Assessment of challenges, knowledge, attitude and practices of abattoirs waste management in Aba and Abia State, South-East Nigeria

Okafor A. T. [1*], Okimiji O. P. [2, **], Atoro, T. [3], Okafor C. B. [4]

[14]*Department of Environmental Management and Toxicology, Michael Okpara University of Agriculture Umudike, P.M.B 7267, Abia State, Nigeria*
[2]*Department of Environmental Management, Faculty of Environmental Sciences, Lagos State University P.M.B 0001 Lagos State, Nigeria*
[3]*Department of Urban and Regional Planning, Faculty of Environmental Sciences, Lagos State University P.M.B 0001 Lagos State, Nigeria*
Corresponding author, Email address: okafor.angela@mouau.edu.ng
**Corresponding author, Email address: oluwaseun.okimiji@lasu.edu.ng*

Abstract: This study evaluated abattoir waste management practices, knowledge, attitudes, and issues in Ubakala, Umuahia South, and Ngwa Road, Aba South. The study employed a cross-sectional survey methodology, utilizing standardized questionnaires to gather data from sixty abattoir operators who were chosen at random. With the use of descriptive statistics, data were examined. Results reveal men as predominate in Ubakala and Ngwa Road (86.7%). Seventy-three percent of the population was unmarried, while 56.7% had completed secondary education. In Ubakala, 56.7% of the population was between the ages of 40 and 55, and 60.0% reported having an average monthly income of ₦100,000 to ₦200,000. Majority of workers (56.7%) were involved in butchery, and 86.7% had five to ten years of experience in the abattoir. The majority of waste produced (46.7%) was animal blood, and 70.0% of it was bore the need to pay waste collection costs. Only 23.3% of respondents said their waste disposal facilities were adequate, while different percentages indicated that other aspects like having a place to kill animals (20.0% and 33.3%), having veterinarians available (13.3%), having pest control (26.7%), and having regular ante- and post-mortem procedures (13.3%) were also adequately provided. Incorrect waste management has been shown to produce unpleasant odors (66.7% and 56.7%), have an adverse effect on people's health (33.3% and 46.7%), act as a haven for flies and mosquitoes (76.7% and 66.7%), draw in animal scavengers (36.7% and 50.0%), pollute the air (56.7% and 66.7%). Hence, 70.0% (Ubakala) and 73.3% (Ngwa Road) of the participants deemed abattoir waste suitable for use as bio-fertilizer, 43.3% and 40.0% as animal feed, and 6.7% and 10.0% as bio-energy. Furthermore, 100.0% of respondents on Ngwa Road agreed that solid waste could be burned, 56.7% said that burying was preferable, and 83.3% and 80.0% said that composting could be used as fertilizer on agricultural areas. Education and public awareness of the consequences of animal husbandry pollution were considered necessary by 73.3% (Ngwa Road) and 76.7% (Ubakala). Modernizing infrastructure, guaranteeing adequate monitoring, and offering health education on best practices were among the suggestions made by 83.3% of respondents for modernizing abattoirs. Pretreatment methods for abattoir waste discharge (86.7%) and avoiding the location of abattoirs close to residential areas (50.0%) were suggested by respondents. Conclusively, in order to improve sanitation within these facilities, abattoirs should be updated with modern infrastructure, tarred, constructed with drainage and gutters, and innovative waste management techniques. Workers and residents should be made aware of the negative environmental effects of improper abattoir waste management.

1. Introduction

In accordance with (Franke-Whittle and Insam, 2013), solid wastes from slaughter facilities include inedible animal tissues (condemned meat and organs, undigested ingestions, ligaments, tendons, bones, horns, hairs, and aborted youngsters). Furthermore, urine, gut contents, blood, and dispersed particles are frequently found in liquid waste (Chukwu et al., 2008). The challenges encountered by the people who reside close to abattoirs encompass pollution in the atmosphere, water quality, both surface and subsurface pollution, and different medical issues linked to the waste produced at the slaughterhouse (Bello and Oyedemi, 2009; Fadare and Afon, 2010; Bandaw and Herago, 2017). Researchers globally have raised worry about the health risks linked to abattoir facilities and problems with the environment, especially in Nigeria. A number of studies have examined the issue at different perspectives, such as how abattoirs impact locals' health, the different types of waste they generate for the environment, and how they manage waste (Bello and Oyedemi, 2009; Abdullahi et al., 2015; Ekpo, 2019; Dada et al., 2020; Daramola and Olowoporoku, 2015; Fadare and Afon, 2010; Omole and Ogbiye, 2013; Oruonye, 2015; Adeolu et al., 2019; Ademola, 2019; Masse and Masse, 2000). As a result, (Adeolu et al., 2019) emphasize the significance of mitigating the difficult health and environmental impacts on residents and employees as well as the inadequate hygienic operations at abattoirs. (Omole and Ogbiye, 2013) essentially warn that feces, blood, and paunch contents from abattoir operations pose a serious risk to the environment.

In view of this, even though several studies have focused on abattoir operations, waste management, and their environmental impacts in Nigeria, (Ezeoha and Ugwuishiwu, 2011) argue that further research is needed to address ongoing waste management challenges. The generation of waste from slaughterhouses is particularly concerning in urban Nigerian communities. The need to meet urban meat consumption demands has resulted in the generation of extensive waste, such as chemicals used amidst processing, inorganic solids, fat, salts, and blood (Ezeohaa and Ugwuishiwu, 2011). This waste also poses significant environmental management challenges to the environment (aborted fetuses, undigested ingesta, horns, hairs, condemned meat and bones) (Adeyemo, 2002). Slaughterhouse wastes contribute to decreased air quality and the spread of infectious diseases among urban populations (Adeyemo et al., 2009; Bello and Oyedemi, 2009). Environmental sanitation practices in these slaughterhouses in developing countries require urgent attention, as they are essential for reducing disease exposure and maintaining a clean environment (World Bank, 2002). The proximity of slaughterhouses to urban consumers in Nigeria may offer convenience, but concerns persist regarding their impact on residents' health and the built environment (Bello and Oyedemi, 2009; Olowoporoku, 2013). The pollution emanating from Nigerian slaughterhouse operations presents a significant challenge.

Ironically, old-fashioned approach for disposing of manure, carcasses and animal wastes have proven inadequate, with effluents often discharged improperly, especially during rainstorms, leading to contamination of surface and groundwater and causing city nuisances (Muhirwa et al., 2010). Inadequate facilities for waste recovery, treatment, and reuse further exacerbate the situation (Olowoporoku, 2013; Adeyemo et al., 2009). Indiscriminate disposal of abattoir solid waste introduces disease-causing organisms, contributing to health issues such as headaches, asthma, dysentery, weakness, fever, typhoid, pneumonia, respiratory ailments, coughing, eye irritation, skin rashes, nausea, vomiting, foot-and-mouth disease, and dengue fever (Robert et al., 2009; Wing and Wolf, 2000; WHO, 2005). While animal dung can serve as valuable manure, it contains viruses, bacteria,

microorganisms, and salts that can degrade water quality when washed into rivers or streams (Adewumi *et al.,* 2016).

Basically, elbow to guarantee public safety in abattoir operations necessitate potent inspection of meat and safety measures, waste management effective systems, and prevention of potential meat-borne infectious agents from reaching the public or contaminating the environment. Recognizing this, the Federal Ministry of Environment has established policy guidelines aimed at improving abattoir operations (FME, 2005). However, challenges persist in implementing these guidelines, with ongoing concerns about food safety and sanitation practices in the handling and distribution of animal food products in Nigeria (Okoli *et al.,* 2006; WHO, 2003). In conclusion, this study aims to assess perceptions of abattoir operators' waste management practices in Umuahia South and Aba South, with a focus on addressing existing challenges toward more effective waste management. The findings will inform planners, environmentalists, and policymakers not only in Umuahia South and Aba South but also in other settings with similar abattoir characteristics.

