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Potential risk factors associated with carcass contamination in slaughterhouse operations and hygiene in Oyo state, Nigeria

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Avoiding meat contamination at slaughterhouses is crucial for food safety; consumers' awareness and concern for the type of food they eat has attracted global attention and redirected research interests towards food safety. The practical hygiene in the slaughterhouse operations play key role in the safety and wholesomeness of meat. A cross sectional survey was carried out on 60 slaughterhouses in Ibadan, Oyo and Ogbomosho, in Oyo State, South Western Nigeria. A well-structured pre-tested checklist was administered and scored; data collected were subjected to descriptive statistics and t-test to separate significant differences between abattoirs and slaughter slabs. This study revealed that for the 50 items scored, only four [environmental cleanliness (66.7%), washing of slaughtering tools and equipments (60%), access to facility to wash hands and shoes (71.7%), and appropriateness of slaughterhouse location (58.3%)] were partially observed. The remaining 46 are non-existent or poorly implemented. However, only 9 out of the 23 items of the practical hygiene and level of cleanliness compared between the surveyed abattoirs and slaughter slabs, showed significant ($p < 0.05$) differences. These are garbage disposal ($p<0.001$), washing of slaughtering tools and equipments ($p<0.001$), disinfection of the slaughterhouse ($p<0.014$), disinfection of premises ($p<0.001$), and disinfection of infrastructure and equipments ($p<0.002$). Others are, availability of sufficient and clean water ($p<0.001$), good hygiene ($p<0.033$) and also, hands washing after slaughtering ($p<0.001$) and hands disinfection ($p<0.001$). The surveyed abattoirs performed better than slaughter slabs in hygiene and level of cleanliness. But nevertheless all evidences of unhygienic practices and predisposing risk factors across the surveyed slaughter locations would serve as critical points for the distribution of contaminated meat to the public, and also serve as medium for occupational disease acquisition. Hence the issue of food safety is called to question. There is the need for workers training on operational hygiene and occupational zoonoses.

Key words: Contamination, meat hygiene, risk factors, slaughterhouse.

INTRODUCTION

Meat contamination results more often than not during meat slaughtering and processing at the slaughterhouse, causing food poisoning or food-borne diseases and thus precipitating a food safety issue (FAO, 2015; Bakhtiary et al., 2016). Food and meat poisoning are acute food-borne disease caused by contamination and have been

common occurrences and a worldwide public health concern (Malangu, 2016). This global burden of food-borne diseases predominate in the developing countries (Africa and South East Asia), and has been shown to cause a high percentage of illnesses in humans and a resultant 421,000 deaths per annum globally (Malangu, 2016; WHO, 2015).

Food poisoning, meat contamination and food safety have become areas of interest and have attracted global attention due to consumers' awareness and concern for the type of meat and food which they eat (FAO, 2015). This has re-directed research interest thereby shifting grounds towards food safety and hence has attracted substantial funding and research grants to third world countries for research in food safety, zoonoses and one's health (Grace, 2015; Bardosh et al., 2017). Contamination at the slaughterhouse and contamination of meat occurs because of inadequate hygienic conditions and handling, and may be as a result of the consequence of contaminated air in form of bioaerosol which is loaded with common microbial contaminants like Salmonella, Escherichia, Clostridium (Lues et al., 2007); causing contamination of the carcass/meat, the working surfaces and equipments used in the processing (Bakhtiary et al., 2016).

Contamination is established from the attachment properties and the biofilm formation of microbes on working surfaces to facilitate cross-contamination (Koo et al., 2013; Schlegelova et al., 2004). Also, the major challenges of handling animal by-products, waste products and slaughterhouse effluents have been implicated in environmental pollution of sources of water around slaughterhouses (Koo et al., 2013). The polluted water, whose quality has been compromised, will ultimately contaminate carcass/meat during processing (Adeyemo, 2002; Cook et al., 2017). Previous studies in Nigeria, published between 2001 and 2016 have shown that contamination of carcass/meat at the abattoirs constitute 37% of the mode of transmission of the identified abattoir zoonoses in slaughter animals (Fasanmi et al., 2017a).

This study is therefore aimed at determining the hygiene status of slaughterhouses, comparing the level of hygiene operations between abattoirs and slaughter slabs across Oyo State and to identify likely risk factors that may contribute to meat contamination during slaughtering and meat processing.

