in Akure, Ondo – State, Nigeria.

CONCLUSION

The microbial impact assessment of a municipal abattoir operation on adjoining soil from its abattoir effluents' receiving water bodies revealed high contamination levels of abattoir wastewater contaminated soil samples. The study revealed that abattoir contaminated soil was acidic and other physicochemical properties in abattoir contaminated soil were significantly different from the non – contaminated soil. The study also shows high microbial composition of abattoir wastewater contaminated adjoining soils. The findings underscore the necessity of treating abattoir wastewater to prevent negative effects on soil physicochemical properties as well as microbial populations and mitigate environmental pollution.

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