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WASTEWATER QUALITY AND UNHYGIENIC PRACTICES IN MINNA ABATTOIR, NORTH CENTRAL NIGERIA

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ABSTRACT
Wastewater collected from Minna abattoir was analyzed for its microbiological and physicochemical properties using standard methods. The results revealed that the wastewater harboured aerobic heterotrophic bacteria (1.1×10^8 - 4.6×10^8cfu/ml), coliforms (6.3×10^5 – 3.9×10^6cfu/ml), *Salmonella* species (1.8×10^3 – 2.1×10^4cfu/ml), and fungi (1.4×10^4 – 4.0×10^4cfu/ml). The microorganisms were identified as species of *Bacillus, Streptococcus, Escherichia, Klebsiella, Staphylococcus, Pseudomonas, Salmonella, Mucor, Aspergillus,* and *Penicillium. Escherichia coli* was more consistently isolated and constituted 23.23% of the total bacterial isolates while *Aspergillus flavus* had the highest frequency of occurrence (28.86%) among the fungal isolates. Ova of parasites *Taenia saginata, Ascaris* sp., and hookworm as well as cysts of *Giardia ovis* were also detected in the wastewater. The wastewater had a pH of 6.03-7.60, suspended solids (8.76-3960 mg/L), ammonia (760-1140mg/L), COD (81555-8200mg/L), BOD (28-836mg/L) and sulphide (1315.2-2333.6mg/L). These values, with the exception of pH are higher than the permissible limits set by the Federal Ministry of Environment (Nigeria). The sanitary condition of Minna abattoir was poor due to indiscriminate dumping of solid wastes, discharge of untreated wastewater, and poor handling and transportation of meat to sales points. The abattoir lacked necessary gadgets for its operations. Besides, there was no potable water supply in the abattoir and therefore, it depended on commercial water vendors for its water supply. The unhygienic conditions of the abattoir and discharge of untreated wastewater into the environment posed serious threats to the environment and human health. There is the need to provide facilities in the abattoir and enlighten the users on the implications of unhygienic practices in the abattoir.

Keywords: Wastewater, Quality, Sanitation Practices, Abattoir, Microorganisms.

INTRODUCTION

An abattoir has been defined as premises approved and registered by the controlling authority for hygienic slaughtering and inspection of animals, processing and effective preservation and storage of meat product for consumption (Alonge, 1991). It is the water that has been used in the cleaning of slaughtered cattle, sheep, goat, the floor of the slaughter hall, personnel and slaughter equipment that constitute the wastewater while the slaughtering of animals results in meat supply and useful by- products like leather and skin. Livestock faeces can introduce enteric pathogens and excess nutrient into water surface (Akpan, 2004; Umaru *et al*., 2018). Abattoir operations produce a characteristic highly organic waste with relatively high levels of suspended solid, liquid and fat. The solid wastes include ingested bones, horns, hair and aborted fetuses, while the liquid waste is usually composed of dissolved solids, blood, gut contents, urine and water (Alonge, 2005).

Abattoir wastes contain bacteria, high level of ammonia and a very high biochemical oxygen demand (BOD). Abattoir wastewater carries high levels of microorganisms that can cause diseases in humans and animals, such as *Salmonella* and *Escherichia coli,* rift valley fever virus and parasites that cause toxoplasmosis and trichinellosis. Other infectious diseases caused by untreated abattoir wastewater include tuberculosis, colibacillosis, brucellosis and heminthosis (Alonge, 2005; Ojegunle and Lateef, 2017). Different methods of wastewater treatment have been developed, for reasons of public health and conservation, which result 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 (Liu *et al*., 2002). However, in Nigeria like many developing countries, the discharge of untreated wastes into the environment is still a problem. Better inspection of abattoir and strict enforcement of the law are needed to be able to reduce environmental contamination and related diseases. Attempt to control the hygiene of slaughter houses include visual assessment of premises and animals and those that are visibly unacceptably dirty or are affected by diseases should not be allowed for slaughter (Inglis and Cohen, 2002).

In Minna abattoir, cattle, sheep, and goats are usually slaughtered with their blood, parts of dung and abdominal contents washed on cemented pavements. The wastewater run through open drainage to wider adjoining environment and may affect streams, and wells including species diversity. This study assessed the waste water quality and unhygienic practices in Minna abattoir in North Central Nigeria.

