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Assessment of the Perception of Abattoir Environmental Hygiene and Sanitation Practices in Ubakala, Abia State, Nigeria

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ABSTRACT: The study assesses hygiene and sanitation practices in abattoirs in order to maintain meat safety procedures. Hence, the objective of this paper is to evaluate the perceived environmental hygiene and sanitation practices of slaughterhouses in Ubakala, Abia State, Nigeria using appropriate standard procedures including 50 structured questionnaire. Results reveal that the majority of operators (85.0%) were men; 50.0% belonged to the 31-41 age group, while 80.0% were married. About 75.0% attended secondary school, and 40.0% average monthly income range from ₦201,000 and ₦300,000. Features of the slaughterhouse show that 95.0% of the time, more than seven cows were killed every day, and 80.0% of the time, the abattoir was located next to a river or stream. Hence, 60.0% of people burn their waste, 65.0% dispose of waste often, and 85.0% wash their soiled aprons once a week. Ninety percent reported a lack of infrastructure, while only five percent reported the use of pest control devices; a hundred and fifty percent reported veterinary doctor inspections, and sixty-five percent mentioned medical examination and care given to employees who handle meat and exhibit symptoms like diarrhea, coughing, or skin infections (95.0%). There are high levels of meat hygiene practices and low levels of bacterial contamination in beef. The study suggests increasing the inspection of meat sold to the public and training meat handlers in hygiene maintenance.

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The demand for water is escalating due to multiple anthropogenic factors, rapid population growth, and increased urbanization (Paiva *et al*., 2020). Water resources are significantly strained by anthropogenic activities, including agriculture, industry, livestock, fishing, domestic use, and healthcare facilities, due to indiscriminate utilization and the release of metal effluents, which are identified as chemical hazards from farms, material makers, and industrial companies situated in or near river catchment areas also generate contaminants (Toma *et al*., 2024). Studies by Ocheri *et al*. (2014), Ado *et al*. (2015), Ighalo and Adeniyi (2020), Okimiji *et al*. (2024), and Isukuru *et al*. (2024) regarding the quality of surface and groundwater systems in Nigeria pinpoint significant pollution sources, such as oil and gas

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exploration, solid mineral mining, abattoirs, domestic waste and sewage, landfill leachates, and inadequate air quality. Water contamination significantly diminishes cultural health by inducing diseases and disrupting metabolism (Liaqat *et al*., 2017; Sanou, 2024); quality declines and becomes tainted due to chemical or biological contamination, adversely affecting humans and other organisms (Hanif *et al*., 2020; Brahimi *et al*., 2015). More so, the natural flow of water often leads to the accumulation of pollutants at centralized collection points, such as reservoirs, which can act as repositories for various contaminants (Nowrouzi and Pourkhabbaz, 2014; Tuhin *et al*., 2024). In this regard, waste by several abattoir has led to significant environmental issues (Tan *et al*., 2013; Adamu and Dahiru, 2020). Consumer health risks may result from improper handling of meat (Haileselassie *et al*., 2013). Because butcheries have a significant risk of contamination, they are essential to the prevention of meat-borne illnesses. In order to offer fresh and nutritious meat for human consumption, it is imperative to practice and maintain adequate hygiene when handling meat (Khanal and Poudel, 2017). Meat workers who don't practice good personal hygiene run the risk of spreading microorganisms through their hands, cuts, lips, skin, and hair (Wambui *et al*., 2017; Ebuete *et al*., 2020). Bacterial contamination, meat loss, and post-harvest meat shortages can occur from neglecting to adhere to basic sanitation and hygiene practices, such as hand washing, donning protective clothes, and cleaning and sanitizing butchery equipment and utensils (Chepkemoi *et al*., 2015). Research carried out in Tanzania (Ntanga *et al*., 2014) and Ethiopia (Birhanu *et al*., 2017) have demonstrated that butcheries' meat and meat-contact surfaces have higher than permitted levels of bacteria. In impoverished nations, standard and hygienic methods for handling and processing meat are frequently disregarded (Rani *et al.,* 2017). The World Health Organization estimates that foodborne infections resulted in 600 million cases, 420,000 deaths, and almost 33 million years of lost life globally in 2010. The continent of Africa experienced the highest death toll from these illnesses (Gutema *et al.,* 2021; Havelaar *et al*., 2015). Improved hygienic handling practices during preparation, distribution, storage, and retail sales are crucial to reducing microbial contamination (Gutema *et al*., 2021). For health and safety, wearing protective clothing and cleaning your hands before and after handling meat are essential (Ntanga, 2013). When handling meat, donning an apron or gown can help prevent the meat handler and the meat from coming into contact with foodborne germs (Sulleyman *et al*., 2018). The knowledge and practices surrounding meat safety have been the subject of numerous studies (Haileselassie *et al*., 2013; Khanal and Poudel, 2017; Al Banna *et al*., 2021). Other studies have looked at meat handling procedures along the beef supply chain (Chepkemoi *et al*., 2015; Sulleyman *et al*., 2018) and the bacteriological quality of meat from butcher shops and abattoirs across international borders (Sulleyman *et al*., 2018; Aburi, 2012). The literature urgently needs to look at the routine procedures followed by food handlers in the course of their jobs and possible sources of microbiological pollutants that could have an impact on the quality of meat products (Shilenge *et al*., 2017). The transmission of infectious and zoonotic diseases is facilitated by inadequate emergency care and first aid facilities at slaughterhouses. Banjo *et al*. (2013) points out that there must be enough first aid facilities available due to the hazardous nature of the work in the meat sector. These include touching contaminated hands, breathing in infected aerosols when burning hides, and exposing mucosal membranes to blood and bodily fluid splashes.