2. Materials and Methods

2.1 Study area description

2.1.1 Ubakala, Umuahia South Study Area

The study was carried out at Ubakala, Umuahia South Local Government Area, Abia State, Nigeria. And it stretches between 5° 49.47ʃN and 7° 41.65ŃE geographical coordinates in the southeast of the Niger Delta Basin, comprising a total land mass of 172,913 square kilometers with an estimated population of 203,669 (Ukandu *et al.,* 2011). The dry and wet seasons are the two principal seasons that determine the subequatorial climatic area in which it is located (Ukandu *et al.,* 2011). The dry season extends from October to March, while the wet season starts in April and wraps up in September, peaking in June and July. Plain topography in the LGA ranges from low lying to fairly high. Approximately 59.5 and 164.5 meters above sea level is the general surface elevation (Olobaniyi *et al.,* 2006). The Imo River and its tributaries, which flow southward and empty into the Atlantic Ocean, are the primary sources of drainage for the relief and drainage area. (Olobaniyi *et al.,* 2006) argue that the region's dendritic drainage pattern suggests a homogenous underlying material devoid of structural control.

2.1.2 Ngwa Road, Aba South Study Area

The investigation was also conducted at Ngwa Road in the Aba South Local Government Area. With a population of over 560,916 people, the area makes up almost 60% (49.2 km^2) of the Aba urban area (FGN, 2015). It encompasses places like Ariaria, Umuola Egbelu, and Ogbor Hill. At 5° 07.03'N and 7° 34.09'E in geographic coordinates, it is situated in southeast Nigeria. The research location is located in southeast Nigeria's humid tropical and rainforest region (Nnaji, 1998). The pattern of rainfall distribution is similar to that found in southern Nigeria. As shown in **Figure 1,** Map of Ubakala, Umuahia South and Ngwa Road, Aba South study area.

2.2 Study design

This study examines the knowledge, attitudes, and practices of abattoir workers on waste management through a cross-sectional survey. It can be included into appropriate abattoir waste management practices at the Ubakala, Umuahia South, and Ngwa Road, Aba South abattoirs to safeguard the environment and public health.

2.3 Target population

The target population for this study was all the people working in Ubakala, Umuahia South, and Ngwa Road, Aba South abattoirs.
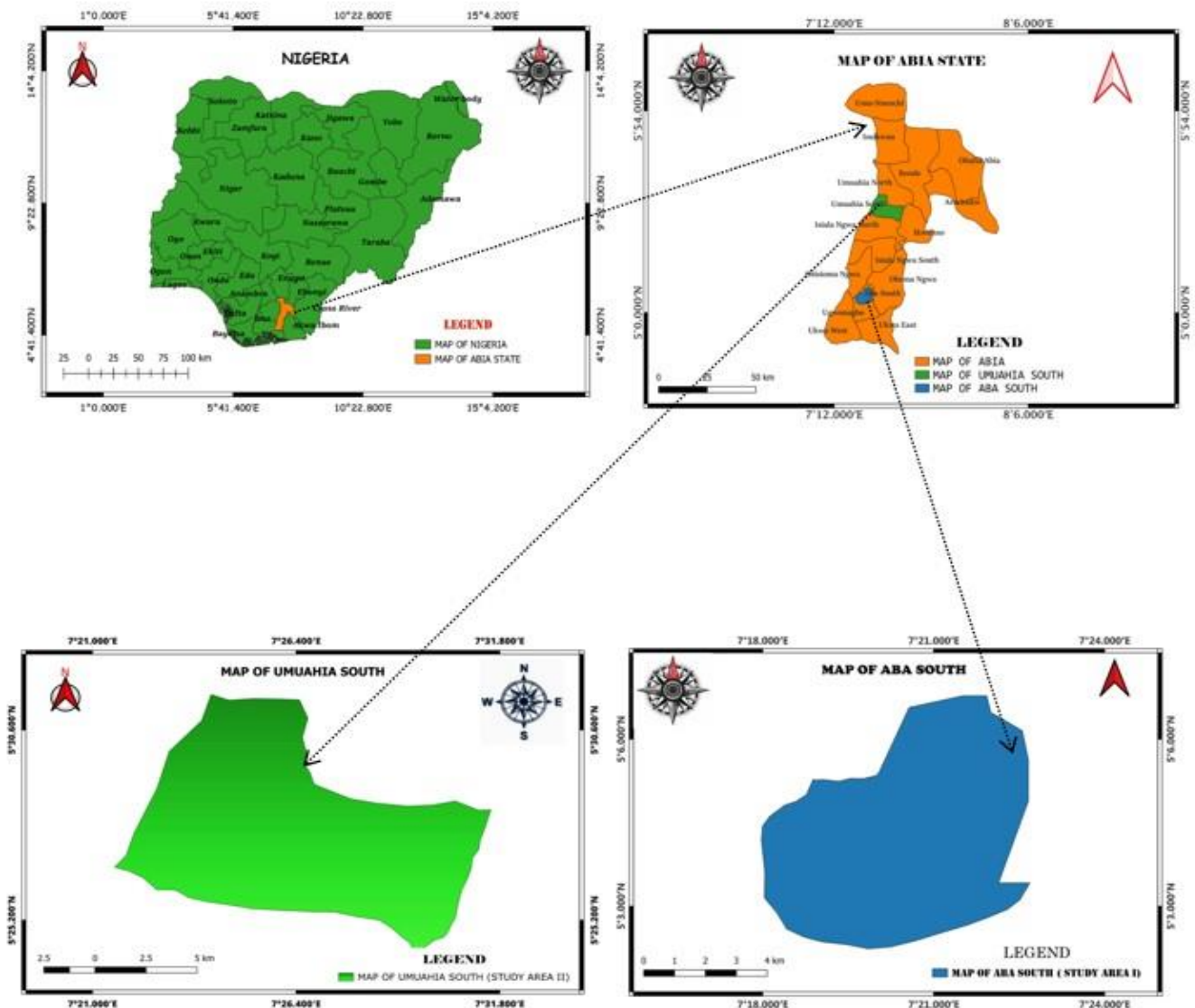

Figure 1. Map of Ubakala, Umuahia South and Ngwa Road, Aba South study area

2.4 Sample size and sampling technique

The sample size was estimated based on the single proportion formula:

$$N = \frac{z^2\, p_q}{d^2}$$

Eqn. 1

Where p is the population proportion, q is equal to $1 - p$, d is the tolerable error (0.05), Z is the reliability coefficient at a 95% confidence interval (1.96), and N is the necessary sample size (Barman, 2015). To the best of our knowledge, the literature on abattoir waste management procedures, attitudes, and knowledge is either nonexistent or extremely scarce. The sample size needed for the investigation was calculated using the population proportion (P =.5) (Kumsa, 2019). In order to estimate the value of p,

a pilot research was carried out, and the results were utilized to determine the sample size. Standard values that may be entered into this calculation to determine sample size could yield a more accurate estimate of p. When an exact estimate of p cannot be determined, this approach is usually used (Wesson, 2006). The pilot investigations that were carried out in two abattoirs and incorporated into the main survey yielded the following percentages. The pilot study involved 60 abattoir workers (30 from each of the two abattoirs, Ubakala and Ngwa Road):

$$N = \frac{(1.96)^2 \ \times 0.89 \ \times 0.11}{(0.05)^2} = \qquad\qquad\qquad \textbf{Eqn. 2}$$

$= 15 + 15\,(10\%)$

$= 30$ sample size;

After the correction Formula:

$$(nf = \frac{ni}{1 + {ni}/{N}} \quad and\ 5\ \% \qquad\qquad\qquad \textbf{Eqn. 3}$$

After participants for the non-response rate were chosen, 30 responders made up the total sample size that was needed. The pilot study's total practice score determined the value of p that was employed in this investigation. Each employee of the chosen abattoir received the pretested questionnaire, resulting in a sample size of thirty. A few surveys were not included in the study because the respondents chose not to participate or the data was incomplete. One of the two abattoirs used for the main study was utilized for the pilot study, and the other was employed for simple random sampling.

2.5 Data quality control

Both closed- and open-ended questions were included in the English-language questionnaire that was used to gather the data. The questionnaire was then translated into regional tongues. The questionnaire was pretested in the slaughterhouse by asking employees of the facility to evaluate how clear the questions were. Changes were made in response to feedback received, and the updated version was used to gather data. Through data cleansing and exploratory techniques in the database, the questionnaire was validated to guarantee data accuracy (Abdulahi *et al.,* 2015). To record events in real time, direct observation was also used (Yin, 2009).