MATERIALS AND METHODS

Description of Study Site

The study site was Minna abattoir located at Agwanbiri, Bosso Local Government Area, Niger State, Nigeria. The abattoir which has a large premises was established in 1990.It is managed by the Chanchaga Local Government Council, Niger State, Nigeria. The abattoir has two slaughter halls which do not have functional animal slaughtering facilities. Besides, the cold room is non-functional. The slaughter slabs and floor are rough. Animals are slaughtered using decapitation technique on the bare floor (Plate.1). Evisceration and dressing are done on the floor in the slaughter halls. The wastewater from the slaughter halls drains out of the halls through a poorly kept drainage channel into a non-functional wastewater retention treatment facility and spill on farmland and to

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residential area. The wastewater and the heap of refuse, mainly decaying cow dung (Plate 2) generate foul smell in the environment.

Plate 1: Activities in the slaughter hall in Minna abattoir

Plate 2: Heap of refuse in Minna abattoir

Collection of Samples

Samples of wastewater were collected in sterile sample bottles from Minna abattoir. The samples were collected at the point of discharge of effluent from slaughter hall (P1), 50 meters (P2) and 100 meters (P3) away from the slaughter hall respectively. The sterile bottles were used to aseptically collect the wastewater running off the drainage channel just as it was leaving the slaughter pavements. The samples were transported in ice box to the laboratory for analysis.

Microbial Counts and Isolation

The wastewater sample was shaken to obtain homogenous mixture; 1mL of the homogenous sample was serially diluted and plated on Nutrient agar (NA), *Salmonella/Shigella* agar (SSA), MacConkey agar (MCA) and Sabouraud dextrose agar (SDA), for the enumeration of total aerobic heterotrophic bacteria, *Salmonella*/*Shigella,* coliforms and fungi respectively. The NA, SSA and MCA were incubated at 37^0C for 24h while SDA plates were incubated at room temperature (28 ± 2^0C) for 72h. Colonies that developed on the plates were counted and recorded as colony forming units per milliliter (CFU/mL) of wastewater. The isolates were subcultured repeatedly on media used for the primary isolation to obtain pure cultures which were maintained on agar slants for further characterization and identification.

Characterization and Identification of Isolates

The characterization and identification of bacterial isolates were based on cell morphology, Gram stain reaction and biochemical tests. The biochemical tests included production of indole, catalase, oxidase, coagulase, urease, starch hydrolysis, motility and nitrate reduction test, carbonhydrate fermentation and methyl red-voges proskauer (MRVP) test. The bacterial isolates were identified by comparing their characteristics with those of known taxa using the scheme of Holt *et al*. (1999). The fungal isolates obtained were characterized based on macroscopic and microscopic appearances. A small portion of the mycelial growth was carefully picked with the aid of a pair of sterile dissecting needles and placed in a drop of lactophenol cotton blue on a slide covered with a cover slip. The slide was examined under the light compound microscope, first with (10x) and then with (40x) objective lens to detect the spores and some special structures of the fungi. The fungal isolates were identified using the scheme of Nagama *et al*. (2006) and Wantanable (2010).

Presence of Parasites in Wastewater

A drop of the wastewater was placed on a sterile slide, covered with a cover slip and viewed with 10x objective lens of the light compound microscope for parasites and ova of parasites.

Physicochemical Analysis of Wastewater

Waste Water samples were analysed for the following physico-chemical parameters: pH, temperature, turbidity, total suspended solids, total dissolved solids, biochemical oxygen demand (BOD), chemical oxygen demand (COD) and conductivity. The pH of the samples was determined with a pH meter (Unicam 9450, Orion model No. 91-02). Temperature was measured with mercury thermometer immediately after sample collection. Turbidity was determined with Milton Roy (USA) Spectronic 20D meter. Gravimetric method involving filtration and evaporation were used to measure total suspended solids and total dissolved solids. Methods recommended by APHA (1998) were followed for the measurement of BOD and COD. Wastewater sample was drawn into a 250ml bottle, incubated in the dark for five days at 20^0C and at the end of five days, the final dissolved oxygen (DO) content was determined. Decrease in DO between the final DO reading and the initial DO reading was corrected for sample dilution and recorded as the BOD of the sample. The COD was estimated by determining equivalent amount of oxygen required to oxidize organic matter in the samples. Conductivity was determined using a conductivity meter (Metrohm 640, Switzerland).

