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Abstract

Background: Pig slaughtering methods influence the quality of pig products and also serves as a critical point for the control of zoonosis and other food-borne infections. This study aimed at assessing the peculiarities, the animal welfare concerns and the public health implications of pig slaughtering activities was conducted on three major abattoirs in Southwestern Nigeria. **Materials and Methods:** Information on pre-slaughter handling, slaughtering and carcass processing were obtained by observation over a continuous 2-week period of normal abattoir activities in each abattoir by the authors. Structured questionnaires were administered and focus group interviews were conducted to obtain information from the abattoir workers and health officials. Data were analyzed using descriptive statistics.

Result and Conclusion: The pig slaughtering methods in the three locations vary considerably with some identified areas of animal welfare concerns which include inhumane transportation, restraining, lairaging, and stunning practices. These amount to excessive stress and poor animal welfare. The abattoir findings with public health implications include floor slaughtering, inadequate water supply, excessive biological intrusions, poor environmental hygiene, poor waste disposal and failure of abattoir workers to use protective clothing. The implications of the findings are discussed.

Key words: Abattoir, Nigeria, Pig, Slaughter, Welfare.

Introduction

Pre-slaughter animal welfare and meat hygiene is a concern worldwide (FAO, 1992) with most developed countries having humane slaughter laws that ensure that food animals are killed quickly, painless and without suffering in other ways. In Nigeria, there are laws on animal welfare and abattoir operations but compliance to these laws are not fully enforced. This situation leads to excessive pre-slaughter stress and poor hygiene conditions of the slaughter areas.

Sources of pre-slaughter stress may range from physical, such as high ambient temperature, vibration and changes in acceleration during transportation, confinement, noise, and crowding; to psychological such as the breakdown of social groupings and mixing with unfamiliar animals, unfamiliar or noxious smells and novel environment (Warriss, 2000). Animals could also suffer from pre-slaughter stresses arising from bruises, injuries, starvation, tiredness, and loading and unloading onto vehicles. Lawrie (2006) reported that with higher levels of stress poorer meat quality is eminent, quite apart from being inhumane. Besides stress, genotype, transportation, lairage time, season of the year, environmental conditions and many other factors will affect pork quality (Küchenmeister, 2005).

Slaughter methods vary with geographic location depending on the technology available and/or adopted and may be influenced by cultural or religious orientation of the people. Quality of equipment and training of abattoir personnel impacts to a large extent on the quality of pork products. With proper stunning methods and equipment, the animal is expected to be unconscious and with no sensitivity to pains. Therefore, well trained personnel and right choice of stunning equipment should be used to avoid unnecessary stress and distress to animals (Adzitey, 2011).

Hygienic practices during pig slaughtering including proper effluent disposal are of utmost importance as these have effect on the health of the public through the wholesomeness of pork products and the direct effects of effluents on the surrounding. In Nigeria, many abattoirs dispose their effluents directly into streams and rivers without any form of treatment (Adelegan, 2002). Such is the situation in several private and government abattoirs in most parts of the country (Osibanjo and Adie, 2007).

This research seeks to investigate and create a better understanding of the current pig slaughtering practices and the animal welfare and hygiene situation in the process in Southwestern Nigeria.

Materials and Methods

Study Area

The study was conducted on government designated abattoirs for pig slaughtering in Oyo, Ogun and Lagos State which are major pig producing states in Southwestern Nigeria. The three government-owned abattoirs serve as designated areas for commercial scale pig slaughtering. These are Bodija Municipal (Ibadan, Oyo State, Latitude 7.420805^o, Longitude 3.923755^o), Oke aro (Akute, Ogun State Latitude. 6.689691^o, Longitude 3.332572^o) and Oko oba (Agege, Lagos State, Latitude 6.664608^o, Longitude.3.691406^o) abattoirs.

Observational study

The observational study design required a 2-week continuous period of observation of activities on each abattoir. The slaughtering of a total of 2,450 pigs was observed in order to assess normal slaughter operations. Information on different aspects including pre-slaughter handling, stunning, slaughter method, cleaning and splitting of carcass and abattoir facilities were obtained by the authors' observation and data capture on digital camera.

Questionnaires and Focus Group Interviews

Information on the demography and training of the personnel were obtained by structured questionnaires administered to 58 workers that were consistent at the abattoirs. Focus group interviews were conducted for twelve and six representatives of the abattoir workers and health officials (veterinarians and animal health officers) respectively. This was done after getting the informed consent of the abattoir authorities and the individuals involved.