According to Kinsella *et al*. (2006), the water activity of beef, which is roughly 0.99, promotes microbial development and allows bacteria to adhere to and multiply on meat. At slaughterhouses and retail establishments, the removal of hides, evisceration, processing, packaging, storage, and distribution are the main times when microbiological contamination of carcasses happens (Abdalla *et al*., 2009). According to Humphrey *et al*. (2007), these microbes commonly cause foodborne diseases in addition to causing spoiling. For meat and meat products, many nations advise using hygienic and quality control procedures, especially in food catering (Tavakoli and Razipour, 2008). According to Fasanmi *et al*. (2010), the use of contaminated water, careless handling techniques, contaminated tables for meat display, and the use of dirty blades and equipment during cutting operations are all common causes of meat contamination in abattoirs and retail establishments. Wooden boards, knives, and scales in retail store are frequently a source of bacterial contamination, particularly from *Shigella* and *Staphylococcus aureus* species (Ali *et al.,* 2010).Consumer acceptability, functional and eating characteristics, and processing attributes are all impacted by low-quality meat (Ferguson and Warner, 2008). Foodborne infections are mostly caused by eating habits, unhygienic conditions in slaughterhouses, and hazardous food storage and transportation (Kebede *et al*., 2014). To inform public health measures, thorough assessments of the sanitary state and handling procedures in abattoirs are necessary (Bersisa *et al*., 2019; Chuku *et al*., 2016, Okechukwu *et al*., 2018; Bersisa *et al*.,

2019). Hence, the objective of this paper is to evaluate the perceived environmental hygiene and sanitation practices of slaughterhouses in Ubakala, Abia State, Nigeria.

MATERIALS AND METHODS

Study area description: The Umuahia South Local Government Area in Abia State, which includes Ubakala, was chosen as the research's study area. It was founded in August 1991 by the Nigerian Federal Government, and it has its offices at Apumiri Ubakala, which is across from the well-known Apumiri market (Ukandu *et al*., 2011). The Local Government Area (LGA) is located in the Equatorial Rain Forest Zone. It is bordered to the north by the Imo River, to the south and southeast by Isiala-Ngwa North Local Government, and to the northeast by the Ikwuano Local Government (Ukandu *et al*., 2011). The coordinates of its location are 5° 31.59' N and 7° 28.59' E. Ubakala has 138,570 people living there, spread across an area of about 140 square kilometers, as reported in the Nigerian census of 2006. The Nigerian Television Authority, Federal Radio Corporation, the Ministry of Environment, and the Cereal Research Institute in Amakama are notable organizations in the region (John, 2016). The LGA is made up of the four well-known clans, Olokoro, Ubakala, Umuopara, and Old Umuahia, which are further divided into forty autonomous communities: Amakama, Umuobia, Umuntu, Amangwu, Amizi, Umuajata, Umudere, Avonkwu, Itu, Agbama, Itaja, Umuoparaozara, Okwu, Abam, Amibo, Amuzu, Avodim, Eziama, Ipupe, Laguru, Mgbarakuma, Nisirimo, Nsukwe, Umuogo, Umuosu, Apumiri, Umuezeala, Umuecheokwu, Okwu, Umuovo, Amuzuta, Ezeleke, Ogbodiukwu, Amizi, Umuajata, Umuovo, and Umunwawa (Ukandu *et al*., 2011). Release and Drainage: Low-lying to moderately high plain topography with surface elevations ranging from 59.5 to 164.5 meters above sea level characterizes the Umuahia South Local Government Area (Ukandu *et al*., 2011). The Imo River and its tributaries, which flow south and empty into the Atlantic Ocean, drain the region. The majority of the drainage pattern is dendritic, with tributaries typically flowing southward. The study area map is shown in Figure 1 below, and the sample collecting area map is shown in Figure 2.

Sample size and sampling technique (questionnaire survey): The persons employed by the slaughterhouses were the study's target population. In all research regions, questionnaires were administered using basic random sampling techniques. A systematic questionnaire was used to gather data on the abattoir's hygiene and meat safety procedures through direct human observation. For this investigation, a total of twenty employees from the Ubakala Umuahia South abattoir were chosen. An association led by a chairman oversees the abattoir, and local government inspectors check the animals each morning before they are killed.