RESULTS

Physical assessment of the premises and practices in the abattoir revealed that there was no proper way of transporting meat to the sales point which is about 5km from the abattoir. Meats were loaded in motor cycles , with the meat coming in contact with the body and clothing of the transporter (Plate 3), wheel barrow (Plate 4) and dilapidated pick up van. Goats in the abattoir were being roasted with tyres, polluting the air with fumes (Plate 5). These practices are unhygienic.

Microbial Counts

Wastewater sample closest to the point of discharge of effluent from slaughter hall (P1) had the highest bacterial load ranging from $3.0x10^8$ CFU/mL to $4.6x10^8$ CFU/mL The least microbial load was recorded at point three (P3) ranging from $1.1x10^{8\,CFU}$/mL to $2.1x10^8$

CFU/mL which is far away from the point of discharge of effluent from the slaughter hall (Fig. 1).

Plate 4: Meat being transported on a motorcycle to sales points

Plate 4: Meat being transported in wheel barrow to sales points

Plate 5: Goats being roasted with used tyres, polluting the surrounding air with fumes

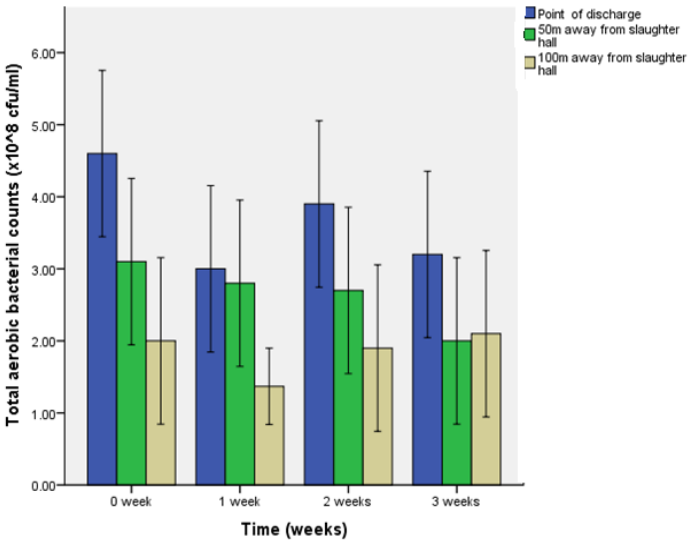

Fig. 1: Total aerobic bacterial counts in wastewater samples analysed

The water samples harboured coliform bacteria of varying counts at the different points. It was observed that the counts were higher at the point of discharge of the wastewater than other points (50m and 100m away from the slaughter hall) (Fig 2). The coliform counts ranged from 0.5 x 10^3 to 1.8 x 10^3 CFU/mL 3.2 x 10^3 – 4.2 x 10^3 CFU/mL 1.2 x 10^3 – 3.3 x 10^3 CFU/mL 2.2 x 10^3 - 3.1 x 10^3 CFU/mL or 0, 1, 2, and 3 weeks respectively (Fig. 2).

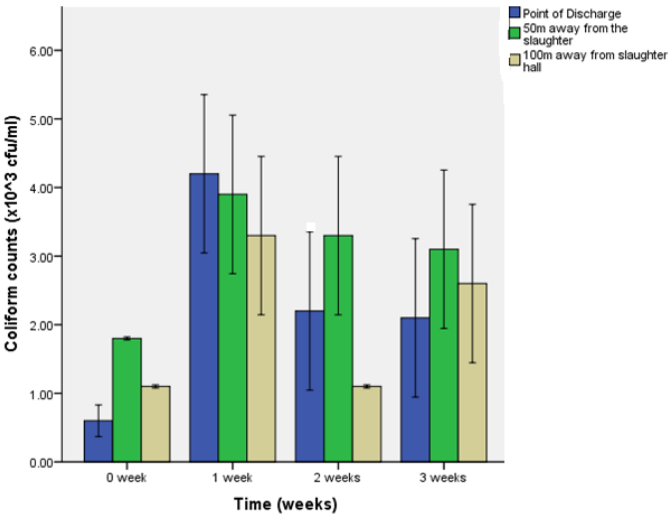

Fig. 2: Total coliform counts in wastewater samples analysed

Salmonella and *Shigella* counts in the water samples were relatively higher at the point of discharge of the wastewater than other points (Fig. 3), particularly at the second week of sampling, after the start of the study. The overall counts ranged from 2.0 x 10^3 CFU/mL to 22.0 x 10^3 CFU/mL (Fig. 3).