2.6 Statistical analysis

Descriptive statistics of the variables collected throughout the investigation were computed using both quantitative and qualitative data from the cross-sectional study. The Statistical Package for Social Sciences (IBM SPSS Statistics 20.0) version was used to examine the data that were obtained. Frequency tables and charts are used in conjunction with descriptive statistics to present data.

3. Results and Discussion

3.1 Socio-economic attributes of abattoir operator

The results of socio-economic attributes of abattoir operators showed that 86.7% of workers in Ubakala and Ngwa Road were males, while 13.3% were female **(Table 2).** The marital status of workers indicates that 73.3% and 56.7% were single, 3.3% and 20.0% were married, and 3.3% (Ubakala) and 6.7% (Ngwa Road) were divorced, while 20.0% and 16.7% were widowers. The educational level of the workers reveals that 46.7% and 26.7% had attended primary school, while

secondary school education accounted for 30.0% (Ubakala) and 56.7% (Ngwa Road); those without formal education constituted 23.3% and 16.7%, respectively. The age group of workers indicated that 3.3% (Ubakala) and 3.3% (Ngwa Road) of abattoir workers were between the ages of 15-25 years, 10.0% and 46.7% fell in the age group of 26-39 years, 40-55 years accounted for 56.7% (Ubakala) and 36.7% (Ngwa Road), and 56-65 years fell in the category of 20.0% and 10.0%, respectively, while only 10.0% and 3.3% were above 66 years old. Further investigation into average monthly income revealed that 10.0% (Ngwa Road) of the abattoir operators were in the income range of ₦100,000-₦200,000. Moreover, 30.0% and 53.3% were in the income range of ₦201,000-₦300,000, and only 10.0% were above ₦301,000 monthly income. The nature of the abattoir workers' involvement shows that 16.7% and 10.0% were owners and cow sellers in Ubakala and Ngwa Road abattoirs, followed by laborers at 23.3% and 20.0%, respectively. Butchers accounted for the highest percentage at 46.7% and 56.7%, while cleaners were only 13.3%. The years of experience of most abattoir operators indicate that 13.3% of workers had worked for less than 5 years, while the majority (86.7%) had 5-10 years of abattoir work experience. Gender, marital status, educational level, age, average monthly income, nature of work involvement, and years of experience were among the socio-economic attributes of the respondents (abattoir workers) assessed **(Table 2).** The results showed that 86.7% of workers in Ubakala and Ngwa Road were males. Most of the workers were still single (73.3% and 56.7%), 26.7% had attended primary school, 30.0% and 56.7% secondary school, while the dominant age group was 40-55 years (56.7% and 36.7%). Moreover, 60.0% and 26.7% fell in the income category of ₦100,000-₦200,000. The majority of workers were butchers, which is the nature of the work they are involved in at the abattoir, while 86.7% had 5-10 years of abattoir work experience. This suggests that socio demographic variables, particularly educational attainment, are thought to influence behavior indirectly by influencing how perceptible an individual's sensitivity to infectious diseases is (Glanz *et al.*, 2008). These results are in line with research by (Olowoporoku, 2016) and (Aburi *et al.*, 2012), who noted that at the South Sudanese abattoirs in Osogbo and Juba town, a higher percentage of the workforce was between the ages of 25 and 35 and lacked formal education.

3.2 Abattoir generated waste

Abattoir-generated waste types show that animal dung constitutes 30.0% and 23.3% in Ubakala and Ngwa Road, respectively **(Figure 2-4).** Animal blood comprises 46.7%, while animal hairs were about 20.0% and 26.7%. Carcasses were only 3.3% across the abattoir. Notably, 10.0% of abattoir workers reported waste collection fees among the butcheries.

Abattoir operators revealed that the government sector should be responsible for the proper disposal and regulation of the waste generated (30.0%), while the majority (70.0%) in Ubakala and Ngwa Road opined that waste collection fees among themselves are the best options to adopt for proper and effective waste management. Notwithstanding their relatively small weight in comparison to other parts of the slaughtered animals (Omole and Ogbiye, 2013), the prevalence of blood and animal feces as slaughterhouse waste is consistent with the findings of research (Bello and Oyedemi, 2009; Adeolu *et al.*, 2019). Additionally, research has demonstrated that bone waste is turned into animal feed and frequently sold alongside meat, making it a manageable issue (Fearon *et al.*, 2014). Despite the fact that slaughterhouse waste contains a lot of potentially dangerous germs for people, it also makes an excellent substrate for the production of biogas (Rabah *et al.*, 2010). This suggests that the numerous wastes produced by butcher shops not only provide a significant challenge to deal environmental management, but they are also linked to a number of infectious organisms that may be harmful to

humans, depleting air quality, and perhaps transferable patterns of antibiotic resistance (Alonge, 1991; Meadows, 1995; Nwanta *et al.,* 2008).

Table 2. Socio-economic attributes of abattoir operator

| Variables	Ubakala, Umuahia South		Ngwa Road, Aba South	
	Frequency (Freq)	Percentage (%)	Frequency (Freq)	Percentage (%)
Gender				
Male	26	86.7	26	86.7
Female	4	13.3	4	13.3
Marital Status				
Single	22	73.3	17	56.7
Married	1	3.3	6	20.0
Divorced	1	3.3	2	6.7
Widow	6	20.0	5	16.7
Widower	-	-	-	-
Educational Level				
Primary School	14	46.7	8	26.7
Secondary School	9	30.0	17	56.7
Tertiary	-	-	-	-
No Formal Education	7	23.3	5	16.7
Age (Years)				
15-25	1	3.3	1	3.3
26-39	3	10.0	14	46.7
40-55	17	56.7	11	36.7
56-65	6	20.0	3	10.0
Above 66	3	10.0	1	3.3
Average Monthly Income				
₦30,000 - ₦90,000	-	-	3	10.0
₦100,000 - ₦200,000	18	60.0	8	26.7
₦201,000 - ₦300,000	9	30.0	16	53.3
Above - ₦301,000	3	10.0	3	10.0
Work Involvement Nature				
Cow seller/owner	5	16.7	3	10.0
Labourer	7	23.3	6	20.0
Butcher	14	46.7	17	56.7
Cleaner	4	13.3	4	13.3
Years of experience				
Less than 5 years	4	13.3	4	13.3
5-10 years	26	86.7	26	86.7
11-20 years	-	-	-	-
Above 20 years	-	-	-	-
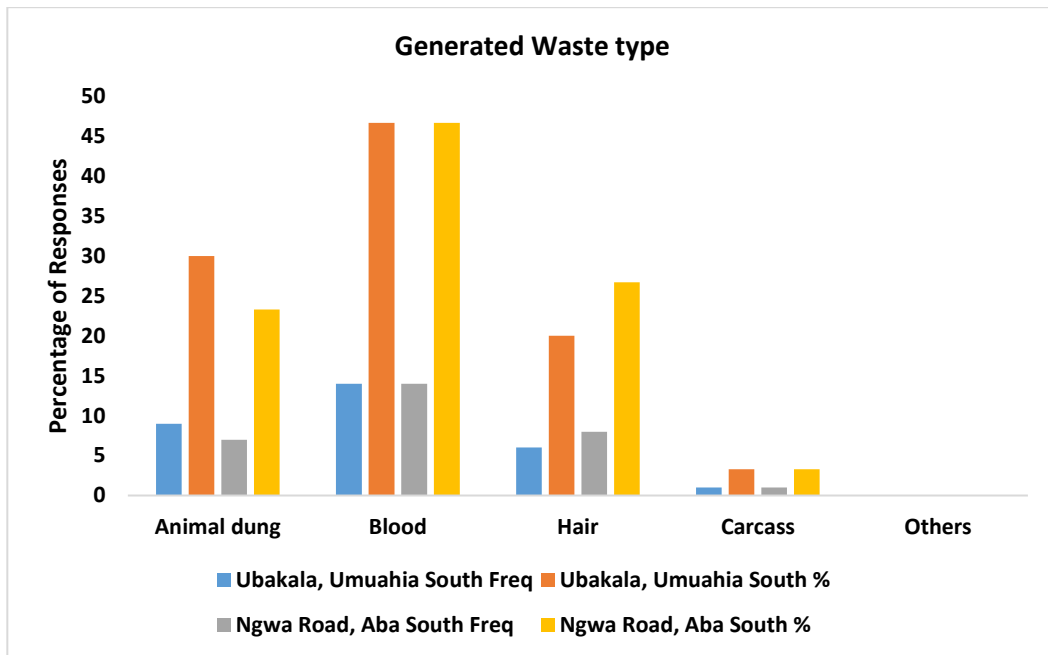
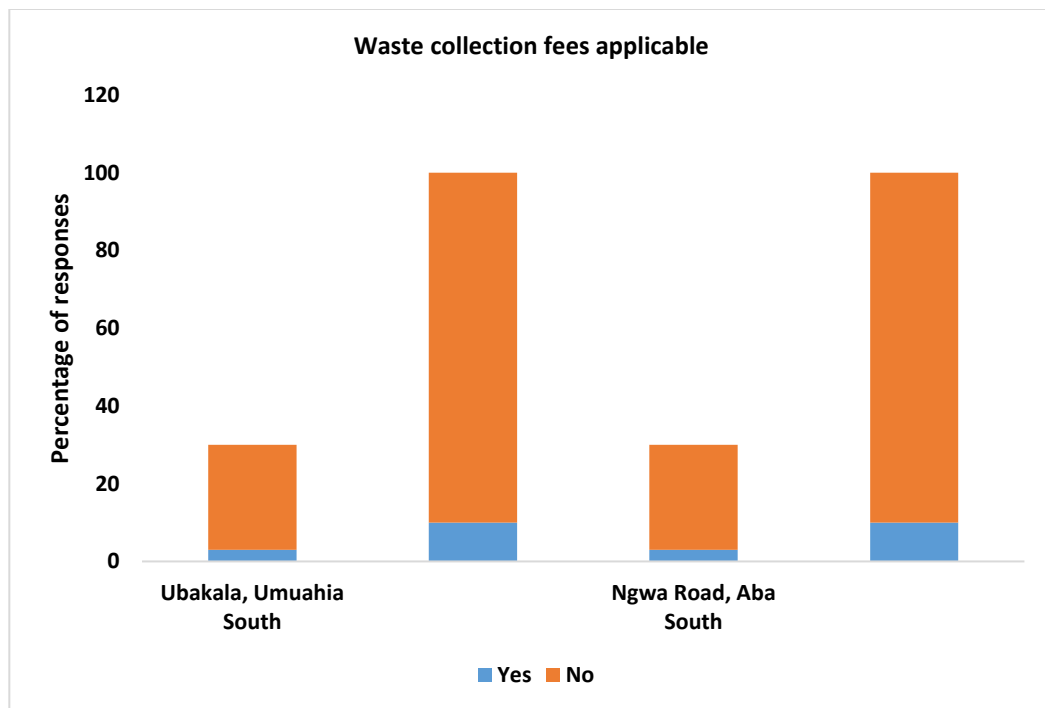**Figure 2.** Abattoir generated waste type