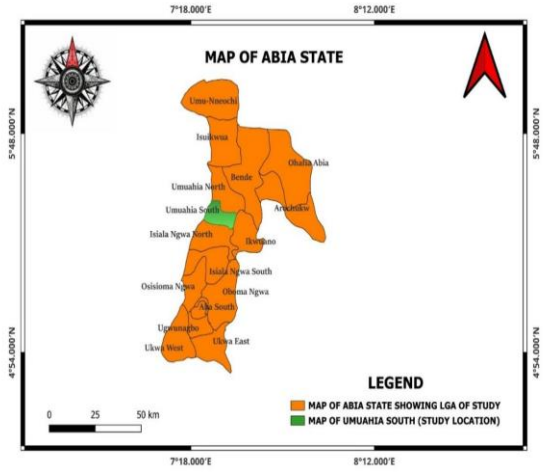

Fig. 1: Map of the study area
Source: Author's Field Survey

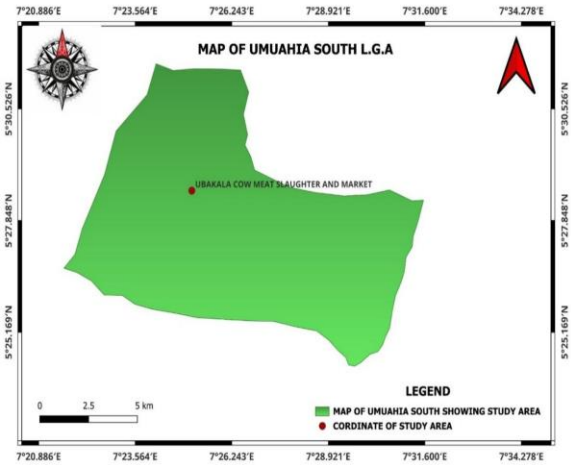

Fig. 2: Map of the sample collection area
Source: Author's Field Survey

In order to evaluate the knowledge of abattoir personnel regarding hygienic and sanitary measures during meat slaughter and processing, twenty copies of a well-structured questionnaire were produced and distributed. The following subjects were included in the questionnaire: (i) The participants' socio demographic details; (ii) meat handlers' hygiene habits; (iii) the hygienic state of their work clothes; (iv) the supermarket/butchery's infrastructure and hygiene upkeep; and (v) the meat's presentation in the butchery. To guarantee validity and reliability, pre-tests were conducted on the questionnaires. According to Van Teijlingen *et al*. (2001), this pilot survey offered insightful information about study

procedures, resource management, and scientific validity. In this regard, the formula provided by Berenson *et al.* (2006) is used to a sample of 10 to 20 participants in this study (Enq 1);

$$n = \frac{Z^2 \times S^2}{D^2} \quad (1)$$

Where n = is the minimum sample size; Z = is the Z-value of the distribution function (for normal distribution z = 1.96 while for alpha = 0.05); S = is the estimated proportion of the population standard deviation while D = is the margin of error (Berenson *et al*., 2006).

When the sample standard deviation is divided by the square root of the sample size, the permissible standard error of the mean, or d, is obtained. The single proportion formula was used to estimate the sample size. Using the Cochran (1977) method, this sample size (n households out of total households) yields a 95% confidence level with a 5% margin of error. The following formulae were employed to calculate the sample size (Enq. 2):

$$n = \frac{\frac{t_{2\ Pq}}{d_2}}{1_N^1 \left[\frac{t_{2\ Pq}}{d_2} - 1\right]} \quad 2$$

Where t = is the degree of confidence (set at 0.95, making t = 1.96), d = is the margin of error (set at 0.05), n= is the minimum number of samples, N = is the population size, p is the proportion of particular characteristics (group), q = is 1 – p, 1 = is a constant number (Cochran, 1977).

At every sampling site, coordinates were captured using a Garmin GPS device (model).

Statistical analysis: Using a Microsoft Excel 2010 spreadsheet, the questionnaire survey employed both qualitative and quantitative data from the cross-sectional study. The study makes use of SPSS version 20.0 for windows to calculate descriptive statistics for the variables that were gathered. Descriptive statistics, such as frequencies and percentage were employed.

RESULTS AND DISCUSSION

Socio-demographic characteristics attributes of abattoir operator: Table 1 summarizes the socio-economic characteristics of abattoir operators, which include age, gender, marital status, educational attainment, and average monthly salary. According to data on the gender of abattoir operators, men were more likely than women (15.0%) to be employed in the slaughterhouse industry (85.0%). According to the marital status of abattoir operators, married operators made up the largest percentage (80.0%), followed by single operators (10.0%) and widows and widowers (5.0% each). According to the educational background of abattoir operators, roughly 25.0% had only completed primary school and 75.0% had attended secondary school. A more thorough examination of average monthly income showed that 60.0% of abattoir operators were in the ₦100,000–₦200,000 income range, while 40.0% were in the ₦201,000–₦300,000 and above income range. According to the respondents' socio demographic data, the majority of operators (85.0%) were men, and 50.0% of them belonged to the younger age group (Table 1).