MATERIALS AND METHODS

Study locations

Oyo state is located in South Western Nigeria, with two distinct seasons namely; wet and dry seasons. The wet season is the period of rainfall, which is between April and October. The dry season covers between November and March and it is characterized by hot weather. The minimum, mean and maximum temperatures in Oyo State are 27, 31 and 35°C, respectively. The topography is about 0 to 500 m above sea level and the mean annual rainfall is within the range of 1000 to 1400 mm. Oyo State is bordered by Benin Republic in the west, in the North and East by Kwara and Osun States respectively and by Ogun State in the South. The State covers an area of approximately 27,000 km2. There are 33 local Government Areas (LGA) in Oyo State, all of which fall under four administrative zones-namely; Ibadan/Ibarapa, Oyo, Ogbomosho and Saki. Sixty slaughterhouses (abattoirs and slaughter slabs) were surveyed in three big cities of Oyo State. The cities include Ibadan (7° 24' 3'' N, 3° 51' 9'' E), Oyo (7° 51' 9.25" N, 3° 55' 52.50" E), Ogbomoso (8° 7' 60'' N, 4° 15' 0'' E). Sixty slaughterhouses were sampled from only 16 out of the 33 LGAs (Figure 1).

Preparation of checklist and locating slaughterhouses

This study was borne out of the need to prevent or possibly reduce the incidence of food poisoning; specifically meat poisoning through meat contamination at the slaughterhouses. The major cause of meat contamination has been attributed to poor hygiene and sanitation (Adeyemo, 2002). The drafting and preparation of this slaughterhouse hygiene and sanitation checklist was drawn from previous slaughterhouse-related studies in Africa (Cook et al., 2017; Okike et al., 2011), experience from slaughterhouse hygiene and operations in Nigeria, and recommendations for improvement on existing hygiene and structures.

A comprehensive checklist was developed based on three criteria: (i) Practical hygiene and sanitation at slaughter house, (ii) facilities, tools and equipments in use at slaughterhouse, and (iii) Operational Policies and regulations. A total of 50 items were identified and included in the checklist after the removal of duplicates and these were arranged based on the three criteria previously stated to determine and evaluate the level of compliance.

The prepared checklist was tested among the penultimate final year veterinary students of the University of Ibadan, Ibadan. Thereafter, the pretested checklists were administered by trained personnel (veterinarians and animal health technologist) in slaughterhouse in three major cities of Oyo State. The slaughterhouses were selected to include those located in both urban and rural areas; and they include abattoirs (licenced area where livestock are slaughtered under relatively hygienic condition in urban areas) and slaughter slabs (a location or makeshift arena where animals are slaughtered, especially in rural areas). Permissions were sought from all the slaughterhouses before the administration of the checklists.

Study design, sampling procedure and scoring of the checklist

A cross sectional survey was carried out by trained personnel using 50-item pre-tested and well structured checklist in slaughterhouses located across sixteen (16)