Fungi were also present in the wastewater samples. The counts were high in all sampling points but much higher at the point of discharge of the wastewater (Fig 4). Generally, the fungal counts ranged from 1.5 x 10^4 CFU/mL l to 4.0 x 104 CFU/mL (Fig 4)

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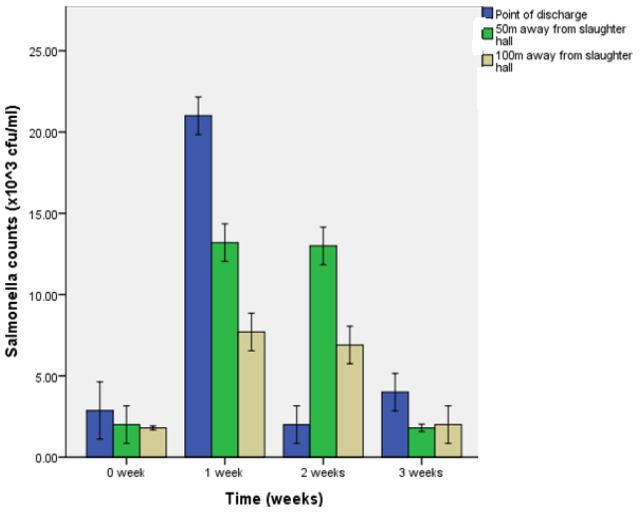

Fig. 3: *Salmonella Shegeilla* counts in wastewater samples analyzed

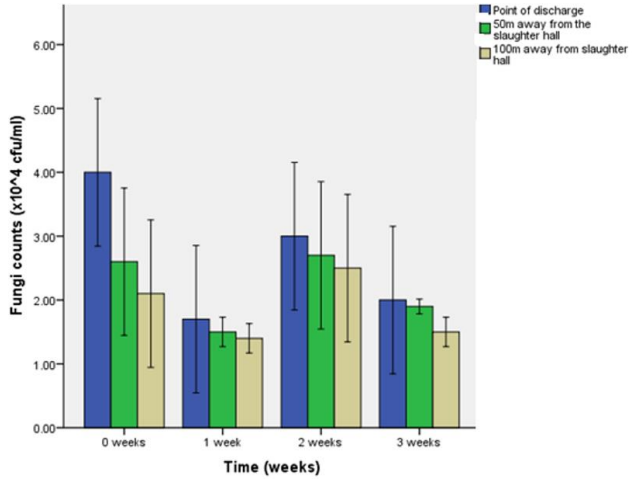

Fig. 4: Total fungi counts in wastewater samples analysed

Identification of Microbial Isolates and their Frequency of Occurrence

The wastewater samples contained various bacteria including *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella* sp., *Pseudomonas aeruginosa, Bacillus cereus, Sreptococcoccus* species, *Bacillus subtilis*, *Salmonella* sp and *Staphylococcus epidermidis. Escherichia coli* had the highest frequency of occurrence (23.73%) followed by *Pseudomonas aeruginosa* (16.99%) while *Bacillus subtilis* had the least (3.11%) frequency of occurrence (Table 1). The following fungi were identified in the wastewater: *Penicillium* sp, *Aspergillus niger, Aspergillus flavus*, and *Mucor* sp. *Aspergillus niger* had the highest frenquency of occurrence (28.86 %) while *Mucor* sp had the least (14.82%) frequency of occurrence (Table 2).

Occurrence of Parasites

The ova of the following parasites were observed: cyst of *Giardia ovis,* ova of *Taenia saginata* (5 ova), hook worm (2 ova), and *Ascaris* sp (3 ova).The predominant parasite, with the highest number of cyst (4 cysts) was *Giardia ovis* while the least recorded parasite with the lowest number of ova was hook worm.