Statistical Analysis

Statistical analysis was done by using descriptive statistics.

Results

The findings of this study based on the observational study, questionnaires and focus group interviews reveal peculiarities, a number of animal welfare concerns and situations with public health implications in pork processing in Southwestern Nigeria.

Observational Study

Abattoir Location, Facilities and Practices

The design and facilities available in the three abattoir locations supports manual method of pig slaughtering. This makes the process labor intensive, time consuming and usually with low output/capita. Different segments of the pork processing area were poorly demarcated often with no clear cut clean or dirty area. The slaughter areas are usually divided vaguely into two segments: the first is meant for activities such as mechanical stunning, slaughtering, and flaying. The second area serves for further cleaning, washing and evisceration of carcass. Approximately 60-80% of processing activities starting from stunning to sales of pork are done on bare cemented floors (Figure 1-8). There are certain observed variations in the three abattoirs. In Oyo state, the abattoir is located in the popular *Bodija* market in Ibadan, adjacent to the cattle slaughter area. The first area of the abattoir which is an outdoor segment serves basically for mechanical stunning, slaughter, boiling of water with firewood and flaying while the second area which is an indoor segment is designated for further cleaning of the carcass usually with razor blades after the initial flaying with knives. The carcasses are washed with water and eviscerated. They are placed on tables where transactions between the butchers and customers who buy for consumption or further distribution takes place. The separated viscera is cleaned out with water, inverted for proper rinsing and parboiled before display for sale. The parboiling practice is generally accepted in the three locations as it is believed to make the visceral keep longer and remain compact. The visceral content and other waste produced are gathered and disposed manually with buckets on nearby dung hills. The processing of carcasses is done simultaneously and the average processing time per animal per butcher is estimated to be 30 minutes.

In Ogun State, the abattoir is located close to *Okearo* pig village. The pig village scheme which is government owned is an expansive area that accommodates over 1,000 independent pig farmers. The pigs slaughtered on the abattoir facilities are almost entirely those raised within the farming village. The slaughter area is located by a stream that runs through the farm. The farm and abattoir effluents run directly into the drainage. The slaughter area is poorly demarcated. Stunning and slaughtering is done in a segment which is not clearly demarcated from the rest of the slaughter area. Several pigs are slaughtered concurrently with the average processing time per animal per butcher estimated to be about 20 minutes. Sales are based on processed weight.

The Lagos abattoir is located at *Oko-oba* in *Agege* area of Lagos State. It has a better layout and appears more organized and managed than the two other locations. It is also located beside a flowing stream that also drains the close-by cattle slaughter area. There are three fairly demarcated segments on the slaughter area and a fourth adjacent separate area is for pork display and sales. The first area is basically for mechanical stunning, slaughtering, boiling of water, flaying and evisceration. The second area which is adjacent to the first is for cleaning of the viscera and the third area which is opposite the first is for washing the carcass and cutting to sizes. The pork is then transferred to a fourth area where tables are available for buyers to transact. Sales are based on dressed weight basis. The average processing time per animal per butcher was estimated to be 15 minutes.

Pre-Slaughter Handling

The pre-slaughter practices observed included transportation, loading and off-loading, restraint methods, identification and lairaging.

Transportation to Abattoir, Restraint Methods and Identification

In Oyo and Lagos states, the pigs are transported to the abattoir from different areas of the state and other neighboring states. The butchers usually go in search of pigs and buy from farms, but a few farmers prefer to bring their produce to the abattoir for sales.

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They usually transport them with trucks, buses, cars and occasionally bikes. The pigs are loaded on and off-loaded the vehicles manually and are restrained with ropes or the barricades formed by the walls of the vehicle. Those transported in buses and cars are usually restrained with short ropes applied to tie their snout to one hind limb above the hock joint (Figure 1). In Ogun state, the pigs are not usually transported with vehicles since they mostly originate from the nearby farming village. They are herded on foot to the abattoir. The butchers have a similar identification system. This is done by scrapping off the bristles of the pigs with sharp blades to form signs unique to each individual.

Lairage Facilities

Lairage facilities available in Oyo and Lagos abattoirs are grossly inadequate. The facilities in Oyo state are two small rooms (12ft²each) attached to the in-door slaughter house with make shift feeding and watering facilities. The Lagos state lairage is made up of cubicles with concrete floor full of crevices, concrete and wooden walls and galvanized roof. In Ogun state, there are no lairages as the pigs move to the slaughter area directly from the farm houses after purchase.