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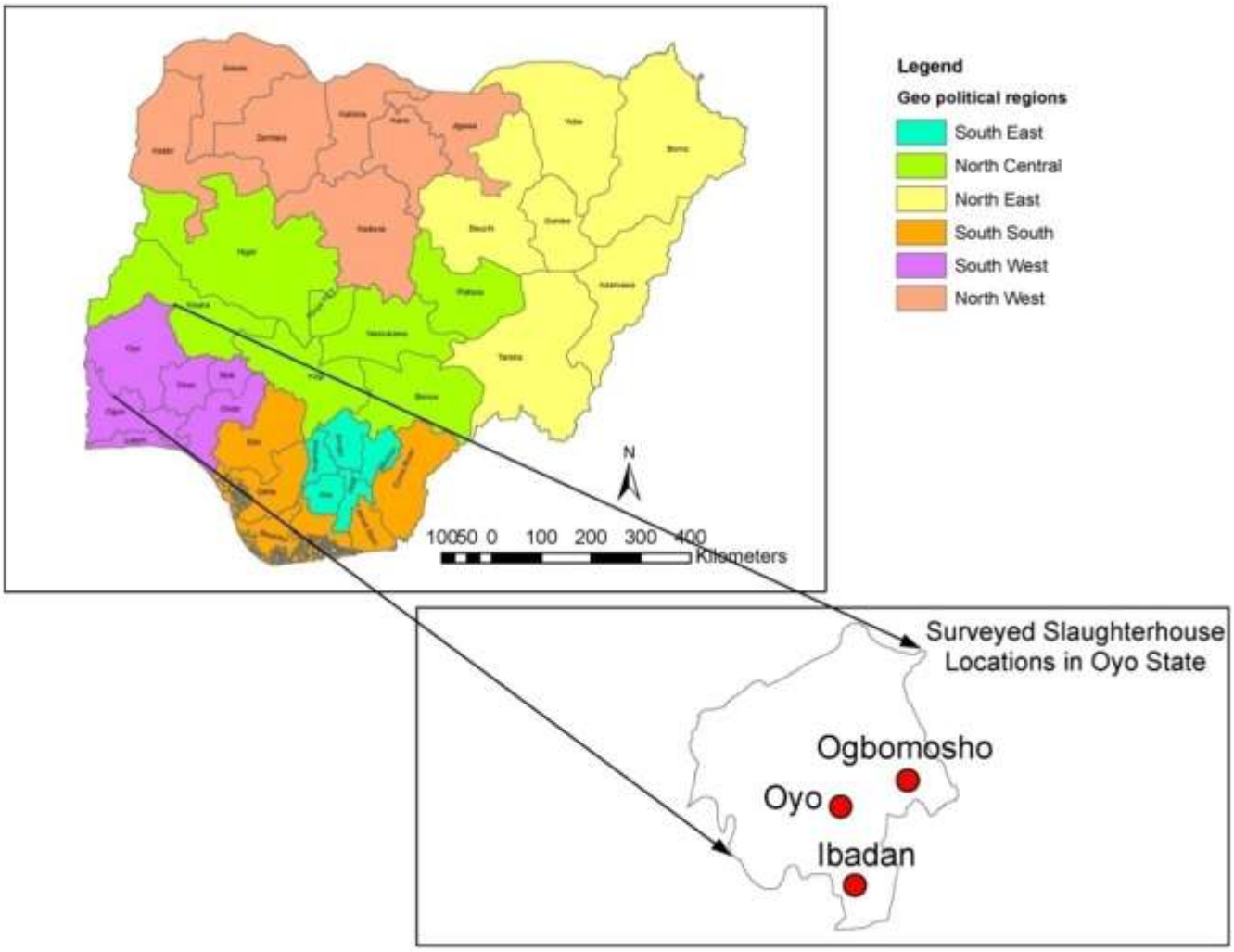

Figure 1. Map of Nigeria showing surveyed slaughterhouse locations in Oyo State.

local government areas. These local government areas are located in 3 cities that include Ibadan, Oyo and Ogbomosho. Sixty (60) slaughterhouses were purposively sampled from these cities. All selected slaughterhouses were visited between April and August, 2017. The number of slaughterhouse sampled was dependent on the number of slaughterhouse per city. Thirty seven (37) slaughterhouses were sampled in Ibadan, seventeen (17) in Oyo and six (6) in Ogbomosho. The 50-item pre-tested and well-structured checklist was scored as follows; observed practical hygiene and level of sanitation compliance: Non-existent to poor (0-49%) and good to very good (50-100%). For any slaughterhouse to be scored as having complied with any item, such a slaughterhouse must have scored ≥ 50%.

Source of data and data analyses

To obtain information, questions were asked by trained personnel from the butchers and workers of the slaughterhouse according to the drafted checklist, while the hygiene and operations were observed and each item was scored accordingly. The scores were categorized into two; either < 50 (non-existent to poor) or ≥ 50 (good to very good).

All scores were entered into Microsoft Excel® (Microsoft Redmond, USA) and analyzed using descriptive statistical program for proportions (in percentage); and t-test to check for significant differences for practical hygiene and level of sanitation between slaughter slabs and Abattoirs in Oyo State. But for the purpose of convenience and to prevent clumsiness of the graph, the figures in percentages were regarded thus; 0 - 24 = 1, 25 - 49% = 2, 50 - 74 = 3 and 75 - 100% = 4.