Table 1: Socio-economic attributes of abattoir operator

Variables	Frequency (Freq)	Percentage (%)
Gender		
Male	17	85.0
Female	3	15.0
Age (years)		
20 – 30	1	5.0
31-41	10	50.0
41 and above	9	45.0
Marital Status		
Single	2	10.0
Married	16	80.0
Divorced	-	-
Widow	1	5.0
Widower	1	5.0
Educational Level		
Primary School	5	25.0
Secondary School	15	75.0
Tertiary	-	-
No Formal Education	-	-
Average Monthly Income		
₦100,000 - ₦200,000	10	50.0
₦201,000 – ₦300,000	8	40.0
₦300,000 and above	2	10.0

This is understandable given that employment at butcher shops is generally thought to be dominated by men. The results pertaining to the youthful age and poor educational attainment of meat handlers in this nation's abattoirs align with previous research endeavors (Junaidu *et al*., 2015; Enem, 2017). Only 25% of respondents finished elementary school, and 75% finished high school. Meanwhile, 50% of operators stated that their average monthly income fell between ₦100,000 and ₦200,000, and 25% fell between ₦201,000 and ₦300,000. Studies have shown a connection between low levels of education and lower levels of environmental consciousness, public health concern, and environmental regulation compliance between education level and

environmental awareness (Daramola, 2012; Daramola, 2015).

Attributes of abattoir: In addition to the socioeconomic characteristics of abattoir operators, the purpose, location, and duration of the abattoir's operation, as well as the number of cows slaughtered every day, were also determined and are shown in Table 2.

Table 2: Attributes of abattoir

Variables	Frequency (Freq)	Percentage (%)
Number of Cows Slaughtered Daily		
1 -3	-	-
4 – 7	1	5.0
Above seven cows daily	19	95.0
Factors Responsible for Location of Abattoir		
Nearness to River/Stream	16	80.0
Very High Water Table	-	-
Nearness to Market	2	10.0
Availability of Land	2	10.0
Availability of Cheap Labour	-	-
Period of Establishment (Years)		
1-10	-	-
11- 20	1	5.0
Above 20	19	95.0

Just 5.0% of cows were slain every day, compared to 95.0% of cows that were murdered every day for more than seven cows. The placement of abattoirs was influenced by a number of factors, including being close to a river or stream (80.0%), a market, and the availability of open space land (10%). About 95.0% of abattoir operators reported having been in operation for more than 20 years, compared to just 5.0% of slaughterhouse operators who reported being in operation for 11 to 20 years. Features of the slaughterhouses showed that 95.0% of the cows were killed every day (Table 2). Eighty percent of the abattoirs' locational factors showed that they were close to a river or stream, and most of them had been in operation for more than 20 years. These results suggest that deficiencies in these crucial characteristics and hygienic factors cast doubt on the safety of meat from these slaughterhouses since poor or nonexistent sanitation creates a haven for microorganisms that cause illness (Dandago, 2009).

Environmental hygiene/ sanitation practices in abattoir: Examining the environmental hygiene and sanitation techniques used by butchers in the study area is a significant result of the abattoir features (Table 3). Table 6 provides a full investigation of the procedures used in the abattoir to dispose of waste. The majority of solid waste disposal methods—60.0%—come from burning waste, followed by 25.0% from dumping into surrounding shrubs and 15.0% from dumping on undeveloped land. When compared to daily disposal, which records a proportion of 35.0%, weekly disposal of solid waste records a greater rate of 65.0%. In terms of how often aprons are washed, 15.0% wash them every day and 85.0% wash them once a week. 100% of animals that are rejected by veterinary doctors who conduct inspections are disposed of without being killed. According to the abattoir's sanitary status, 65.0% of operators regularly dispose of their waste by burning, and 60.0% of operator's burn their trash (Table 3). Once a week, aprons are cleaned, and animals that are rejected are disposed of without being killed. A major part of preventing meat-borne illnesses is played by butchers because of the high danger of meat contamination at the butchery level. It is essential to follow and uphold proper hygiene when handling meat in order to guarantee safe and fresh meat for human consumption (Khanal and Poudel, 2017). Reducing microbiological contamination in the abattoir requires routine cleaning and disinfection.

Meat safety practices and hygiene: The staff members who prepare and handle raw meat are kept apart from those who prepare and handle meat that is ready to eat, according to the majority of abattoir operators (100.0%) (Table 4). Furthermore, just 10.0% of respondents mentioned that the butchery's infrastructure and hygienic conditions were maintained. Additionally, just 5.0% of respondents said the butchery's structure is in good shape and does not promote cross-contamination. It was discovered that while 95.0% of respondents said cutting tables had non-toxic elements like mildew and rust on them, 65.0% said the butchery floor looked clean. 95.0% of abattoir owners reported having a safe water supply to the butchery, while the majority (90.0%) claimed that disposable paper towels are accessible. Ninety-one percent of respondents agreed that chopping boards, knives, tongs, and other utensils are used separately for raw meat and ready-to-eat meats. In contrast, only five percent of respondents said that weighing scales, mincers, and slicers are used separately for raw meat and ready-to-eat meats (Table 4). According to Table 4, 80.0% of the waste from the abattoir is contained, controlled, and disposed of appropriately. Furthermore, 95.0 % of respondents state that detergents and cleaning cloths are kept visible. But just 5.0% can be attributed to the availability of pest control equipment.