Physicochemical Qualities of Abattoir Wastewater

Table 3 shows the physicochemical qualities of abattoir wastewater analysed. The wastewater had rotten beef odour and dark brown colour. The pH ranged from 6.03 to 7.60 while the ammonia content ranged from 760mg/l to 1140mg/l. The BOD, COD, TSS, TDS and sulphide were equally high (Table 3). It was observed that wide variations existed in values of the various parameters at different time of sampling. While turbidity, BOD nitrogen increased with time, dissolved oxygen, sulphide and ammonia decreased (Table 3).

Table 1: Frequency of occurrence of bacterial isolates from abattoir wastewater analyse

Bacteria	P1	P2	P3	Total
Staphylococcus aureus	9(10.59)	5(10.42)	4(.11)	18(10.71)
Escherichia coli	18(21.18)	12(25)	9(25)	39(23.73)
Klebsiella sp	10(11.76)	6(12.5)	5(13.89)	21(12.72)
Pseudomonas aeruginosa	15(17.65)	8(16.67)	6(16.67)	29(16.99)
Bacillus subtilis	2(2.35)	2(4.17)	1(2.78)	5(3.11)
Bacillius cereus	3(3.53)	3(6.23)	2(5.56)	8(5.11)
Streptococcus sp.	9(10.59)	2(4.17)	1(2.8)	12(5.85)
Salmonella sp.	12(14.12)	7(14.58)	6(16.67)	25(15.12)
Staphylococcus epidermidis	7(8.24)	3(6.25)	2(5.56)	12(5.45)

Numbers in parenthesis represent the percentage occurrence of isolates

Key:
P1: Point of discharge of wastewater from slaughter hall
P2: 50m away from the slaughter hall
P3: 100m away from slaughter hall

Table 2: Frequency of occurrence of fungal isolates in abattoir wastewater analysed

Fungi	P 1	P 2	P 3	Total
Aspergillus flavus	12(27.91)	9(29.03)	8(29.63)	29(28.86)
Mucor sp.	9(20.93)	5(16.13)	2(7.41)	16(14.82)
Aspegillus niger	12(27.91)	9(29.03)	8(29.63)	29(28.85)
Penicillium sp.	10(23.26)	8(33.33)	9(33.33)	27(27.47)

Key;
P1: Point of discharge of wastewater from slaughter hall
P2: 50m away from the slaughter hall
P3: 100m away from slaughter hall

Table 3: Physicochemical qualities of Abattoir wastewater analysed

Parameters	Time (Weeks)		
	0	1	3
Appearance	Opaque	Highly opaque	Opaque
Odor	Rotten beef	Faecal smell	Faecal smell
Colour	Dark brown	Dirty brown	Dirty brown
pH	6.60	6.03	7.60
Conductivity	4600	6360	4200
Temperature(^{0}C)	26.9	28.9	28.2
DO_2 (mg/l)	3.06	1.29	0.65
TDS (mg/l)	3082	4261.2	2814
Ammonia (mg/l)	1140	760	949
Nitrogen (mg/l)	182.9	625	403.95
Total suspended solid (mg/l)	8.76	10.32	3960
Turbidity (NTU)	432	2576	721
COD (mg/l)	8200	8120	8155
BOD_5 (mg/l)	28	821	821
Sulphide (mg/l)	2333.6	1820	1820

Samples from P1, P2 and P3 were pooled together for analysis for each date
mg/l: Milligram per litre
NTU: Nephelometric turbidity unit

DISCUSSION

Hygienic practices in Minna abattoir were generally poor. The premises was not properly planned and lacked facilities for proper functioning of the operation of the slaughter house. The wastewater channels were drained into nearby farmland. There was poor road infrastructure and non- functional wastewater retention facility. These inadequacies are attributed to poor management of the abattoir and thus, the abattoir is a source of pollution (Adesemoye *et al*., 2006; WHO, 2010). The total bacterial and fungal counts were high for the wastewater samples analysed. Bridges *et al*. (2001) reported that total bacterial counts higher than 10^2 mL indicate dangerous contaminant. The investigators suggested that it is likely that such water indicates faecal contamination which could be as a result of poor dressing technique and such water contains food poisoning organisms such as *Salmonella* or Enteropathogenic *Escherichia coli.* (Nwanta *et al*., 2010) *Escherichia coli* were the predominant bacteria detected in the present study. *Bacillius subtilis* was the least predominant organism isolated. *Bacillus subtilis* is a spore former and is known to produce toxin. Alonge (2005) indicated that *Bacillus subtilis* may be an etiologic agent of food poisoning that is characterized either by diarrhea and abdominal pain or by nausea and vomiting after ingestion of contaminated water .The presence of *Bacillius subtilis* in the water suggests that the water sample might have been contaminated by dust carrying the resistant form of the organism because a large number of *Bacillus subtilis* often occur in the soil and dust, such that any slight disturbance of the dust can lift up their resistant forms into the air. Pathogens in abattoir waste may originate from the digestive tracts or hides of the animals.