RESULTS

The overall results show that the majority of the

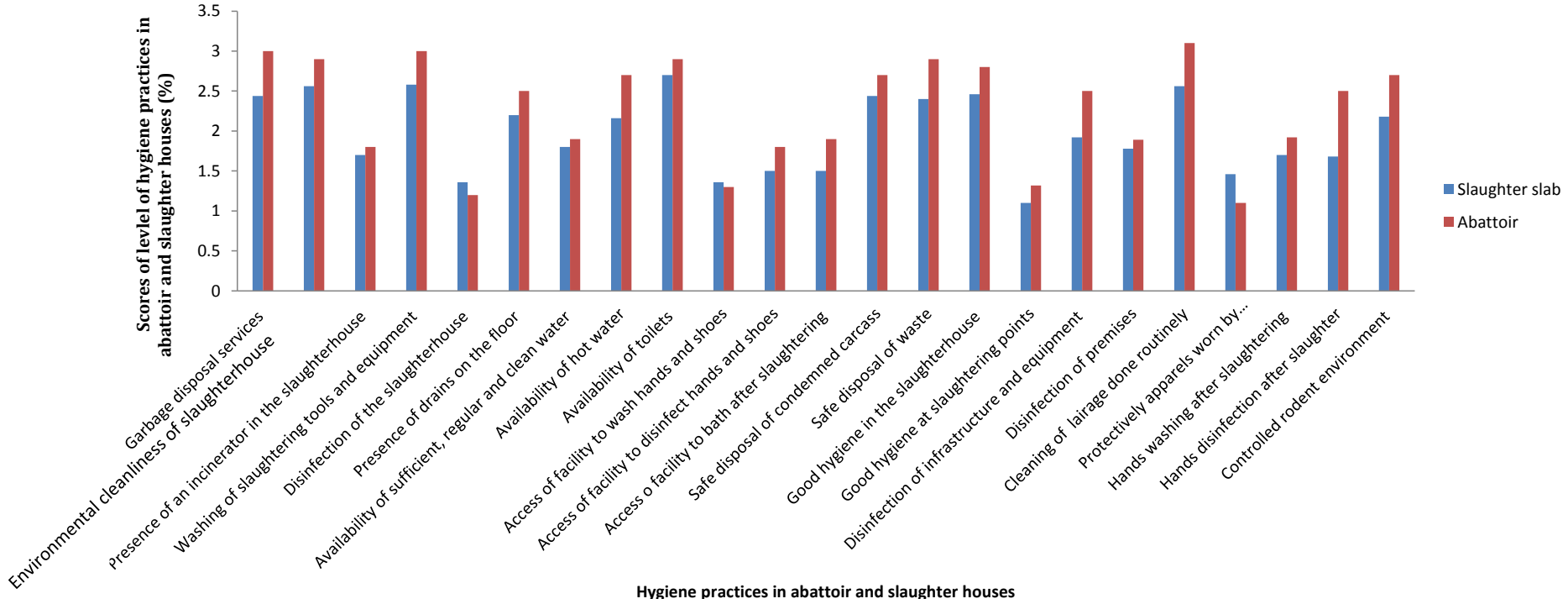

Figure 2. Graphical comparison of practical hygiene and level of sanitation at the abattoirs and slaughter slabs.

slaughterhouses in Oyo state performed poorly in the scoring of the entire 50-item checklist in the surveyed locations and final assessment. However some significant differences ($p < 0.05$) were observed when these items were compared between the abattoir and slaughter slabs in the operational hygiene and sanitation in Oyo state (Figure 2).

Practical hygiene and sanitation at slaughterhouses

Majority of the items scored for the slaughterhouses are between non-existent and poor, especially garbage disposal services (58.3% of the surveyed slaughterhouses), disinfection of slaughterhouse (100%), infrastructure and equipments (51.7%), disinfection of premises (98.3%) and hands after slaughter (71.7%), safe disposal of waste (86.7%) and controlled rodent environment (83.3%). Other scored items that fall within non-existent to poor are presence of incinerators (95%), floor drains (63.4%), availability of sufficient, regular and clean water (88.3%), hot water (71.7%) and toilets (66.7%), access to facility to bath after slaughtering (90%), to disinfect hands and shoes (96.7%) and safe disposal of waste (86.7%) and condemned carcass (96.7%). While on the other hand, only three of the scored items are good or very good; they include environmental cleanliness of slaughterhouse (66.7%), washing of slaughtering tools and equipments (60%) and access to facility to wash hands and shoes (71.7%) (Table 1).

Facilities, tools and equipments in use in slaughterhouses

Only one of the items (appropriateness of location of slaughterhouse) has a score categorized as

Table 1. Practical hygiene and level of sanitation at slaughterhouses in Oyo State.

