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Bacteriological Assessment of Vibrio species on Abattoir Soil

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Abstract

An abattoir, also known as a slaughterhouse, is a place where animals are butchered. The main aim of the study is to isolate and identify Vibrio species on abattoir soils. Soil samples (20 g) were collected from the abattoir in the contaminated areas of Ekpoma and Auchi. The soil samples were collected into a sterile, dark polythene bag using a sterile spatula at a depth of 10 cm. The soil samples were collected from five different sites on the abattoir in both locations selected (Auchi and Ekpoma). A 1 g soil sample was crushed and air dried before being diluted in 9 ml of sterile distilled water, followed by serial dilution (one ml of the soil suspension was then serially (ten-fold) diluted). In Ekpoma, no Vibrio species was isolated, but Vibrio was isolated from Auchi but has a very low count. Other organisms isolated from the soil samples include those in Auchi (Streptococcus spp., Staphylococcus aureus, Escherichia coli, Klebsiella spp., and Pseudomonas spp.) and Ekpoma (Proteus spp., Klebsiella spp., Streptococcus spp., *Staphylococcus aureus*, and Escherichia. On assessment of the total viable count of Vibrio spp. isolated from the soil samples studied, the results were presented based on dilution factors (103 and 104). In the Auchi soil samples studied, the total viable count of Vibrio spp. was 1.2 x 102 CFU/g (103 dilutions) and 0.4 x 102 CFU/g (104 dilutions), while in Ekpoma the total viable count of Vibrio spp. was 0.5 x 102 CFU/g (103 dilutions) and 0.3 x 102 CFU/g (104 dilutions). The mean total viable count of organisms isolated from the study was 4.62 1.7 x 104 CFU/g, while the Ekpoma sample had a total viable count of 4.24 1.6 x 104 CFU/g. Since Vibrio species are present in abattoir soil samples, though in low numbers, it is likely that they could also be present in the meat gotten from the abattoir itself, with the implicit consumer health risk, particularly with the increase in meat consumption. They can also become a major vector for cross-contamination when not properly handled. There were presence of high bacterial presence in Auchi and Ekpoma abattoir soils. The study further confirmed the dangers associated with discharging untreated wastes to the soil, thus the need for adequate treatment to ensure decontamination.

Keywords: *Soil, Bacteria colony, Vibrio species, Abattoirs, Gram positive, Gram negative*

Introduction

The Abattoir industry is an important component of livestock industry in Nigeria, providing domestic meat supplies to over 150 million people and employment opportunities for the teaming population (Nafarnda et al., 2012). An abattoir, also known as slaughter house is a place where animals are butchered for food according to Collins English dictionary. Abattoir acts (1985) defined an Abattoir as any premises used for or in connection with slaughter of animals whose meat is intended for human consumption and include a slaughter house but does not include a place

situated on a farm. Abattoirs are known all over the world to pollute the environment either directly or indirectly from their various processes.

An abattoir is a special facility designed and licensed for receiving, holding, slaughtering, and inspecting meat animals and meat products before release to the public. Abattoir inspection of live animals (ante-mortem) and carcasses (post-mortem) is critical to surveillance for animal diseases and zoonoses (Nwanta et al., 2008). Cadmus et al. (1999) reported that pathogens of zoonotic importance are associated with more than 80% of public abattoirs in Nigeria. This observation has serious public health implications, as many Nigerian abattoirs dispose their effluents directly into streams and rivers without any form of treatment (Alonge, 2005). Incidentally, these streams and rivers also serve as water sources for domestic, agricultural, recreational, as well as drinking purposes for communities and settlements downstream. It is little wonder, therefore, that waterborne diseases such as cholera are recurring in Nigeria.

Vibrio species are Gram negative, facultative anaerobic motile asporogenous rod or curved rod-shaped bacteria with a single polar flagellum. The genus contains at least twelve species pathogenic to human, eight of which can cause or are associated with food-borne illness (Dickinson et al., 2013). The majority of the food-borne illness is caused by Vibrio paraheamolyticus, Vibrio vulnificus, Vibrio fluvialis and Vibrio cholerae. V. vulnificus is responsible for 95% of sea food related deaths while immune suppressed individuals are most susceptible to other Vibrio infection (Miyoshi, 2013). Marine Vibrios are ubiquitous in the marine environment; therefore, it is not surprising that many are pathogenic for various seafood hosts which are harvested for human consumption. Some species are primarily associated with gastrointestinal illness (V. cholerae and V. parahaemolyticus) while others can cause non-intestinal illness, such as septicemia (V. vulnificus). In tropical and temperate regions, disease-causing species of Vibrio occur naturally in marine, coastal and estuarine environments and are most abundant in estuarine. Pathogenic Vibrios, in particular V. cholerae, can also be recovered from freshwater reaches of estuaries (Lutz et al., 2013). The occurrence of these bacteria does not generally correlate with numbers of fecal coli forms and depurations of shellfish may not reduce their numbers. However, a positive correlation between fecal contamination and levels of V. cholerae may be found in areas experiencing cholera outbreaks (Kaysner and DePaola, 2004).