Table 3: Hygiene status of the abattoir

Variables	Frequency (Freq)	Percentage (%)
Solid Waste Disposal Methods		
Burning	12	60.0
Dump on Vacant Land	3	15.0
Dump in Nearby Bush	5	25.0
Dump along Drainage	-	-
Frequency of Solid Waste Disposal		
Daily	7	35.0
Twice in a Week	13	65.0
Monthly	-	-
Frequency of washing aprons/overalls		
Daily	3	15.0
Once a week	17	85.0
Twice weekly	-	-
Thrice weekly	-	-
Only when adjudged dirty		
Rejected animal by inspected veterinary doctors for slaughter		
Slaughtered	-	-
Treated	-	-
Dispose without slaughtering	20	100.0

Table 4: Assessing of meat safety practices and hygiene cont'd

Variables	Frequency (Freq)	Percentage (%)
Staff preparing and handling raw meat is separate from staff preparing and handling ready to eat meats		
Yes	20	100.0
No	-	-
Availability of Infrastructure and maintenance of hygiene in butchery		
Yes	2	10.0
No	18	90.0
Structure of butchery is in good condition and will not yield cross contamination		
Yes	1	5.0
No	19	95.0
Butchery floor appears clean		
Yes	13	65.0
No	7	35.0
Cutting tables contain non-harmful materials (rust, mold)		
Yes	19	95.0
No	1	5.0
Disposable paper towels are available		
Yes	18	90.0
No	2	10.0
Availability of safe water supply to the butchery		
Yes	19	95.0
No	1	5.0
Weighing scales, mincers and slicers are separately used for raw meat and ready to eat meats		
Yes	1	5.0
No	19	95.0
Chopping boards, knives, tongs, and other utensils are separated for raw meat and ready to eat meats		
Yes	18	90.0
No	2	10.0

Operators in slaughterhouses have observed that the meat frequently has a strong stench and is discolored or dark brown. The results show that there is a sanitary control system in place, which makes up roughly 95.0% of the system, and that veterinary doctors inspect cattle at a rate of 100.0%. Additionally, regular worker medical checkups and treatments are performed (65.0%). Additionally, it was shown that 95.0% of people handle meat even when they have diarrhea, a cough, or skin illnesses (Table 4).Only 5.0% of respondents said they knew that weighing scales, mincers, and slicers are used

separately for raw and ready-to-eat meats (Table 4). In contrast, 95.0% of respondents said they knew that chopping boards, knives, tongs, and other utensils are used separately for raw and ready-to-eat meats. It was discovered that there was less usage of personal protective equipment (PPE), proper coughing technique, and sickness and injury management at work. This result is in line with research from Venkata *et al*. (2019). In addition, 80% of respondents stated that garbage is contained, handled, and disposed of appropriately, and 95% said that cleaning supplies and detergents are kept visible. To stop the spread of viruses that cause foodborne illnesses, butcher shops and abattoirs must properly dispose of their waste (Kwaghe *et al*., 2016). The killing process which includes stabbing, bleeding, skinning, evisceration, hanging, and cutting/deboning was not clearly divided, according to the report. Additionally, the abattoir lacked a preventive system for controlling pests and rodents, which is consistent with findings in earlier publications (Haileselassie *et al*., 2013). Before killing an animal, veterinary professionals inspect it, according to the majority of operators (100.0%) (Table 4). Although a large percentage of workers (65.0%) receive medical checks and treatments, 95.0 percent of operators acknowledged handling meat despite having symptoms including diarrhea, coughing, or skin infections. The research area's slaughterhouse operations negatively impact the environment, according to observations and questionnaire responses. This is because the smells of the facilities draw disease-carrying insects like cockroaches, flies, and rodents, which can expose people to diseases like malaria, typhoid, and cholera. Recreation involving water can also spread pathogens to humans, including *E. coli*, *Bacillus*, *Salmonella* infections, *Brucellosis*, and helminthic disorders (Daramola, 2012). The possible pollution of aquatic life is another risk posed by these procedures. Physical observations, in addition to questionnaire replies, highlight the necessity of better slaughterhouse design and efficient waste management in the city.

Table 4: Assessing of meat safety practices and hygiene cont'd

Variables	Frequency (Freq)	Percentage (%)
Waste is confined, managed, and properly disposed		
Yes	16	80.0
No	4	20.0
Cleaning cloths and detergents are stored in sight		
Yes	19	95.0
No	1	5.0
Pest control devices are available		
Yes	1	5.0
No	19	95.0
Meat appears dark brown/dis-coloured with strong odour		
Yes	20	100.0
No	-	-
Presence of sanitary regulation system		
Yes	19	95.0
No	1	5.0
Livestock must be inspected by veterinary doctors		
Yes	20	100.0
No	-	-
Medical examination and treatment of workers		
Yes	13	65.0
No	7	35.0
Handling of meat when having Cough, Diarrhea, Skin infection		
Yes	19	95.0
No	1	5.0

Conclusion : This study examine hygiene and sanitation practices of abattoir in Ubakala, Umuahia South, Abia State, as well as the socio demographic traits, features, and hygienic state of meat safety practices at an abattoir. Hence, the findings reveal that the use of contaminated water, careless handling techniques, contaminated tables for meat display, and the use of dirty blades and equipment during cutting operations are all common causes of meat contamination in the abattoir. Therefore, it is essential to produce and distribute meat in a hygienic manner in order to minimize or completely remove dangers to the public's health, prevent illnesses, and prevent financial losses from early meat spoiling brought on by cross-contamination. In order to minimize waste and generate employment opportunities, more research should be done to identify and describe the bacterial loads present in the meats from various abattoirs.