S/N	Variable	Score < 50	Score ≥ 50	Remark
1	Garbage disposal services	35(58.3)	25(41.7)	Poor
2	Environmental cleanliness of slaughterhouse	20(33.3)	40(66.7)	Good
3	Presence of an incinerator in the slaughterhouse	57(95.0)	3(5.0)	Poor
4	Washing of slaughtering tools and equipment	24(40.0)	36(60.0)	Good
5	Disinfection of the slaughterhouse	60(100)	0(0.0)	Poor
6	Presence of drains on the floor	38(63.4)	22(36.6)	Poor
7	Availability of sufficient, regular and clean water	57(95.0)	3(5.0)	Poor
8	Availability of hot water	43(71.7)	17(28.3)	Poor
9	Availability of toilets	40(66.7)	20(33.3)	Poor
10	Access of facility to wash hands and shoes	43(71.7)	17(28.3)	Poor
11	Access of facility to disinfect hands and shoes	58(96.7)	3(3.3)	Poor
12	Access of facility to bath after slaughtering	54(90.0)	6(10.0)	Poor
13	Safe disposal of condemned carcass	58(96.7)	2(3.3)	Poor
14	Safe disposal of waste	52(86.7)	8(13.3)	Poor
15	Good hygiene in the slaughterhouse	36(60.0)	24(40.0)	Poor
16	Good hygiene at slaughtering points	32(53.3)	26(46.7)	Poor
17	Disinfection of infrastructure and equipment	31(51.7)	29(48.3)	Poor
18	Disinfection of premises	59(98.3)	1(1.7)	Poor
19	Cleaning of lairage done routinely	60(100)	0(0.0)	Poor
20	Protective apparels worn by slaughter/ processing persons	41(68.3)	19(31.7)	Poor
21	Hands washing after slaughtering	48(80.0)	12(20.0)	Poor
22	Hands disinfection after slaughter	43(71.7)	17(28.3)	Poor
23	Controlled rodent environment	50(83.3)	10(16.7)	Poor

Scores: Non- existent to poor (0-49%) or < 50; Good to very good (50-100%) or ≥ 50.

Table 2. Facilities, tools and equipment in use at slaughterhouses in Oyo State.

S/N	Variable	Score< 50	Score≥ 50	Remark
1	Lairage usage in the slaughterhouse	47(78.3)	13(21.7)	Poor
2	Resting of livestock before slaughtering and processing	34(56.7)	26(43.3)	Poor
3	Appropriateness of location of slaughterhouse	25(41.7)	35(58.3)	Good
4	Fencing and gates around the slaughterhouse	48(80.0)	12(20.0)	Poor
5	Isolation of abattoir from residential houses/markets	40(66.7)	20(33.3)	Poor
6	Compartmentalization of slaughterhouse	37(61.7)	23(38.3)	Poor
7	Availability of cold chain	58(96.7)	2(3.3)	Poor
8	Availability of lairage facility	38(63.3)	22(36.7)	Poor
9	Water delivery system in place in the slaughterhouse	32(53.3)	28(46.7)	Poor
10	Disinfection of lairage done routinely	58(96.7)	2(3.3)	Poor
11	Disinfection of equipments used for slaughtering	60(100)	0(0.0)	Poor
12	Slaughterhouse design	36(60.0)	24(40.9)	Poor
13	Enough space for future expansion	30(50.0)	30(50.0)	Fair
14	Location of water source	34(56.7)	26(43.3)	Poor

Scores; Non- existent to poor (0-49%) or < 50; Good to very good (50-100%) or ≥ 50.

good (58.3% of the slaughterhouses complied), and enough space for expansion is just fair (50%) (Table 2). All other items scored that are non-existent to poor, lairage usage (78.3% of the slaughterhouses underutilize them), non-resting of livestock before slaughtering (56.7%), non-compartmentalization of slaughterhouse

Table 3. Operational policies and regulations in slaughterhouses in Oyo State.

S/N	Variable	Score< 50	Score≥ 50	Remark
1	Monitoring of stages of slaughtering activities	51(85.0)	9(15.0)	Poor
2	Documentation of numbers of livestock slaughtered	20(50.0)	30(50.0)	Fair
3	Level of education of operators	55(91.7)	5(8.3)	Poor
4	Ratio of inspectors to slaughtered animals	51(85.0)	9(15.0)	Poor
5	Ratio of support staff to slaughtered animals	35(58.0)	25(41.7)	Poor
6	Access to veterinary inputs	48(80.0)	12(20.0)	Poor
7	All in all out policy in slaughterhouse	53(88.3)	7(11.7)	Poor
8	Separation of sick animals	51(85.0)	9(15.0)	Poor
9	Separation of different species of animals slaughtered	53(88.3)	7(11.7)	Poor
10	Restriction of movement of operators within the slaughterhouse	39(65.0)	21(35.0)	Poor
11	Compensation mechanism in place for condemned carcass	54(90.0)	6(10.0)	Poor
12	Monitoring of the state of health of operators	49(81.7)	11(18.3)	Poor
13	Regulation of environmental waste/effluent disposal	41(68.3)	19(31.7)	Poor

Scores; Non- existent to poor (0-49%) or < 50; Good to very good (50-100%) or ≥ 50.

(61.7%), non-availability of cold chain (96.7%), disinfection of equipments (100%), poor location of water source (56.7%) and other items scored under this category fall within non-existent to poor.