Efforts have been geared towards curbing the menace of pollution around the world, particularly by the United Nations organs e.g., United Nations Environmental Programme. There are many international conferences and protocols to this effect. Rio de Janeiro Conference of 1992 was a major effort, collating previous environmental issues and bringing them to the fore (Oyesola, 1998). Nevertheless, in many parts of the world, human activities e.g., animal production, still impact negatively on the environment and biodiversity. Some of the consequences of man-made pollution are– transmission of diseases by water borne pathogens, eutrophication of natural water bodies, accumulation of toxic or recalcitrant chemicals in the soil, destabilization of ecological balance and negative effects on human health (Amisu et al., 2003).

Among Vibrio and related genera, V. anguillarum, V. parahaemolyticus and V. vulnificus are the main pathogenic species involved in salt water, and V. mimicus and V. cholerae in fresh water culture. The Vibrio species pathogenic for marine fish are V. alginolyticus, V. anguillarum, V. carchariae, V. cholerae, V. ordalii, V. vulnificus and V. parahaemolyticus. Within the Vibrionaceae the species causing the most economically serious diseases in marine are V. anguillarum, V. ordalii, V. samonicida and V. vulnificus biotype 2 (Toranzo et al., 2005). Vibrio cholerae causes cholera in human. It spreads indirectly through faecal contaminated water and foods which are undercooked or consumed raw. V. parahaemolyticus has a worldwide distribution in estuarine and coastal environments and has been isolated from many species of fish, shellfish and crustaceans (FDA, 1992).

Many Vibrio species are pathogens to human and have been implicated in foodborne disease (FDA, 1992). Vibrio species form part of the indigenous micro flora of aquatic habitats of various salinity and the major causative agents for some of the most serious diseases in fish, shellfish and Penaeid shrimp (Sung et al., 2001).

Different methods of waste treatment have been developed, for reasons of public health and conservation, which results in the destruction of pathogens and the mineralization of the organic components of sewage prior to discharge. Anaerobic wastewater treatment using granular sludge reactor is one of such methods. However, in Nigeria, like many developing countries, the discharge of untreated wastes into the environment is still a problem, despite the establishment of Federal

Environmental Protection Agency (FEPA) since 1998 (Adeyemo, 2003). Better inspection of abattoir and strict enforcement of the law are needed to be able to reduce environmental contamination and related diseases especially zoonotic diseases. Attempts to control the hygiene of slaughter house should include visual assessment of premises and animals themselves, and those that are "visibly unacceptably dirty" or are affected by diseases should not be allowed for slaughter (Amisu et al., 2003). Although abattoir effluents and soil have been reported (Atieno et al., 2013; Ogbonna, 2014) to be important environmental reservoirs for Vibrio species, there is a dearth of information in the literature on antibiotic susceptibility patterns of Vibrio species isolated from abattoir effluents and soil in Nigeria. Therefore, the aim of this study is to isolate and identify the Vibrio species present on abattoir soil in Ekpoma and Auchi, Edo State.

The main aim of the study is to isolate and identify Vibrio species on abattoir soils.

Materials And Methods

Collection of soil sample

Soil samples (20g) were collected from abattoir in Ekpoma and Auchi contaminated area and the neighbourhood without contamination to serve as control according to the method described by Adesemoye et al., (2006). Ekpoma and Auchi abattoir was chosen for soil sample collection because slaughtering activities was relatively higher and the abattoir was well demarcated with a fence. Whatever contamination observed from the soil samples was therefore attributed to the wastewater. Five samples were collected from each site. The soil samples were collected into a sterile dark polythene bag using sterile spatula at the depth of 10cm. All samples were well labeled and transported to the laboratory for analyses immediately after collection. Samples were processed within 24 hours of collection; in the event of slight delay, samples were refrigerated overnight at 4°C prior to analyses.