Figure 3. Waste collection fees applicable

3.3 Knowledge of abattoir workers toward abattoir waste management

The knowledge of abattoir workers toward abattoir waste management reveals that 23.3% of the operators in both selected abattoirs indicate that abattoir waste is adequately disposed **(Table 3).** Further investigation reveals that 20.0% (Ubakala) and 33.3% (Ngwa road) reported that the ground for killing of the animals is in good condition. 13.3% in Ngwa road abattoir indicates veterinary adequacy, while 26.7% (Ubakala and Ngwa road) report adequate pest control. The routine ante-mortem and post-mortem procedures constitute about 3.3 percent. Knowledge about abattoir waste had

the highest percentage (100.0%). Hence, if abattoir waste is improperly handled and disposed, it generates bad odor, recorded about 66.7% in Ubakala and 56.7% in Ngwa road. Bad odor from abattoir waste affects people's health, constituting 33.3% and 46.7%, respectively. Abattoir waste, if improperly handled and disposed, serves as a breeding ground for flies and mosquitoes, recording the highest percentage of 76.7% and 66.7%. Improperly disposed abattoir waste could attract animal scavengers, accounting for 36.7% (Ubakala) and 50.0% (Ngwa road).
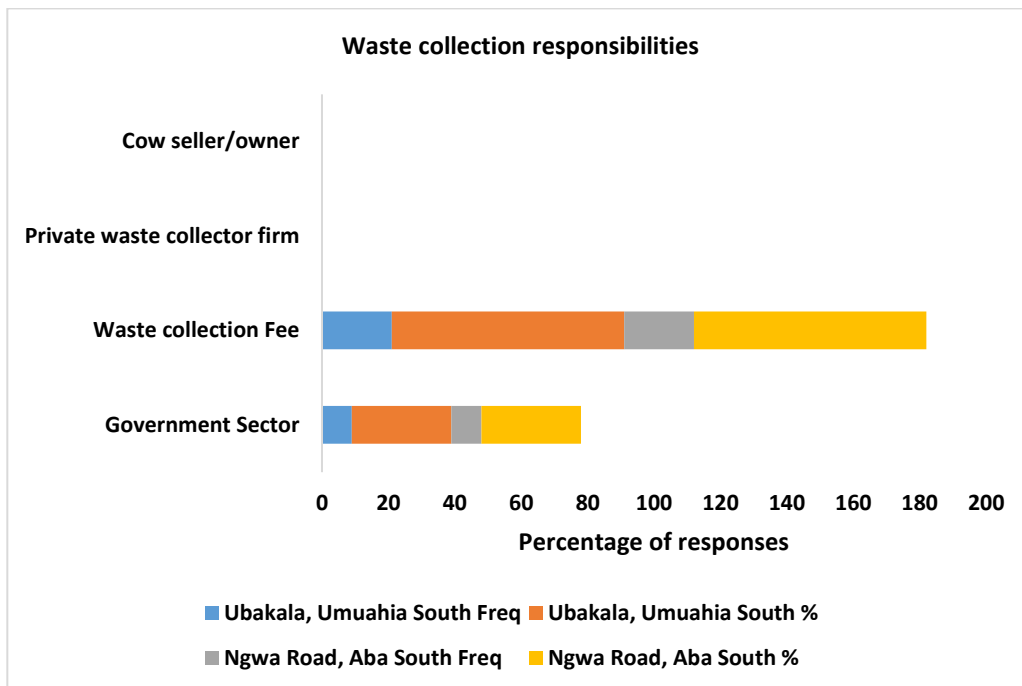

Figure 4. Waste collection responsibilities

In this context, 56.7% and 66.7% of abattoir operators indicate that improperly handled and disposed abattoir waste pollutes the air, while 26.7% and 50.0% report it pollutes surface water, followed by those who report it pollutes underground water (16.7% and 20.0%). Knowledge about how abattoir waste should be disposed constitutes 50.0% in the two assessed abattoirs. Moreover, waste from abattoirs could be used as bio-fertilizer, recording 70.0% and 73.3%, 13.3% and 40.0% indicate its usefulness as animal feed, while 6.7% and 10.0% report its usage as bioenergy in Ubakala and Ngwa road. Knowledge of abattoir workers toward abattoir waste management reveals that 100.0% of the workers report being knowledgeable about abattoir waste **(Table 3).** 23.3% indicate adequacy of waste disposal, 20.0% and 33.3% report a good ground for killing animals, and 13.3% indicate veterinary adequacy, while 26.7% report pest control adequacy. According to (Adebowale et al., 2012), these results demonstrate that Nigerian slaughterhouses are typified by inadequate waste management facilities, marshy surroundings caused by poor drainage, air and water pollution, unsanitary operations, outdated and poorly designed amenities, and insufficient government policies and funding. Furthermore, according to the participating parties, routine ante- and post-mortem exams reported 13.3 percent. This indicates that the preservation of the public's health is the main motivation behind the post-mortem examination of corpses at abattoirs (DARD, 2008).

In reference to meat inspection, (Adebowale, 2019) stated that para veterinarians perform the majority of meat inspections. The standard protocol for meat examinations involves palpation, incision of visceral organs, and ocular inspection.