Declaration of Conflict of Interest: The authors declare no conflict of interest

Data Availability Statement: Data are available upon request from the corresponding author

REFERENCES

Abdalla, MA; Suliman, SE; Ahmed, DE; Bakhiet, AO (2009). Estimation of bacterial contamination of indigenous bovine carcasses in Khartoum (Sudan). *Afr. J. Microbiol. Res*. 3: 882–886.

Abdullahi, A; Kadarman, N; Hassan, A; Madobi, IS (2015). Negative impact of abattoir activities and management in residential neighborhoods in Kuala Terengganu, Malaysia. *Inter. J. Public Health. Sci.* 4(2): 124-130.

Aburi, PAS (2012). Assessment of Hygiene Practices Used by Small Butchers and Slaughter Slabs in Beef Value Chain in Juba Town-South Sudan; Van Hall Larenstein University of Applied Science: Leeuwarden, the Netherlands, 2012; pp. 1–51.

Adamu, MT; Dahiru, M (2020). Review on Abattoir Wastewater Treatment for Environmental Health Improvement. *J. Environ. Bioremed. Toxicol.* 3 (2): 26-31

Adjagodo, A; Agassounon, DTM; Kelome, NC; Lawani, R (2016). Flux des polluants liés aux activités anthropiques, risques sur les ressources en eau de surface et la chaine trophique à travers le monde: synthèse bibliographique. *Int. J. Biol. Chem. Sci.* 10(3), 1459-1472

Ado, A; Tukur, AI; Ladan, M; Gumel, SM; Muhammad, AA; Habibu, S; et al (2015). A review on industrial effluents as major sources of water pollution in Nigeria. *Chem. J*. 1, 159–164.

Al Banna, H; Disu, TR; Kundu, S; Ahinkorah, BO; Brazendale, K; Seidu, AA; Okyere, J; Rahman, N; Mondal, S; Matubber, B; et al (2021). Factors associated with food safety knowledge and practices among meat handlers in Bangladesh: A cross sectional study. *Environ. Health Prev. Med*. 2021, 26, 84.

Ali, N; Farooqui, A; Khan, A; Kazmi, S (2010). Microbial contamination of raw meat and its environment in retail shops in Karachi, Pakistan," *Journal of Infection in Developing Countries*, vol. 4, no. 6, pp. 382–388, 2010.

Banjo, TA; Onilude, AA; Amoo, AOJ; Busari, A; Ogundahunsi, OA (2013). Occupational Health Hazards among Abattoir Workers in Abeokuta. *Academia Arena* 5(10) 29-36.

Barman, RN (2015). Linking farmers access to micro finance, input and service delivery systems with crop production performance: A study in disadvantage areas of North Bank Plains Zone of Assam. *Micro Finance Rev.* 7(2): 91-102

Berenson, ML; David, ML; Krehbiel, TC (2006). Basic Business Statistics Concepts and Application. Prentice-Hall. Inc. Englewood Cliffs, NJ. Pp: 763.

Bersisa, A; Tulu, D; Negera, C (2019). Investigation of Bacteriological Quality of Meat from Abattoir and Butcher Shops in Bishoftu, Central Ethiopia. *Int. J. Microbiol*. 1-8. 6416803.

Birhanu, W; Weldegebriel, S; Bassazin, G; Mitku, F; Birku, L; Tadesse, M (2017). Assessment of microbiological quality and meat handling practices in butcher shops and abattoir found in Gondar town, Ethiopia. *Inter. J. Microbiol. Res.*8(2): 59–68, 2017.

Brahimi, A; Chafi, A; Nouayti, N; et al (2015). Metal typology contamination of surface waters of Za River, Lower Moulouya, Eastern Morocco, Der Pharma Chemica, 7(9), 346-353

Brémi, AZ; Diarra, A; Akesse, DPV. (2024) Assessment of the impact of urban dynamics on aquaculture activities in the municipality of Daloa, *J. Mat. Environ. Sci*. 15(10): 1368-1382

Chepkemoi, S; Lamuka, PO; Abong, GO; Matofari, J (2015). Sanitation and hygiene meat handling practices in small and medium enterprise butcheries in Kenya-case study of Nairobi and Isiolo Counties. *Inter. J. Food. Safe*. 17: 64–74.

Chuku, A; Etim, LB; Obande , GA; Asikong , BE; Sani, BE (2016). Bacteriological quality of fresh raw beef and chevon retailed in Lafia Metropolis, Nigeria, *J. Microb. Res*. 6 (2) (2016) 29–34

Cochran, WG (1977). Sampling Techniques, 2nd Ed., New York: John Wiley and Sons, Inc. 50 pp.