Preparation of Samples

Soil samples were processed using the method of Adesemoye et al., (2006). Ten grams of the soil sample was weighed and added to 90ml of sterile distilled water to get an aliquot. One milliliter of the aliquots samples was then serially diluted using the ten-fold serial dilution method as described by Prescott et al (2005).

Media Preparation

The media used for bacteriological analysis was Nutrient Agar Media (NA), MacConkey agar (MA) and thiosulphate citrate bile salts sucrose (TCBS). The media were prepared according to manufacturer instruction.

Sterilization Techniques

The polythene bags used for sample collection were cold-sterilized in UV-radiation box for at least 12 hours (usually overnight), while glassware was treated in the hot-air oven at 1600C for 2 hours. Growth media and diluents (distilled water) were autoclaved at 1210C for 15minutes. The working bench surface was sterilized by swabbing with 70% alcohol. Naked flame was also used during inoculation, serial dilution and sub-culturing in other to enhance aseptic condition.

Microbiological Analysis

Preparation of diluents, isolation and identification of isolates: A measure of 1g of soil sample was crushed and air dried and was diluted in 9ml of sterile distilled water, followed by serial dilution (One ml of the soil suspension was then diluted serially (ten-fold). Then, the serial diluents were aseptically inoculated onto different plates of melted sterile medium and used in the estimation of aerobic heterotrophic bacterial population by pour plate method. This was done by inoculating 1 ml tenfold serially diluted samples onto nutrient agar. The inoculated nutrient agar plates were incubated at 370C for 24 hours and also into thiosulphate citrate bile salt (TCBS) agar. After incubation, plates with 30-300 colonies were chosen for counting and the total plate count for bacteria was expressed as number of colonies forming units (cfu) per gram of soil. Sub-culturing was done until distinct colonies (pure cultures) were obtained. The bacterial isolates were characterized based on their cultural, biochemical properties and microscopic appearances as described by Cheesbrough (2005). Biochemical tests done using standard methods include; Gram stain, motility, urease activity, carbohydrate utilization, oxidase, catalase, indole production, citrate utilization and hydrogen sulphide production (Anon, 1994; Cappuccino and Sherman, 1998).

Total heterotrophic bacterial counts: This was determined with the nutrient agar using the spread plate technique as described by Prescott et al (2005). Here sterile nutrient agar was aseptically inoculated with aliquot of serial diluents (10-4 - 10-6) of the samples and incubated at 37oC for 24hr. After incubation, colonies that appeared on the plates were counted and the mean expressed as cfu/g for soil samples.

Identification of Test Organisms: All isolates for this study were identified by their colonial appearance on the media, Gram staining reaction and Biochemical tests.

Isolation and preliminary identification of Vibrio species

Aliquots of the samples were inoculated into alkaline peptone water (APW, Pronadisa, Madrid, Spain) and incubated aerobically at 37°C for 18 to 24 hours. Turbid cultures were streaked onto thiosulphate citrate bile salts sucrose (TCBS) agar (Pronadisa, Madrid, Spain) and incubated at 37°C for 24 hours. Suspected Vibrio species appear as green or yellow colonies on TCBS. Colonies per plate were randomly picked from each sample and sub-cultured onto fresh TCBS agar plates. The pure isolates were subjected to preliminary identification using standard cultural and biochemical methods as described by Kaysner and DePaola (2004).

Total Vibrio count: Total Vibrio count was determined with the thiosulphate citrate bile salt (TCBS) agar using the spread plate technique as described by Prescott et al., (2005). One milliliter of the serially diluted samples was inoculated onto sterile pre-dried TCBS agar plates in triplicates and then spread evenly with a sterile bent glass rod. The plates were incubated at 37oC for 24 hours, after which the colonies that developed were counted and the mean recorded accordingly for surface water, wastewater, sediment and soil samples.

Data Analysis

The results obtained in this study were assessed in colony forming unit (cfu/g).

Results

The main aim of the study is to isolate and identify Vibrio species on abattoir soils. This study is limited to the isolation of vibrio species from the soil samples of abattoir in Auchi and Ekpoma.

The soil samples were collected from 5 different sites on the abattoir in both locations selected (Auchi and Ekpoma). In Ekpoma, no Vibrio specie was isolated but Vibrio was isolated from Auchi but has a very low count. Other organisms isolated from the soil samples include; Auchi (Streptococcus spp, Staphylococcus aureus, Escherichia coli, Klebsiella spp and Pseudomonas spp) and in Ekpoma (Proteus spp, Klebsiella spp, Streptococcus spp, Staphylococcus aureus and Escherichia coli) (Table 1).