Table 3. Knowledge of abattoir workers toward abattoir waste management

Variables	Ubakala, Umuahia South		Ngwa Road, Aba South	
	Frequency (Freq)	Percentage (%)	Frequency (Freq)	Percentage (%)
Waste disposal adequate				
Yes	-	-	7	23.3
No	30	100.0	23	76.7
Ground killing of animals is good				
Yes	6	20.0	10	33.3
No	24	80.0	20	66.7
Veterinarians adequate				
Yes	-	-	4	13.3
No	30.	100.0	26	86.7
Pest Control Adequate				
Yes	8	26.7	8	26.7
No	22	73.3	22	73.3
Routine Ante-Mortem and Post-Mortem				
Yes	4	13.3	2	13.3
No	26	86.7	26	86.7
Knowledge About Abattoir Waste				
Yes	30	100.0	30	100.0
No	-	-	-	-
Abattoir Waste, If Improperly Handled and Disposed, Generates Bad Odor				
Yes	20	66.7	17	56.7
No	10	33.3	13	43.3
Bad Odor from Abattoir Waste Affects the People Health				
Yes	10	33.3	14	46.7
No	20	66.7	16	53.3
Abattoir Waste if Improperly Handled and Disposed, Serves as a Breeding Ground for Flies and Mosquitoes				
Yes	23	76.7	20	66.7
No	7	23.3	10	33.3
Abattoir Waste if Improperly Disposed Could Attract Animal Scavengers				
Yes	11	36.7	15	50.0
No	19	63.3	15	50.0
Abattoir Waste if Improperly Handled and Disposed Pollutes Air				
Yes	17	56.7	20	66.7
No	13	43.3	10	33.3
Abattoir Waste if Improperly Handled and Disposed Pollutes Surface Water				
Yes	8	26.7	15	50.0
No	22	73.3	15	50.0
Abattoir Waste if Improperly Handle Pollutes Underground Water				
Yes	5	16.7	6	20.0
No	25	83.3	24	80.0
Knowledge on how Abattoir Waste Should Be Disposed				
Yes	15	50.0	15	50.0
No	15	50.0	15	50.0
Abattoir Waste could be Used as Bio-Fertilizer				
Yes	21	70.0	22	73.3
No	9	30.0	8	26.7
Abattoir Waste could be Used as Animal Feed				
Yes	13	43.3	12	40.0
No	17	56.7	18	60.0
Abattoir Waste could be Used as Bioenergy				
Yes	2	6.7	3	10.0
No	28	93.3	27	90.0

According to (Lawan et al., 2010), inadequate post-mortem and ante-mortem assessment at abattoir facilities can thereby exacerbate the dissemination and transfer of animal foods to humans. Subsequent analysis finds that 66.7% and 56.7% of the workers say that incorrect handling and disposal

of abattoir waste results in an unpleasant odor and has an impact on people's health (33.3%) **(Table 3),** contributes to air pollution (56.7% and 66.7%), surface water pollution (26.7% and 50.0%), animal scavenger attraction (36.7% and 50.0%), fly and mosquito breeding grounds (76.7% and 66.7%), and subsurface pollution (16.7% and 20.0%). In addition, 251 (94.0%) of the participants concurred that handling abattoir waste incorrectly could result in an unpleasant stench that could harm people's health and draw scavengers. According to a study by (Gana and Oludele, 2020), one of the main sources of water contamination is waste that is released from slaughterhouses.

This result is in line with other findings that show 84.44% of participants agreed on these issues (Adesokan and Raji, 2014). In Ubakala and Ngwa Road abattoirs, 50.0% of the staff is aware of proper disposal procedures for abattoir waste. According to employees at abattoirs, waste from these facilities can be utilized as animal feed (13.3% and 40.0%), bioenergy (6.7% and 10.0%), and bio-fertilizer (70.0% and 73.3%). These results are consistent with study conducted in Ethiopia, which shows that 55.4%, 57.3%, and 36.35% of participants thought that slaughterhouse wastes may be used as biofuel, animal feed, and bio-fertilizer (Sindibu *et al.,* 2018). Due to the low knowledge and attitudes of butchery workers in the majority of poor nations, there is insufficient waste management strategy planning in slaughterhouses (Chukwu, 2008), which calls for immediate attention (Haileselassie *et al.,* 2013). Because of the hazard associated with slaughterhouse wastes and other significant proxy, adequate knowledge and practice of appropriate waste management are crucial to resolving these issues (Adesokan and Sulaimon, 2014).

3.4 Attitude of abattoir workers toward abattoir waste management

A total of 18 (60.0%) and 16 (53.3%) participants agreed that abattoir waste could cause offensive odor in the surrounding environment **(Table 4).** Moreover, 46.7% (Ubakala) and 43.3% (Ngwa Road) agreed that odor from abattoir waste could pose a health problem to people. All participants (100.0%) agreed that waste drained from the abattoir serves as a breeding ground for flies and mosquitoes. Additionally, 10.0% (Ubakala) and 13.3% (Ngwa Road) agreed that waste discharge attracts animal scavengers. About 20.0% of workers in Ubakala and Ngwa Road abattoirs agreed that waste discharge could pollute the air, while 16.7% agreed that abattoir waste could pollute surface water, and 20.0% agreed it could pollute underground water. Further investigation reveals that 73.3% (Ubakala) and 63.3% (Ngwa Road) agreed that disposed abattoir waste could be used as animal feed, 60.0% agreed it could be used as bio-fertilizer, and 40.0% from both abattoirs agreed it could be used as bio-fuel. Moreover, 56.75% and 53.3% agreed that abattoir waste is properly disposed. The attitudes of abattoir workers toward abattoir waste management reveal that 60.0% and 53.3% agreed that abattoir waste released could cause offensive odor in the surrounding environment **(Table 4).** Additionally, 46.7% and 43.3% agreed that such odor could pose health problems to people. All participants (100.0%) agreed that abattoir waste serves as a breeding ground for flies and mosquitoes, while 10.0% and 13.3% agreed it attracts animal scavengers.

A little over 20.0% of respondents agreed that waste discharge may contaminate air, 16.7% said it could contaminate surface water, and 20.0% said it could contaminate subsurface water. Further research shows that, although 53.3% of respondents agreed that abattoir waste is disposed of appropriately, 40.0% and 56.7% of respondents said that the waste might be used as biofuel and fertilizer, respectively. These results suggest that activities related to abattoirs affect air quality, subsurface and surface water pollution, and the health of those who live close to slaughterhouses (Odoemelan and Ajunwa, 2008; Patra *et al.,* 2007).

Table 4. Attitude of abattoir workers toward abattoir waste management

Variables	Ubakala, Umuahia South		Ngwa Road, Aba South	
	Frequency (Freq)	Percentage (%)	Frequency (Freq)	Percentage (%)
Abattoir Waste Releases Could Cause Offensive Odor to the Surrounding Environment				
Agree	18	60.0	16	53.3
Disagree	8	26.7	10	33.3
Neutral	4	13.3	4	13.3
Abattoir Waste Odour could Pose a Health Problem to People				
Agree	14	46.7	13	43.3
Disagree	9	30.0	10	33.3
Neutral	7	23.3	7	23.3
Abattoir Waste Drain Serves as a Breeding Ground for Flies and Mosquitoes				
Agree	30	100.0	30	100.0
Disagree	-	-	-	-
Neutral	-	-	-	-
Abattoir Waste Discharge Attracts Animal Scavengers				
Agree	3	10.0	4	13.3
Disagree	19	63.3	18	60.0
Neutral	8	26.7	8	26.7
Abattoir Waste Discharge Could Pollute the Air				
Agree	6	20.0	6	20.0
Disagree	18	60.0	17	56.7
Neutral	6	20.0	7	23.3
Abattoir Waste could Pollute Surface Water				
Agree	5	16.7	5	16.7
Disagree	22	73.3	21	70.0
Neutral	3	10.0	4	13.3
Abattoir Waste Discharge Could Pollute Underground Water				
Agree	6	20.0	6	20.0
Disagree	21	70.0	16	53.3
Neutral	3	10.0	8	26.7
Disposed Abattoir Waste could be Used as Animal Feed				
Agree	22	73.3	19	63.3
Disagree	8	26.7	11	36.7
Neutral	-	-		
Disposed Abattoir Waste could be Used as Bio-Fertilizer				
Agree	18	60.0	18	60.0
Disagree	6	20.0	6	20.0
Neutral	6	20.0	6	20.0
Abattoir Waste could be Used as Biofuel				
Agree	12	40.0	12	40.0
Disagree	15	50.0	12	40.0
Neutral	3	10.0	6	20.0
Abattoir Waste is Properly Disposed				
Agree	17	56.7	16	53.3
Disagree	12	40.0	13	43.3
Neutral	1	3.3	1	3.3

Consequently, research also indicates that the accumulation of waste from slaughterhouses may contribute to pollution and the production of methane gas, which intensifies the greenhouse effect (Adeyemo, 2002). Furthermore, a significant amount of suspended solids, liquid waste, and odor

production are the main environmental issues associated with slaughterhouse wastewater (Gauri, 2006). Thus, by preserving nitrogen, which serves as fertilizer, and other ingredients in the processed slurry, the conversion of slaughterhouse waste into biogas might lessen environmental challenges (Alvarez and Liden, 2008).