Dandago, MA; Farouk, SU; Igwe, EC (2009). Evaluation of slaughter practices in Kano abattoir. *Technol. Sci. Africana* J. 3(1):28-31

Daramola, OP (2012). Clapping With One Hand: The Case of Urban Environmental Sanitation Practices in Nigeria Journal of Applied Technology in Environmental Sanitation, Vol. 2 No.4, pp. 223-228.

Daramola, SA (2015). Urban environmental problems in Nigeria: implications for sustainable development.

Ebuete, AW; Isiya, S; Ndiwari, LE; Ebuete, IY; Walson, PT; Wolisi, I (2020). The Food and the Poison, a

Retrospect of Abattoir, Butcher Markets and Buckateria in Nigeria: An empirical Study. *Am. J. Epidemiol. Public Health.* 4: 24–31.

El Abdouni, A; Bouhout, S; Merimi, I; Hammouti, B; Haboubi, K (2021). Physicochemical characterization of wastewater from the Al-Hoceima slaughterhouse in Morocco. *Caspian. J. Environ. Sci.* 19(3), 423-429

Enem, SI (2017). An appraisal of the knowledge attitude and practices (KAP) of meat handlers on their personal hygiene in Gwagwalada municipal abattoir, Abuja, Nigeria. *Inter. J. Develop. Res.* 7(12):17807-17811.

Fasanmi, G; Olukole, S; Kehinde, O (2010). Microbial studies of table scrapings from meat stalls in Ibadan metropolis, Nigeria: implications on meat hygiene. *Afr. J. Biotechno.* 9(21): 3158–3162.

Gutema, FD; Agga, GE; Abdi, RD; Jufare, A; Duchateau, L; De Zutter, L; Gabriël, S (2021). Assessment of Hygienic Practices in Beef Cattle Slaughterhouses and Retail Shops in Bishoftu, Ethiopia: Implications for Public Health. *Int. J. Environ. Res. Public Health.* 18: 2729.

Haileselassie, M; Taddele, H; Adhana, K; Kalayou, S (2013). Food safety knowledge and practices of abattoir and butchery shops and the microbial profile of meat in Mekelle City, Ethiopia. *Asian Pac. J. Trop. Biomed*. 2013, 3, 407–412.

Hanif, MA; Miah, R; Islam, MA; Marzia, S (2020). Impact of Kapotaksha river water pollution on human health and environment, Progressive agriculture, 31(1), 1-9.

Havelaar, AH; Kirk, MD; Torgerson, PR; Gibb, HJ; Hald, T; Lake, RJ Praet, N; Bellinger, DC; de Silva, NR; Gargouri, N; et al (2015). World Health Organization Global Estimates and Regional Comparisons of the Burden of Foodborne Disease in 2010. PLoSMed. 2015,12, e1001923.

Humphrey, T; O'Brien, S; Madsen, M (2007). Campylobacters as zoonotic pathogens: a food production perspective. *Int. J. Food Microbiol*. 117, 237–257.

Ighalo, JO; Adeniyi, AG (2020). A comprehensive review of water quality monitoring and assessment in Nigeria. *Chemos*. 260: 127569

Isukuru, EJ; Opha, JO; Isaiah, OW; Orovwighose, B; Emmanuel, SS (2024). Nigeria's water crisis: Abundant water, polluted reality. *J. Cleaner Wat.* 2: 100026.

John, AM (2016). Indigenous Knowledge System and Environmental Conservation Practices In Umuahia South Local Government Area, Abia State. A Thesis Presented to the School of Graduate Studies University of Port Harcourt. Pp 1-121

Junaidu, YM; Bhagavandas, M; Yushau, U (2015). Study of knowledge, attitude and practices regarding hygiene among abattoir workers in Kano state metropolitan, Nigeria. *Inter. J. Sci. Res.* 4(1): 2474-2478

Kebede, T; Afera, B; Taddele, H; Bsrat, A (2014). Assessment of Bacteriological Quality of Sold Meat in the Butcher Shops of Adigrat, Tigray, Ethiopia. *Appl. J. Hyg.* 3(3): 38-44.

Khanal, G; Poudel, S. (2017). Factors Associated with Meat Safety Knowledge and Practices among Butchers of Ratnanagar Municipality, Chitwan, Nepal: A Cross-Sectional Study. Asia Pac. *J. Public Health* 2017, 29, 683–691.

Kinsella, KJ; Sheridan, JJ; Rowe, TA; Butler, F; Delgado, A; Quispe-Ramirez, A; Blair, IS; McDowell, DA (2006). Impact of a novel spray-chilling system on surface microflora, water activity and weight loss during beef carcass chilling. *Food Microbiol*. 23, 483–490.

Kumsa, B (2019). Cystic echinococcosis in slaughtered cattle at Addis Ababa Abattoir enterprise, Ethiopia. *Vet. Anim. Sci*., 7(2019), 100050

Kwaghe, AV; Adesokan, HK; Ameh, JA; Ambali, AG; Dika, M; Ndahi, SIC; Kudi, AC (2016). The Debilitating State of the Maiduguri Main Abattoir, Poor Sanitary and Waste Disposal Methods; the Way Forward. *Nat. Sci*. 14, 38–48.