On assessment of the total viable count of Vibrio spp isolated from the soil samples studied (Table 2), the results were presented based on dilution factors (103 and 104). In Auchi soil samples studied, the total viable count of Vibrio spp is 1.2 x 102cfu/g (103 dilutions) and 0.4 x 102cfu/g (104 dilutions), while in Ekpoma the total viable count of Vibrio spp is 0.5 x 102cfu/g (103 dilutions) and 0.3 x 102cfu/g (104 dilutions).

Table 3 demonstrates the mean total viable count of organisms isolated from the study; it was observed that the mean total viable count from Auchi is 4.62±1.7 x 104 cfu/g while the mean total viable count from Ekpoma sample is 4.24±1.6 x 104 cfu/g.

Table 4 presents the result of the cultural characteristics and biochemical analysis of bacterial isolates. The organisms on the agar plate showed circular to irregular shape, they were bright yellow, creamy, grey, translucent blue and translucent creamy in colour with surface appearances (consistency) which were moist, mucoid and dry.

Table 1: Soil samples collected from different locations at Auchi and Ekpoma Abattoir

Location	No. of sites examined	Organisms Isolated
Auchi	5	Vibrio spp Escherichia coli Staphylococcus aureus Streptococcus spp Pseudomonas spp Klebsiella spp
Ekpoma	5	Escherichia coli Klebsiella spp Staphylococcus aureus Streptococcus spp Proteus spp
TOTAL	**10**	

Table 2: Mean Total Viable Count of Vibrio spp isolated in the study

Location	Dilution Factor	
	10^3 (cfu/g)	10^4 (cfu/g)
Auchi	1.2 x 102	0.4 x 102
Ekpoma	0.5 x 102	0.3 x 102

Table 3: Mean Total Viable Count of Bacteria isolated from the study

Different sites at the Abattoir	Auchi (cfu/g)	Ekpoma (cfu/g)
Site A	7.48 x 10^4	5.82 x 10^4
Site B	3.06 x 10^4	5.87 x 10^4
Site C	4.70 x 10^4	3.41 x 10^4
Site D	2.84 x 104	4.08 x 104
Site E	5.03 x 104	2.04 x 104
TOTAL	4.62±1.7 x 104	4.24±1.6 x 104

KEY

+ = Positive, A = Acid production, A/G = Acid and Gas production, MCA = MacConkey agar, - = Negative, G = Gas, B=Bacteria, NA = Nutrient agar, TCBS = Thiosulphate Citrate Bile Salt agar

Table 4: Cultural Characteristics and Biochemical Identification of Bacterial Isolates.

Isolate	Cultural characteristics				Biochemical analysis								Sugar Fermentation				Organis
	Shape	Elevation	Consistenay	Color	Gram	Catalase	Coagulas	Indole	Motility	Oxidase	Citrate	Urease	Glucose	Maltose	Sucrose	Lactose	
B1	Coccin	Spherical	Moist	Golden yellow in NA	+	+	+	_	_	_	+	+	A	A	A	A	Staphylococcus
B2	Rod	Convex	Mucoid	Rose Pink in MCA	_	+	_	+	+	_	_	_	A/G	A/G	A/G	A/G	Escheric hia coli
B3	Rod	Raised	Mucoid	Light Pink	-	+	-	+	-	-	+	+	A/G	A/G	A/G	A/G	Klebsiella spp
B4	Rod	Raised	Mucoid	Cream in MacConkey	_	+	_	_	_	+	+	_	A	A/G	A	A/G	Pseudomonas spp
B5	Rod	Flat and	Buterious	Light Pink	-	+	-	-	+	-	+	+	A/G	_	A	_	Proteus spp
B6	Cocci in chains	Spherical	Moist	Shinning greyish white	+	-	-	-	-	-	+	-	A	A	A	A	Streptococcus spp
B7	Curved	Convex	Mucoid	Pink in TCBS	-	-	+	+	-	+	+	-	A/G	A/G	-	A	Vibrio spp

Discussion

The main aim of the study is to isolate and identify Vibrio species on abattoir soils. The soil samples were collected from 5 different sites from the abattoir in both locations selected (Auchi and Ekpoma). In Ekpoma, no Vibrio specie was isolated but Vibrio was isolated from Auchi but has a very low count. Other organisms isolated from the soil samples include; Auchi (Streptococcus spp, Staphylococcus aureus, Escherichia coli, Klebsiella spp and Pseudomonas spp) and in Ekpoma (Proteus spp, Klebsiella spp, Streptococcus spp, Staphylococcus aureus and Escherichia coli) (Table 1).