Salmonella, *Escherichia* and *Camphylobacter* species have been reported in abattoir waste (Adeyemi and Adeyemo, 2007; Nwanta *et al*., 2010). The bacteria with the exception of *Campylobacter* species have been isolated from the abattoir wastewater in the present study. *Escherichia coli* (enterotoxigenic strains ETEC) are the most important cause of diarrhea in children in developing countries and can be spread by water contaminated by human or animal sewage Mims *et al*. (2004) reported that all *Samonella* except for *S.typhi* and *S. paratyphi* are found in animals as well as humans and there exists a large animal reservoir of infection, which is transmitted to man via contaminated food, especially poultry and diary products.

For fungal species, *Aspergillius niger* is omnipresent in nature being found everywhere. This may be the reason for being one of the predominant organisms in the abattoir wastewater analysed. *Penicillium* species were equally abundant in the wastewater. This means that the wastewater had adequate nutrients to support their growth in the wastewater. Prescott *et al*. (1990) reported that many fungal diseases (mycoses) occur in domestic animals as a result of environmental exposure on direct animal –to- animal contact. *Mucor* species was the least predominant fungus probably because the abattoir wastewater was not favorable for its growth.

For parasites, ova of *Taenia saginata* was the most predominant ova of parasites identified in the abattoir wastewater analysed. Alonge (1991) reported that taeniasis occur when these eggs are ingested with water by man. Taeniasis is caused by *Taenia saginata* (beef tape worm) which produces only gastro-intestinal infections in man, the larva stage occurs in cattle. Transmission is mostly by faeces contaminated water supply. The presence of cyst of *Giadia ovis*, ova of hookworm and *Ascaris* species in the wastewater is a cause for concern, because hookworm diseases can lead to anaemia and protein loss (Mims *et al*., 2004). Giardiasis is of worldwide distribution. The disease is caused by *Giardia* species (e.g. *G. lamblia*) which can be transmitted through contaminated water where cysts, even from animals have been introduced (Mims *et al*., 2004). Peng *et al*. (2020) reported that *Giardia diodenalis* can cause the occurrence of diarrhea, weight loss, and even death in animals or human. This threatens the husbandry industry and public health. This assertion was supported by Li *et al*. (2020).

The biochemical oxygen demand of the wastewater was quite high. Biochemical oxygen demand determines the quantity of oxygen required for oxidation of inorganic and organic matter in water samples under controlled condition of oxidizing agent (dichromate). Adeyemo (2003) reported that contamination of water with pollutants such as blood and animal waste increased the BOD value because it contains mainly organic matter. This makes oxygen less available to aquatic organisms, resulting in euthrophication. Akpan (2004) reported that low dissolved oxygen content could be attributed to the presence of degradable organic matter in water. These organic matters can enter water bodies in many ways, such as sewage or pollution of water with abattoir wastewater. Alonge (1991) reported that high concentration of sulphide is as a result of presence of organic matter and it is poisonous to aquatic life when polluted water is discharged into water bodies. Madigan *et al.* (2001) reported that ammonia occurs as a result of breakdown of nitrogenous materials in natural water. Ammonia is harmful to fish and other form of aquatic life.

Conclusion

The abattoir analysed wastewater harbored pathogenic bacteria, fungi, and parasites. High level of contamination of the wastewater as revealed in this study, further confirms the dangers associated with discharging untreated wastewater to the environment as it poses serious health risk to human. The Authority in charge of the abattoir should install necessary standard equipment and major functional facilities in the abattoir. Proper hygiene should be

maintained within the abattoir and the surroundings. Target areas for sanitization should include facilities, equipment, surrounding areas, abattoir workers and visitors.

Existing health and hygiene regulations should be strictly enforced. Appropriate technology should be developed, which can handle all the waste being generated in the abattoir

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