Operational policies and regulations in slaughterhouses

General scoring of the items here is poor, out of the thirteen items in this class, just one item (documentation of numbers of livestock slaughtered) is rated 50% and fairly complied with in the slaughterhouses. All other scored items which include; non-monitoring of stages of slaughtering activities (85%), poor level of education (91.7% of the slaughterhouses), bad ratio of inspectors to slaughtered animals (85% of slaughterhouses), all in all out policy not practiced (88.3%), non-separation of sick animals (85%), non-restriction of movement of operators (65% of slaughterhouses), non-monitoring the state of health of operators (81.7%) and non-regulation of environmental waste/effluent disposal (68.3%) fall within non-existent to poor (Table 3).

Comparison of practical hygiene and sanitation at the abattoirs and slaughterhouse slabs

Out of the twenty three items considered, only nine showed significant differences ($p<0.05$) between the abattoirs and slaughter slabs. The nine items are garbage disposal services ($p<0.001$), washing of slaughtering tools and equipments ($p<0.001$), disinfection of the slaughterhouse ($p<0.014$), disinfection of premises ($p<0.001$) and disinfection of infrastructures and equipments ($p<0.002$). Others are, availability of sufficient, regular and clean water ($p<0.001$), good hygiene in the slaughterhouse ($p<0.033$) and also, hands washing after slaughter ($p<0.001$) and hands disinfection after slaughter (0.001) (Figure 2 and Table 4).

DISCUSSION

Slaughterhouses are licensed key locations where slaughter animals are slaughtered for human consumption, under the supervision of inspectors. At the slaughterhouses there are possibilities of different degrees of contamination (Adeyemo, 2002). Due to variations in slaughterhouse contaminations across Nigeria, Okike et al. (2011) inferred that only 2% of meat samples processed from slaughterhouses in the country complied with acceptable meat standards and hence are not contaminated.

Meat has been classified as a first class protein, recommended at 0.75 g per kilogram body weight per day, as the requirement to maintain healthy living (maintenance and repairs of worn out tissues) among others (FAO, 2003). When meat is properly prepared it is useful, nutritive, wholesome and fit for human consumption (Govindarajan, 1990; FAO, 2016), but if not may serve as medium for disease propagation (Mensah et al., 2012). The slaughtering of meat animals, preparation of meat, the environment for meat preparation and the distribution of meat must be carried out in a hygienic manner with minimal contamination (Skaarup, 1985). However, meat produced in an unhygienic condition could pose threat to the health of the consumers as well as compromise the keeping quality of such meat, thereby affecting the shelf life and wholesomeness of meat produced (Govender, 2014).

The proper disposal of condemned carcasses and

Table 4. Differences in practical hygiene and level of sanitation at the abattoirs and slaughter slabs in Oyo State.

S/N	Variable	Slaughter slab	Abattoir	p-value
1	Garbage disposal services	2.24	3.00	0.001*
2	Environmental cleanliness of slaughterhouse	2.56	2.90	0.059
3	Presence of an incinerator in the slaughterhouse	1.70	1.80	0.058
4	Washing of slaughtering tools and equipment	2.58	3.00	0.001*
5	Disinfection of the slaughterhouse	1.20	1.36	0.014*
6	Presence of drains on the floor	2.20	2.50	0.720
7	Availability of sufficient, regular and clean water	1.80	1.90	0.001*
8	Availability of hot water	2.16	2.70	0.582
9	Availability of toilets	2.70	2.90	0.843
10	Access of facility to wash hands and shoes	1.36	1.30	0.269
11	Access of facility to disinfect hands and shoes	1.50	1.80	0.958
12	Access of facility to bath after slaughtering	1.50	1.90	0.565
13	Safe disposal of condemned carcass	2.44	2.70	0.821
14	Safe disposal of waste	2.40	2.90	0.208
15	Good hygiene in the slaughterhouse	2.46	2.80	0.033*
16	Good hygiene at slaughtering points	1.10	1.32	0.847
17	Disinfection of infrastructure and equipment	1.92	2.50	0.002*
18	Disinfection of premises	1.78	1.89	0.001*
19	Cleaning of lairage done routinely	2.56	3.10	0.866
20	Protective apparels worn by slaughter/ processing persons	1.46	1.10	0.070
21	Hands washing after slaughtering	1.70	1.92	0.001*
22	Hands disinfection after slaughter	1.68	2.50	0.001*
23	Controlled rodent environment	2.18	2.70	0.526

* Significant at $p < 0.05$.

wastes in a safe area and installations of incinerators are contributory to the success of slaughterhouses across the world, because these practices will prevent the littering of the environment with disease causing agents, which can be persistent (Bengtssom and Whitttaker, 1988). Observations revealed that majority of the slaughterhouses sampled (95%) lack the listed facilities and disposal of condemned carcasses and wastes indiscriminately within the slaughterhouse environment. Most of the time these carcasses and wastes are littered not far from the water sources; there are usually high possibility of microbial contamination of the environment and the water for processing (Kwadzah and Iorhemen, 2015).