Although Vibrios are frequently associated with mortality of farmed species, their role as causative agent or secondary opportunistic colonizers is not well understood. Most analyses are based on moribund animals often infected by multiple agents (viruses, bacteria) and laboratory experiments rely on challenge via injection, a method that does not reflect the natural route of infection and may thus exclude other important factors (e.g., chemotaxis, colonization). Here by sampling the soil around the abattoir, attempt is made to isolate and identify Vibrio species on abattoir soil.

On assessment of the total viable count of Vibrio spp isolated from the soil samples studied (Table 2), the results were presented based on dilution factors (103 and 104). In Auchi soil samples studied, the total viable count of Vibrio spp is 1.2 x 102cfu/g (103 dilutions) and 0.4 x 102cfu/g (104 dilutions), while in Ekpoma the total viable count of Vibrio spp is 0.5 x 102cfu/g (103 dilutions) and 0.3 x 102cfu/g (104 dilutions) was isolated. Vibrio spp produce an enterotoxin, which causes the intense diarrhoea which is so typical of the disease cholera. The detection of cholera toxin (CT) production is an important indicator of virulence.

Table 3 demonstrates the mean total viable count of organisms isolated from the study, it was observed that the mean total viable count from Auchi is 4.62±1.7 x 104 cfu/g while the mean total viable count from Ekpoma sample is 4.24±1.6 x 104 cfu/g. Ideally, the design, operation process, and location of Abattoirs respond to a variety of concerns in any community they are situated. It may vary in size and sophistication depending on location and local government ordinance; but it should contain the following facilities or have them nearby: Lairage, Isolation block, Slaughter Hall, Cooling Hall, Hide and Skin Store, Guttery and Tripery, Offices, condemned meat room or apartment, Laboratory and Lavatory, dressing accommodation with lockers, laundry, etc (Merck Veterinary Manual, 1998). Conversely, it is disheartening to note that, despite availability of legislature on animal slaughter in the country, diverse problems such as slaughtering animals on untidy floors, absence of stunning and ripening operations, inadequate slaughtering facilities, lack of sewage disposal systems, inadequate clean water supply abound with meat handling procedures in abattoir. Other common challenges include: Lack of a refrigeration system, inadequate transport system for meat products and lack of price incentives for quality.

The high bacterial counts obtained in the contaminated soil in both Auchi and Ekpoma indicated that they had a high population density than the control soil. In was generally observed that E. coli had the highest frequency of occurrence in abattoir effluents contaminated soil, while Proteus sp. has the lowest frequency of occurrence. The waste water from the abattoirs may contain growth factors that could be utilized by the organisms found in this contaminated soil, hence, the high microbial counts. Contamination due to discharge of waste into the soil ecosystem might have resulted in the destabilization of the soil ecological balance. Rabah et al., (2008) and Adesemoye et al., (2006) reported similar high counts of 3.7 x 106 and 3.36 x 107 cfu/g of bacteria of waste water contaminated soil samples in Sokoto and Lagos states in Nigeria abattoirs respectively which is in close range with that of our study in Auchi and Ekpoma mean count 4.62±1.7 x 104 cfu/g and 4.24±1.6 x 104 cfu/g respectively. The presence of E. coli and Streptococcus spp in the contaminated soil samples could be attributed to the great amount of animal excreta in the wastewater. This is an indication of recent fecal pollution. Similar findings were reported by Bala (2006) of the isolation of similar organisms from water sources in Jimeta-Yola that were faecally contaminated. Escherichia coli, Staphylococcus aureus and Pseudomonas species are microorganisms that inhabit the skin and stomach of the animals being slaughtered as normal flora. The presence of these organisms is a pointer to pollution and may have an effect on the soil ecological balance. These findings were in conformity to that of Ogbonna and Igbenijie (2006). The two abattoirs soil samples indicated that Auchi abattoir had the highest bacterial counts.

The high level of contamination of Abattoir soil as obtained in this study confirm the dangers associated with discharging untreated waste water to the soil, thus the need for adequate treatment to ensure decontamination. The higher rate of contamination of soil with these organisms is an indication of deplorable state of poor hygienic and sanitary practices employed right from the abattoir environment. Some microbial diseases and their effect cannot be categorized under a specific mode of transmission. However, similar to previous study, there is tremendous variety of living organisms in the abattoir environment.