3.5 Practices of abattoir workers toward abattoir waste management

Among the study participants (N=60), 100.0% in Ubakala and Ngwa Road properly separate the edible parts from non-edible parts in their daily work activities **(Table 5).** Moreover, 30.0% use abattoir waste as bio-fertilizer for the surroundings, while 16.7% and 20.0% use some important parts of the abattoir waste for animal feed. However, the majority of the participants report that they do not prepare bone, blood, and feather meal from abattoir waste.

Table 5. Practices of abattoir workers toward abattoir waste management

Variables	Ubakala, Umuahia South		Ngwa Road, Aba South	
	Frequency (Freq)	Percentage (%)	Frequency (Freq)	Percentage (%)
Properly Separate the Edible Parts from Non-edible Parts in your Daily Work Activities				
Yes	30	100.0	30	100.0
No	-	-	-	-
Usage of Abattoir Waste as Bio-Fertilizer for Surroundings				
Yes	9	30.0	9	30.0
No	21	70.0	21	70.0
Use Some Important Abattoir Waste for Animal Feed				
Yes	5	16.7	6	20.0
No	25	83.3	24	80.0
Use the Abattoir Waste for Biogas				
Yes	-	-	-	-
No	30	100.0	30	100.0
Prepare Bone, Blood and Feather Meal from Abattoir Waste				
Yes	-	-	-	-
No	30	100.0	30	100.0
Segregate Semi-Solid/Liquid Parts from Solid Waste Before Disposal				
Yes	-	-	-	-
No	30	100.0	30	100.0
Dispose Liquid Abattoir Waste on the Agricultural Fields as Fertilizer				
Yes	18	60.0	19	63.3
No	12	40.0	11	36.7
Dispose Abattoir Waste by Incineration				
Yes	-	-	30	100.0
No	30	100.0	-	-
Dispose Abattoir Waste by Burial				
Yes	17	56.7	17	56.7
No	13	43.3	13	43.3
Use Abattoir Waste as Compost				
Yes	25	83.3	24	80.0
No	5	16.7	6	20.0

Additionally, 100.0% indicate that they do not segregate semi-solid/liquid parts from solid waste before disposal. Although 60.0% and 63.3% report disposing of liquid abattoir waste on agricultural fields as fertilizer, and 100.0% in Ngwa Road indicate that they dispose of abattoir waste by incineration, with 56.7% from both abattoirs revealing that they dispose of abattoir waste by burial. Furthermore, 83.3% and 80.0% of the participants use abattoir waste as compost. Practices of abattoir workers toward abattoir waste management show that 100.0% of the workers properly separate the edible parts from non-edible parts in their daily work activities **(Table 5).** Additionally, 30.0% use waste as bio-fertilizer for the surroundings, 16.7% and 20.0% as animal feed.

Additionally, 60.0% and 63.3% report using liquid abattoir waste as fertilizer on fields, 100.0% report incinerating the waste, 56.7% report burying it, and 83.3% and 80.0% report using compost. These findings indicate that the likelihood of contaminating meat meant for human consumption rises when solid waste is kept in the abattoir for longer than a day. Numerous reports exist of inadequate handling of abattoir wastes in almost all Nigerian butcher shops (Nwanta *et al.,* 2008; Cadmus *et al.,* 2010; Lawan *et al.,* 2010). Additionally, the environment, public health, and food safety may be at risk from the careless disposal of liquid and solid waste. Because of the high amounts of bacterial adulterant, meat produced at unhygienic slaughterhouses is susceptible to rapid deterioration (Nwanta *et al.,* 2008). According to studies, airborne pollutants and toxic chemicals from decomposing animal dung piles hasten the effects of greenhouse gasses, including respiratory ailments, cardiovascular issues, and early mortality (Ogbonna *et al.,* 2002). Similarly, studies have shown that unprocessed waste from slaughterhouse discharges has a well-documented impact on Nigeria's surface and groundwater (Kwadzah and Iorhemen, 2015; Adebowale *et al.,* 2016).

3.6 *Preventive measures that would improve the practices of abattoir workers*

An investigation into preventive measures that could improve the practices of abattoir workers reveals that 76.7% and 73.3% (Ubakala and Ngwa Road) of the workers report that public awareness and enlightenment on the impacts of pollution from abattoir wastes should be embarked upon by relevant agencies **(Table 6).** Additionally, 83.3% in both locations suggest that modernization of abattoirs should include adequate infrastructure, proper supervision, and health education of operators on healthy practices. Furthermore, 86.7% indicate that a pretreatment system should be constructed before the discharge of abattoir waste. However, 46.7% and 50.0% believe that abattoirs should not be sited in close proximity to residential areas. Preventive measures aimed at improving the practices of abattoir workers show that 76.7% and 73.3% of the workers emphasize the need for public awareness and enlightenment on the impacts of pollution from abattoir wastes by relevant agencies **(Table 6).** Additionally, 83.3% suggest that modernizing abattoirs should include adequate infrastructure, proper supervision, and health education for operators on healthy practices. Furthermore, 86.7% advocate for constructing a pretreatment system before discharging abattoir waste, while 46.7% and 50.0% recommend not siting abattoirs in close proximity to residential areas.

These results highlight how crucial it is to maintain hygienic conditions and sufficient infrastructure for the production and distribution of meat in abattoirs, as well as to prevent the spread and transmission of food for both humans and animals. Regrettably, many abattoirs in underdeveloped nations are ill-built, inadequately equipped for meat inspection, and staffed with a dearth of qualified meat inspectors and hygienic procedures (Biu *et al.,* 2006). This has important ramifications for public health as well as the possible spread of zoonotic illnesses between humans and the environment

(Tassew *et al.,* 2010). (FAO, 2006) stated that, as a result, resolving these concerns is essential to striking a balance between the environmental impact and the demand for animal food products. Given that meat is extremely perishable (Bindu *et al.,* 2012) and that abattoir environments require a lot of labor, educating consumers and giving meat handlers the necessary training on hygienic management are crucial control points in food chains that are essential to reducing consumer health risks (Haileselassie *et al.,* 2013). More than butchery operations, marketing, operating, and processing procedures are engulfed in sanitary distress (Djeni *et al.,* 2014; Amoah *and al.,* 2018; Nagarajan *et al.,* 2018; OIE, 2019). Therefore, improving abattoir food safety knowledge and practices is crucial to eradicating zoonotic bacteria that are emerging and re-emerging as well as guaranteeing the production of wholesome and healthful meat.