Potable water is essential for the smooth running of any slaughterhouse and must be readily accessible during slaughtering, for cleaning, and washing of slaughtering equipments and workers' hands with proper disinfection (CAC, 2003). Also, hot water from pressure hose is needed for some level of disinfection for use at the slaughterhouse (FAO, 1985). These processing activities will need pipe-borne water or well cited and properly sunk bore-holes that are only available in very few slaughterhouses in Oyo State; this study observed that the use of hot water is not a common practice for disinfection. There was lack of water, no hand washing facilities, and no proper disinfection in most slaughterhouses, so majority of the slaughterhouse workers hardly observe these hygienic routines.

Previous studies have shown that hand washing is practiced in order to protect carcass/meat from getting contaminated and this practice also confer some levels of protection of the worker against direct infection from certain microbes such as *E. coli* and *Salmonella* sp. (Gomes-Neves et al., 2012). The washing of slaughtering tools and equipments is normally done, but there is lack of disinfection culture amongst the operators and butchers. This practice will allow the persistence of microbes on knife, cutting surfaces and wearing apparels, which can lead to contamination of carcass and meat (EC, 2001). It was also observed that most of the slaughterhouses lack facilities to wash and disinfect hands and shoes, and also majority of them do not have bath rooms and toilets; all these have public health implications to workers and the community at large.

The presence of rodents and other animals in and around the slaughterhouse will favour the transmission of abattoir infectious or zoonotic disease and can lead to persistence and spread of such diseases in the slaughterhouse environment (Bengtssom and Whittaker, 1998).

The protective apparels worn by the meat handlers in

the slaughterhouse are meant to prevent contamination of the carcass/meat products and vice versa due to the vulnerability of the meat handlers to occupational hazards (EC, 2001). Barely 32% of meat handlers wear protective apparels during slaughtering and meat processing, and they claim ignorance of not having any knowledge of occupational hazards.

Most structures needed for slaughterhouses are present, except toilets which are not common finding in most of the slaughterhouses, but are not put into proper use. Water supply is very poor, in most cases stream and poorly dug and cited wells are used, most of which are already contaminated by surface run-offs and poorly discharged effluents (Nafarnda et al., 2012).

There are differences between availability of lairages and usage of lairages; the lairage is the first section of a slaughterhouse where slaughter animals are rested and inspected prior to slaughtering (Heinz, 2008). Majority of the slaughterhouses lack lairage facilities, whenever it is present it is either under-utilized or not put into use, and most of the time it is in a deplorable state with very poor level of hygiene. Majority of the lairages in slaughterhouses in Oyo State are not routinely cleaned, this further supports the findings of previous studies, that most slaughterhouses in Nigeria do not have functional lairages (Lawan et al., 2013). Also, the usage of lairage if present at all for resting of livestock before slaughtering is poor, which is in line with the assertion of Adeyemo et al. (2009), that lairage has been largely implicated as a point for cross contamination among animals being rested after transportation from long distance.

In an ideal setting, there should be compartmentalization of the slaughterhouse, especially between the dirty (killing and bleeding sections) and clean (eviscerating and splitting sections) to forestall carcass contamination (CAC, 2003). But on the contrary, majority of the slaughterhouses in the surveyed areas carry out all their operations (slaughtering, bleeding, skinning, evisceration, and carcass splitting) on the same spot. This type of operation and practice will lead to contamination of carcasses due to traffic flow against the normal directional flow and likelihood of contamination of carcass and the environment where there are human habitations (Spickler, 2016).

Meat inspection and monitoring of slaughtering operations are crucial for the detection of slaughterhouse diseases, contaminated carcass/meat and facilities/ equipments (CAC, 2003; Ninios et al., 2014). Due to absence of or insufficient meat inspectors in most of the slaughterhouses, most of the operations and slaughtering activities are carried out without proper supervision, which is contrary to the recommended regulations (Komba et al., 2012; Cook et al., 2017). This prevents thorough ante-mortem inspection, which is essential for preventing the slaughter of sick animals, post-mortem inspection for detailed carcass and organ examination to detect signs of disease; and facility and hygiene inspection to detect flaws in operational hygiene. Slaughtering infected animals has been shown to be a risk factor for infection with possibility of causing zoonosis (Brown et al., 2011).