Thus, many people find the subject of animal slaughter very unpleasant and prefer not to know the details of what goes on inside the abattoir. In their turn, most abattoirs are secretive to avoid controversy. As such, the connection between meat products in the markets and the live animals they are derived from is very obscured. Nevertheless, the majority of people still eat meat, because they attach personal ethics to their purchasing power and believe there are health benefits for themselves and their families.

To prevent Vibrio infections, proper hygiene cooking, treatment of water supply and avoidance of eating raw food should be encouraged seriously; there should be establishment of a well separated sewage treatment infrastructure. Warning on possible cholera or other Vibrio spp. contamination should be reported around contaminated area and water sources with direction on how to decontaminate the water and the possible source of the contamination around the water body for possible use. Effective sanitations practices should be practiced, if instituted and adhered to in time they are usually sufficient to stop an epidemic. Patients who present diarrhea symptoms should be referred to the health centre or hospital for immediate diagnosis and treatment. It is important to note that this research is laying serious emphasis on the need for high level of hygiene and proper cooking of meat before eating. It is also important to note the need to establish regular nationwide antibiotic susceptibility surveillance of Vibrio species in different parts of the country so as to provide guidance on the best option in different situation.

Since Vibrio species are present in abattoir soil samples though in low count, it is likely that they could also be present in the meat gotten from the abattoir itself, with the implicit consumer health risk, particularly in the increase in meat consumption. They can also become a major vector for cross contamination when not properly handled. We use some of the words of Ogunseitan (2003) to submit that sustainability in food production (in this case – meat production) should be given priority of place since it intertwines with public health and economic development. Another related question (outside this study) is the relationship of wastewater contamination to soil fertility. This area is recommended for further studies.

In conclusion, although abattoir operation could be very beneficial to man in that it provides meat for human consumption and other useful by-products, still it can be very hazardous to public health with respect to the wastes that is generated. The high level of contamination of Auchi and Ekpoma abattoir soil as obtained in this study further confirmed the dangers associated with discharging untreated wastes to the

soil, thus the need for adequate treatment to ensure decontamination. Considering the present demand for livestock due to growth in population and requirement on health grounds for meeting up with the calcium and protein requirements of the population, sustainability in meat production should be given priority of place since it intertwines with public health and economic development.

Therefore, the role of Veterinary meat hygiene in public health services cannot be over stressed as it ensures that infected or contaminated meat or its products are not sold to the public, precautions are taken to prevent meat contamination, prevent meat adulteration, detect and control infectious diseases by trace back. However, the current situation in most local abattoirs in Nigeria, including the one under review is that, the slaughter of animals for meat consumption is often carried out under less-than-ideal conditions. Meat produced under such conditions lacks veterinary inspection, is often contaminated and must be considered a hazard to human health. Whether for health reasons or for aesthetic reasons, it is highly expedient that this issue of unhealthy abattoirs be resolved finally. Based on the public reactions and outcry garnered from previous reports in this series, we can all collectively agree that it is indeed a national disgrace to have our abattoir where some of our staple food is produced in such unhealthy and filthy states. Therefore, it is the collective jobs of all and sundry to ensure that practical solutions are carried out for a systematic positive change in our abattoirs.

We hereby propose the following recommendations;

- It is recommended that better inspection of abattoirs and strict enforcement of law be made to be able to reduce environmental contamination and related diseases especially zoonotic diseases.
- Attempts should also be made to control the hygiene of slaughter house using visual assessment of premises and animals themselves, and those that are visibly unacceptably dirty or affected by diseases should not be allowed for slaughter.
- Government agencies and other stake holders should develop methods of waste treatments for reasons of public health and conservation which result in the destruction of pathogens. Such methods can include anaerobic waste water treatment using granular sludge reaction.
- There should be a complete overhaul and rehabilitation of the entire Abattoir System in Nigeria and this should be in tandem with global standards.
- The government at all levels should employ more veterinarians and other relevant officials to serve the purpose of inspecting meat at all times so as to make available wholesome meat fit for human consumption. In the same tone, existing meat hygiene laws and policies must be enforced at all abattoirs around the country.
- Finally, solid waste from slaughtered animals can be fermented in tanks to produce compost and biogas. Biogas can be used as additional energy for the production of industrial and household gas. Thus, encouraging sustainable agriculture.

Conflict of interest

The authors declare no conflicts of interest. The authors alone are responsible for the content and the writing of the paper.

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