Nowrouzi, M; Pourkhabbaz, A (2014). Application of Geo-accumulation index and Enrichment Factor for Assessing Metal Contamination in the Sediments of Hara Biosphere Reserve, Iran. *Chem. Speciat. Bioavail.* 26(2), 99–105

Ntanga, PD; Mdegela, RH; Nonga, HE (2014). Assessment of beef microbial contamination at abattoir and retail meat shops in Morogoro Municipality, Tanzania, *Tanzania Vet. J.* 29,52-61.

Ntanga, PD (2013). Assessment of Microbial Contamination in Beef from Abattoir to Retail Meat Outlets in Morogoro Municipality, Tanzania. Master's Thesis, Sokoine University of Agriculture, Morogoro, Tanzania, 2013.

Ocheri, MI; Odoma, LA; Umar, ND (2014). Groundwater quality in Nigerian urban areas: a review. *Glob. J. Sci. Front. Res.: Environ. Earth Sci*. 14.

Okechukwu , KI; Agwu , NA; Ugo , UE; Chinasa, OA (2018). Bacteriological Qualities of Beef Sold in Abia and Imo States, Nigeria: implications for the Sustenance of Enteric Diseases, *Int. J. Sci. Res*. 8 (7) (2018) 539–546.

Okimiji, OP; Simon, JN; Aborisade, MA; Adedeji, OH; Okafor, AT; Tope-Ajayi, OO; Ezennia, JO (2024). Integrated GIS-based and water quality index for evaluation of groundwater quality in the coastal slum settlements of Lagos, Nigeria. *J. Groundwater. Sustain. Develop.* 25: 101170.

Paiva, ACE; Nathalia, N; Rodriguez, DA; Tomasella, J; Carriello, F; Rezende, FS (2020). Urban expansion and its impact on water security: the case of the Paraíba do Sul River Basin, S˜ao Paulo, Brazil. *Sci. Total Environ.* 720, 137509.

Rani, Z; Hugo, A; Hugo, C; Vimiso, P; Muchenje, V (2017). Effect of post-slaughter handling during distribution on microbiological quality and safety of meat in the formal and informal sectors of South Africa: A review. S. *Afr. J. Anim. Sci*. 47: 255.

Sanou, A; Ouattara LY; Amon NL; Amadou Kiari MN; Sanou I; Traoré, S; Yao, KB (2024). Evaluation of the physicochemical properties and heavy metals contamination level of fish farms waters from Soubré (Côte d'Ivoire). *J. Mater. Environ. Sci.* 15(10): 1439-1455

Shilenge, LB; Shale, K; Matodzi, T; Machete, F; Tshelane, CA (2017). Review of microbial hazards associated with meat processing in butcheries. *Afr. J. Sci. Technol. Innov. Dev*. 9:1–6.

Sulleyman, K; Adzitey, F; Boateng, E (2018). Knowledge and practices of meat safety by meat sellers in the Accra metropolis of Ghana. *Int. J. Vet. Sci*. 7: 167–171.

Tan, SL; Lee, HY; Abu Bakar, F; Abdul Karim, MS; Rukayadi, Y; Mahyudin, NA (2013). Microbiological Quality on Food Handlers' Hands at Primary Schools in Hulu Langat District, Malaysia. *Inter. Food. Res. J*. 20(5): 2973-2977.

Tavakoli, H; Razipour, M (2008). Microbial quality of cooked meat foods in Tehran Universities restaurants. *Pak. J. Med. Sci*. 24: 595–599

Toma, LT; Farukh, MA; Rehana, K (2024). Exploring Bioaccumulation and Eco-toxicological potentiality of Heavy Metals in Natural Water Ways of the Padma River, *J. Mater. Environ. Sci.*, 15(3), 325-348

Tuhin, TR; Nipa, N; Auyon, ST; Usha, KF; Islam, MA; Ali, MA (2024). Assessment of heavy metals and environmental monitoring in surface sediments and water at Some shwari River, North-Eastern Bangladesh, *J. Mater. Environ. Sci*., 15(10), 1478-1490

Ukandu, JS; Udom, GJ; Nwankwoala, HO (2011). Aspects of the Hydrogeology of Umuahia South Local Government Area, Abia State, Nigeria. *J. Environ. Res. Manage.* 2(2):014-026

Van Teijlingen, ER; Rennie, AM; Hundley, V; Graham, W (2001). The Importance of Conducting and Reporting Pilot Studies: The Example of the Scottish Births Survey. *J. Adv. Nurs.* 34: (1) 289-295

Venkata, SRC; Sujitha, B; Maheswara, RD; Vani S (2019). Awareness and practices followed by the butchers in hygienic meat production chain in YSR Kadapa district of Andhra Pradesh. *Pharma Innov. J.* 8(10): 140-145

Wambui, J; Karuri, E; Lamuka, P; Matofari, J (2017). Good hygiene practices among meat handlers in small and medium enterprise slaughterhouses in Kenya. *Food Control*. 81, 34–39.

Wesson, PS (2006). Five dimensional physics, classical and quantum consequences of Kaluza-Klein theory. World press scientific, Singapore

Yin, RK (2009). Case study research: Design and methods (4th Ed.). Thousand Oaks, CA:Sage.doi.org/10.33542/cjar.v14i1.73