Table 6. Preventive measures that would improve the practices of abattoir workers

Variables	Ubakala, Umuahia South		Ngwa Road, Aba South	
	Frequency (Freq)	**Percentage (%)**	**Frequency (Freq)**	**Percentage (%)**
Public Awareness and Enlightenment on Impacts of Pollution from Abattoir Wastes Should be Embarked Upon by Relevant Agencies				
Yes	23	76.7	22	73.3
No	7	23.3	8	26.7
Modernization of Abattoir should include Adequate Infrastructure, Proper Supervision and Health Education of the Operators on Healthy Practices				
Yes	25	83.3	25	83.3
No	5	16.7	5	16.7
Pretreatment System should be Constructed before the Discharge of the Abattoir Waste				
Yes	26	86.7	26	86.7
No	4	13.3	4	13.3
Abattoirs should not be Sited in Close Proximity to Residential Areas				
Yes	14	46.7	15	50.0
No	16	53.3	15	50.0

Conclusion

The study evaluated abattoir waste management methods, knowledge, attitudes, and problems. According to the results, men predominate in both Ubakala and Ngwa Road (86.7%). Higher percentages of people were single (73.3% and 56.7%), and 56.7% of them had completed secondary education. In Ubakala, the 40–55 age group made up 56.7% of the population. Sixty percent of the population had an average monthly salary between ₦100,000 and ₦200,000. Of these, 56.7% worked in the butchery industry, and 86.7% had five to ten years of experience in the abattoir. The majority of trash produced (46.7%) was animal blood, with 70.0% signifying payment for waste removal services. In addition, twenty-nine percent and thirty-three percent said that garbage was disposed of appropriately, thirteen percent thought that veterinarians were adequate, and twenty-six percent thought that pest management was adequate. 13.3% of cases included routine ante- and post-mortem examinations. Furthermore, 66.7% and 56.7% of respondents said that poor waste management results in an unpleasant stench, and 33.3% and 46.7% said that waste odor has an impact on people's health. Additionally, 36.7% and 50.0% said that waste draws animal scavengers, and 76.7% and 66.7% said

that waste serves as a breeding ground for flies and mosquitoes. 56.7% and 66.7% of respondents reported air pollution, 26.7% and 50.0% reported surface water pollution, and 16.7% and 20.0% reported subsurface water contamination. Abattoir waste may be utilized as animal feed by 43.3% and 70.0% (Ubakala and 73.3% Ngwa Road) as bio-fertilizer.40.0%, and 6.7% and 10.0% as bioenergy. While 46.7% and 43.3% said that abattoir waste provides a health risk to individuals, 60% and 53.3% agreed that it produces an unpleasant stench in the environment. Twenty percent and sixteen percent reported air pollution, twenty percent and sixteen percent mentioned surface water pollution, twenty percent and sixteen percent mentioned underground water pollution, and all participants acknowledged waste as a haven for flies and mosquitoes. Additionally, ten percent and thirteen percent said it draws scavengers. Furthermore, 100% of respondents said they separated edible from non-edible components in their everyday activities; 30.0% used waste as bio-fertilizer for the neighborhood, and 16.7% (Ubakala) and 20.0% (Ngwa Road) used it as animal feed.

Sixty percent and sixty-three percent disposed of liquid waste as fertilizer on fields; 100.0% (Ngwa Road) utilized incineration; 56.7% chose burial; 83.3% and 80.0% used composting. In terms of preventive measures, 76.7% and 73.3% of the workers recommended that relevant agencies raise public awareness and educate the public about the negative effects of abattoir pollution, while 83.3% stressed the need for abattoirs to be modernized with enough infrastructure, proper supervision, and health education for operators on healthy practices. Moreover, 86.7% suggested building a pretreatment mechanism prior to releasing waste from slaughterhouses. Finally, fifty percent of respondents thought that slaughterhouses shouldn't be located near residential areas. These results highlight the unfavorable environmental effects of state-run meat processing facilities, inadequate meat inspection services, and the potential for residents to consume tainted meat, which poses a major health concern. Constructing new abattoirs with state-of-the-art equipment and amenities for clean handling, storage, and sale of meat is essential to avoiding fly infestation and other health-harming vector infestations. Prioritizing stakeholder sensitization and environmental education would help create awareness about abattoir safety measures. This will ensure that all safety components are covered in detail for efficient information delivery.

References

Abdullahi A., Kadarman N., Hassan A., Madobi I. S., (2015) Negative impact of abattoir activities and management in residential neighbourhoods in Kuala Terengganu, Malaysia. International Journal of Public Health Science, 4(2):124-130. ISSN: 2252-8806

Adebowale O. O., (2019) Waste management and practices in a slaughterhouse in Abeokuta Nigeria. Case Study, implications and alternative methods. Sokoto Journal of Veterinary Medicine, 17(3):52-55. http://dx.doi. org/10.4314/sokjvs.v17i3.9

Ademola I. T. (2019). An assessment of abattoir waste management in Ogun state. BSc. Dissertation, Olabisi Onabanjo University, Nigeria.

Adeolu A.T., Opasola A.O., Salami O.O., Iyandaa.Y., Omenta R. C., (2019) Sanitary status and compliance with the standard slaughter practices in Karu abattoir Abuja municipal area council of the FCT, Nigeria.

International Journal of Current Innovations in Advanced Research, 2(2):1-14.

Adeoye, P. A., Dauda, S. M., Musa, J. J., Adebayo, S. E., Sadeeq, M. A., (2012) Evaluation of water quality standards and sanitary conditions in Moniya Abattoir, Ibadan, Nigeria. Journal of Applied Technology in Environmental Sanitation, 2(1), 17-22.

Adesokan, H. K., Sulaimon, M. A., (2014) Poor slaughterhouse waste management: empirical evidences from Nigeria and implications on achieving millennium development goals. AFRREV STECH Int J Sci Technol. 2014;3:110-127.

Adewumi, J. R., Babatola, J. O., Adejuwon, E. O., (2016) Assessment of Abattoir Wastes Management Strategy in Akure South West Nigeria. *Futo Journal Series* 2(1), 186-194.

Adeyemi, I. G., Adeyemo, O. K., (2006) Waste management practices at the Bodija abattoir, Nigeria. *International Journal of Environmental Studies*, 64 (1): 71-82.

Adeyemo, O. K., (2002) Unhygienic Situation of a City Abattoir in South Western Nigeria: Environmental Implication.'AJEAM/RAGEE Vol. 4 No. 1 pp 23-28

Adeyemo, O., Adeyemi, I., Awosanya, E., (2009) Cattle Cruelty and Risks of Meat contamination at Akinyele Cattle Market and Slaughter Slab in Oyo State, Nigeria. *Tropical Animal Health and Production,* 41, 1715- 1721.

Adonu, R. E., Dzokoto, L., Salifu, S. I., (2017) Sanitary and hygiene conditions of slaughterhouses and its effect on the health of residents: A case study of Amasaman slaughterhouse in the Ga west municipality, Ghana. *Food Science and Quality Management,* 65, 11- 15.

Akindele S.T., Abimbola W.A., Oluwabiyi B.A., Jokotagba O.A., Agbolade O.M., Sam-Wobo S.O., (2015) Microbiological assessment of waste-water and soil in Ijebu-Igbo abattoir, Southwest, Nigeria. *International Journal of Advancements in Research & Technology,* 4(10):1- 12. ISSN 2278-7763. Awolowo University, Ile-Ife, Nigeria.

Bandaw T., Herago T., (2017) Review on abattoir waste management. *Global Veterinaria,* 19(2):517-524. https:// doi.org/10.5829/idosi.gv.2017.517.524

Bello Y.O., Oyedemi D.T. A., (2009) The impact of abattoir activities and management in residential neighbourhoods: A case study of Ogbomosho, Nigeria. *Journal of Social Science*, 19(2):121-127.

Chukwu, O., Mustapha, H. I., Abdul Gafar, H. B., (2008) The effect of Minna Abattoir waste on surface water quality II. *Environmental Research Journal,* 2 (6): 339-342.

Chukwu O., (2008) Analysis of groundwater pollution from abattoir waste in Minna, Nigeria. *Res J Diary Sci.* 2008;2:74-77.

Chukwu, O., Adeoye, P. A., Chidiebere, I., (2011) Abattoir wastes generation, management and the environment: a case of Minna, North Central Nigeria. *International Journal of Biosciences* (IJB), 1(6): 100-109. ISSN: 2220-6655 (Print) 2222-5234 (Online).

Coker, A. O., Olugasa, B. O., Adeyemi, A. O., (2001) Abattoir wastewater Quality in South Western Nigeria, Proceedings of the 27th WEDC Conference, pp. 329-331, Lusaka, Zambia, Loughborough University, United Kingdom

Dada O.T., Odufuwa B.O., Badiora A.I., Hafeez I.A., Ogunseye N.O., Omoniyi S. S., (2020) Environmental hazard and health risks associated with slaughterhouses in Ibadan, Nigeria. *Environmental Hazards.* https://doi.org/10.1080/17477891.2020.1747382

Daramola O.P., Olowoporoku O. A., (2017) Living with a Fatal Choice: Effects of Slaughterhouse Activities on Residents' Health in Osogbo, Nigeria. *International Journal of Environmental Problems*, 3(1):26-35. https://doi. org/10.13187/ijep.2017.1.26

Ekpo C.G., (2019) Environmental problems associated with abattoir operations in Gwagwalada area council, Federal Capital Territory, Abuja. *Advances in Social Sciences Research Journal*, 6(3): 215-226. https://doi.org.10.14738/ assrj.63.6089

Elemile, O. O., Raphael, D. O., Omole, D. O., Oloruntoba, E. O., Ajayi, E. O., Ohwavborua, N. A., (2019) Assessment of the impact of abattoir effluent on the quality of groundwater in a residential area of Omu-

Aran, Nigeria. *Environmental Science Europe*, 31(1): 16-25.