The level of education of the slaughterhouse operators across the sampled locations is very low (8.3%), this will make it difficult for them to be able to comprehend the reasons behind certain activities. Alhaji and Baiwa (2015) emphasize the importance of education and knowledge in operational hygiene, that lack of knowledge vis-a-vis hygiene during meat processing and meat contamination will ultimately affect the quality of the meat derived thereof. The training of slaughterhouse operators in the acquisition of knowledge and understanding of the importance of hygiene during slaughtering and meat processing so as to improve the level of cleanliness and operational hygiene in slaughterhouses; and thus leading to the reduction of microbial contamination of carcass/meat (Wamalwa et al., 2012).

The slaughterhouses are poorly staffed, right from the veterinary inputs, inspectors to support staff, which has negative effects on the monitoring of the stages of slaughtering activities. The policy of all in all out is rarely observed, so also the separation of different slaughter animal species and sick from healthy animals.

If the role and response of the government in the compensation for condemned carcasses is not good enough, stake holders in the slaughterhouse will not be willing to submit condemned carcass for destruction; this infected carcass will be sold to unsuspecting public and residents of surveyed locations who stand high risk of contracting infections or zoonotic diseases through consumption of contaminated meat (Qekwana et al., 2017). The monitoring of the state of health of slaughterhouse operators (especially wounds that can also contaminate carcass/meat and that could predispose further to occupational diseases) is very poor across the sampled locations.

Animal health personnel, slaughterhouse workers and other stakeholders in the slaughterhouse are also at high risk of exposure to certain zoonotic pathogens which can infect them, and render them carriers of the zoonoses that can be spread to other human population living with them in the same community (Lejeune and Kersting, 2010).

Based on previous studies, hygiene and sanitation are better practiced at the abattoir when compared with the slaughter slabs; this has been attributed to many factors, among which are; construction and compartmentalization of the abattoir, which reduces the level of contamination during slaughtering and processing (CAC, 2003). The identification of critical control points (CCPs) helps to counter the hazards/risks of contamination in the slaughterhouse (CAC, 2003; Govender, 2014). Hazard Analysis and Critical Control Point (HACCP) is a system for food safety management. It is a preventative approach to food safety (FSA, 2005).

Fasanmi et al. (2017b), identified more CCPs (12) for abattoir when compared with the slaughter slab (9) with muddled up activities during slaughtering, thereby leading to difficulties in the monitoring, prevention and control of probable hazard(s). The numbers of CCPs positively correlate with level of hygiene and cleanliness; and hence there is lower tendency of contamination. This is why there is always higher incidence of carcass and/or meat contamination in slaughter slabs when compared with the abattoirs. These studies further corroborate the previous findings.

Also the availability of sufficient, clean and regular water supply has positive correlations with washing of slaughtering tools and equipments, and hands washing after slaughtering. These are better done in the abattoir than the slabs across the surveyed slaughterhouses. Disinfection is different from washing; disinfection reduces the microbial loads on contaminated surfaces in slaughterhouses (Connor et al., 2017); this study shows that the disinfection of the slaughterhouse, the disinfection of hands after slaughtering, disinfection of the premises and equipments were also better done at the abattoir than the slabs. The reasons for all the aforementioned could not be farfetched; a lot of attention is paid to the abattoir because of they are established by the Municipal or local government council and having enough inspectors and support staff courtesy of the municipal and regulatory authorities that also make provisions for facilities, amenities and infrastructures (Davey, 1989).

Conclusion

All evidences of unhygienic practices and the risk factors in slaughterhouses across sampled locations is an indication that majority of the abattoirs or slaughter slabs are contaminated. By implication, the meats derived thereof are unwholesome and not safe. This implies that the slaughterhouses are non-compliant with the established regulations governing the establishment and operations of slaughterhouse. These locations may serve as critical points for the distribution of contaminated meat to the unsuspecting public and also medium where unprotected and vulnerable abattoir workers are exposed to occupational diseases. Hence, this has called to question the issue of food safety in the surveyed slaughterhouses across Oyo State, South Western Nigeria. Therefore, there is the need for slaughterhouse workers to be trained and retrained on occupational zoonoses and the relevance of hygiene and sanitation of slaughterhouse operations in the production of wholesome meat, before they are released for human consumption. The provision of facilities and infrastructures, such as toilets, bathrooms, incinerators and good sources of water by the government or private slaughterhouse owners is a necessity.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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