Ezeoha S.L., Ugwuishiwu B. O., (2011) Status of abattoir wastes research in Nigeria. *Nigerian Journal of Technology,* 30(2): 143-148.

Ezeoha, S. L., Ugwuishiwu, B. O., (2011) Status of abattoir wastes research in Nigeria. *Nigerian Journal of Technology,* 30(2), 143-148.

Fadare S. O., Afon A.O., (2010) Waste handling practices at abattoirs: Experience from Ile-Ife, Nigeria. *The Lagos Journal of Environmental Studies*, 7(2): 51-57.

Fearon J., Mensah S.B., Boateng V., (2014) Abattoir operations, waste generation and management in the Tamale metropolis: Case study of the Tamale slaughterhouse. *Journal of Public Health and Epidemiology*, 6(1): 14-19. https://doi. org/10.5897/JPHE2013.0574

FME., (2005) Federal Ministry of Environment (FME), Policy Guidelines on Market and Abattoir Sanitation. Abuja: Federal Ministry of Environment.

Franke-Whittle, I. H., Insam, H., (2013) Treatment alternatives of slaughterhouse wastes, and their effect on the inactivation of different pathogens: A review. *Critical Review in Microbiology,* 39(2): 139-151. https://doi.org/10.3109/1 040841X.2012.694410

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.

Magaji, J. Y., Chup, C. D., (2012) The Effects of abattoir waste on water quality in Gwagwalada – Abuja. *Ethiopia Journal of Environmental Studies and Management (EJESM), 5(4) (Supplementary* 2) 542 – 549. https://doi.org/10.4314/ejesm.v5i4.S14

Masse D.I., Masse L., (2000) Characterization of wastewater from hog slaughterhouses in Eastern Canada and evaluation of their in-plant wastewater treatment systems. *Canadian Agricultural Engineering,* 42(3): 139-146.

Muhirwa, D., Nhapi, I., Wali, U., Banadda, N., Kashaigili, J., Kimwaga, R., (2010) Characterization of Wastewater from an Abattoir in Rwanda and the Impact on Downstream Water Quality. *International Journal of Ecology and Development* 16, 30-46.

Nafarnda, W. D., Ajayi, I. E., Shawulu, J. C., Kawe, M. S., Omeiza, G. K., Sani, N. A., Tenuche, O. Z., Dantong, D. D., Tags, S. Z., (2012) Bacteriological quality of Abattoir effluents discharged into water bodies in Abuja, Nigeria. *International Scholarly Research Network Veterinary Science.* https://doi.org/10.5402/2012/515689

Nafarnda, W. D., Yaji, A., Kubkomawa, H. I., (2006) Impact of slaughterhouse waste on aquatic life: a case study of Yola slaughterhouse. *Global Journal of Pure and Applied Sciences*, 12, 31–33. https://doi.org/10.4314./gjpas.v12i1.16540

Nwankwo, B., (2011) Evaluation of Environmental Sanitation in Owerri Municipal Council of Imo state. *Research Journal of Medical Science* Vol. 3. N. 44, pp. 137-140.

Nwanta, J. A., Onunkwo, J., Ezenduka, E., (2010) Analysis of Nsukka Metropolitan Abattoir Solid Waste and Its Bacterial Contents in South Eastern Nigeria: Public Health Implication. *Archives of Environmental & Occupational Health* 65(1), 21-26. https://doi.org/10.1080/193.382.40903390263

Nwanta, J. A., Onunkwo, J. I., Ezenduka, V. E., Phil-Eze, P. O. Egege S. C., (2008) Abattoir Operations and Waste Management in Nigeria: A Review of Challenges and Prospects Sokoto Journal of Veterinary Sciences Vol 7, No.2, pp.61 67.

Obidiegwu C. S., Chineke H. N., Ubajaka C. N., Adogu P.O.U., (2019) Public health challenges in Somachi main abattoir Owerri, Nigeria: A review and field activity report. EJMED, *European Journal of Medical and Health Sciences,* 1(2):1-7. http://dx.doi.org/10.24018/ ejmed.2019.1.2.34

Oduguwa B. O., Raimi, C. O., Talabi, A. O., Sogunle, O. M., (2013) Fetal losses from slaughtering pregnant cows at Lafenwa abattoir in Abeokuta, South Western Nigeria. *Global Journal of Biology, Agriculture & Health Science,* 2(2):38-41. ISSN: 2319–5584.https://www.longdom.org/articles/fetal-losses-from-

slaughtering-pregnant-cows-at-lafenwa -abattoir-in- abeokuta-south-western-nigeria.pdf

Officha M.C., Onwuemesi F.E., Nzewi D. C., (2018) Impact of abattoir on environment in Igbo-Etiti local government area of Enugu State. *International Research Journal of Biotechnology,* 5(1):10-14. https://www. interesjournals.org/biotechnology.html

Ogbonnaya, C., (2008) Analysis of groundwater pollution from abattoir waste in Minna, Nigeria. *Research Journal of Dairy Sciences,* 2(4):74-77.

Okoli, C. G., Okoli, I. C., Okorondu, U. V., Opara, M. N., (2006) Environmental and public health issues of animal food products delivery system in Imo state, Nigeria. *Journal of Health and Allied Science,* 5(2): 2.

Olawuni, P. O., Daramola, O. P., Soumah, M., (2015) Environmental Implications of Abattoir Waste Generation and Management in Developing Countries: The Case of Lagos State Abattoir in Agege, Nigeria. *Greener Journal of Social Sciences,* 7 (2): 007-014.

Olowoporoku O. A., (2013) Environmental Sanitation Practices in Slaughterhouses in Osogbo, Nigeria. An Independent Thesis Submitted to the Department of Urban and Regional Planning, Faculty of Environmental Design and Management, Obafemi

Omole D. O., Ogbiye A. S., (2013) An evaluation of slaughterhouse wastes in south-west Nigeria. *American Journal of Environmental Protection,* 2(3):85-89.

Omole, D. O., Longe, E.O., (2008) An assessment of the impact of abattoir effluents on River Illo, Ota, Nigeria.*Journal of Environmental Science and Technology*, 1(2), 56 - 54.

Oruonye, E. D., (2015) Challenges of abattoir waste management in Jalingo metropolis, Nigeria. *International Journal of Research in Geography,* 1(2):22-31. ISSN 2454- 8685.

Osibanjo, O., Adie G. U., (2007) Impact of effluent from Bodija abattoir on the physio-chemical parameters of Oshunkaye stream in Ibadan city, Nigeria. *African Journal of Biotechnology* 6(15), 1806 – 1811.

Roberts, H., De jager, L., Blight, G., (2009) Waste handling practices at red meat abattoirs in South Africa. Waste Management Resources, 27(1), 25-30. https://doi.org/10.1177/0734242X07085754

UN., (2013) United Nations. The world's population concentrated in urban and its challenges. No. 2014/3:1-14, 2013.

Wing, S., Wolf, S., (2000) Intensive livestock operations, Health and Quality of life among Eastern North Carolina Residents". *Environmental Health Perspectives,* 108(3), 233-238. https://doi.org/10.1289/ehp.00108233

World Bank., (2002) Sustainable Sanitation [http://www.NETSSAF.net], (accessed 2010 March 11).

WHO., (2003) World Health Organization (WHO). (2003). Bangkok, Thailand (2003): Regional office for Africa "Developing and Maintaining Food Safety Control Systems for Africa Current Status and Prospects for Change", Second FAO/WHO Global Forum of Food Safety Regulators; pp. 12–14.

WHO., (2005) World Health Organization (WHO). (2005). Public Health and Air pollution. http://www.cleanairforce.com/docs/GCAFHealthBenefitsPoster.pdf retrieved on 24th May, 2019

(2024) ; http://www.jmaterenvironsci.com