Slaughter Processes

The slaughter processes observed are fully manual, laborious and time consuming. The observed processes includes: stunning, slaughter practices, flaying, evisceration and splitting of carcass, processing of viscera and distribution of pork.

Stunning and Slaughter Practices

The stunning practices adopted in the three locations are similar. Physical stunning is employed. Usually, a heavy metal or wooden material is used to apply a sharp force on the frontal bone area of the pigs, then a jugular or nuchal ligament slit is done. The stunning method is inhumane and often ineffective as many pigs are observed to show post slaughter wriggles as signs of consciousness and pains. The slaughtering practices vary slightly. In Ogun state, a peculiar slaughter practice in the abattoir after physical stunning is the making of a deep dorso-ventral cut on the neck region to sever the nuchal ligament as against jugular slit in the other abattoirs (Figure 5). This immobilizes the pigs and is believed to reduce post-slaughter wriggles which occasionally follow the jugular slit. Jugular slit exclusively is practiced in Lagos and Oyo abattoirs (Figure 3).

Flaying, Washing, Evisceration, Splitting of Carcass and Processing of Visceras

Flaying is done using hot water and knives or cans. The carcass is placed on the cemented floor and hot water boiled often with fire wood is poured over it. The carcass occasionally may be dipped in the drums of boiling water. Knives or used metal cans are then used to flay to remove bristles and epidermal coatings of the skin (Figure 7 & 8). The heads are removed, further boiled and flayed. Evisceration is done after majority of the bristles have been removed and the carcass washed with water. This is done by making a slit from the pubis to the sternum along the medial line and a further anterior cut through the sternal cartilages to expose the abdominal and thoracic cavity. The thoracic organs are removed as a pluck starting from the trachea and kept separate. The intestines are removed with caution to prevent burst of the gall bladder which is carefully discarded. The viscera is transferred to certain butchers that are specialized in their cleaning. In Oyo state, majority of the intestinal content are cleaned out before placing in water filled buckets. The intestines are cut into segments and carefully inverted and washed in buckets to minimize water use. In Lagos and Ogun states, there are designated running taps for this purpose. Water is run into the lumen of the intestine from the anterior portion to flush out the content and the viscera is then inverted. It is a generally accepted practice to parboil the viscera after cleaning to prolong its shelf life. The carcasses are split into various sizes and are set for distribution.

Sales and Distribution of Processed Pork

The number of pigs slaughtered per day in all the abattoirs varies and is determined by demand as there are no functional facilities for freeze preservation of pork. The average number of pigs slaughtered per day in Oyo, Ogun and Lagos state abattoir was 22, 80 and 105 respectively. In Oyo state, almost all the pigs slaughtered are supplied to individual meat traders and consumers who come to the abattoir. In Ogun and Lagos states, there are corporate and bulk buyers in addition to the regular individual buyers.

Water Source

Bore-hole with associated facilities is available in the three abattoirs. The facility in the Oyo state abattoir was not functional at the time of the study and therefore creating a need for commercial water fetchers to supply water. The quality of water supplied could not be ascertained as the commercial fetchers go around scavenging for water. This discourages the copious use of water among the butchers for pig slaughtering and cleaning. The water supply facilities in Lagos and Ogun were functional although the bore-hole facility was majorly run on locally generated power. This made supply occasionally erratic.

Biological Intrusions

These are humans and animals which were observed on the slaughter area without direct involvement and benefit to the slaughter processes. (Figure 2 & 4).

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In Oyo state, the second area of the abattoir which is an in-door area also serves as the sales point. This arrangement therefore makes this area often occupied with people who are only interested in buying the products. They intrude into the slaughter area with their wares and containers for collection of their purchase. Observed animal intrusions include house flies, stray dogs, free range pigs and chickens (Table 1).

In Ogun state, there are also similar human intrusions as there are no limits set for customers. Cattle egrets were observed to be abundant on the fringes of the nearby stream and occasionally came over to the slaughter area to feed (Figure 6). House flies were abundant and stray chicken were also observed. These animals are observed to feed on the nearby stream and stray around thereby serving as a potential source of transmission of food borne diseases.

In Lagos state, Human intrusions are minimal as there is a fourth area clearly set for sales. Cattle egrets were also abundant on the fringes of the stream which occasionally strayed into the slaughter area to feed. House flies and Lizards were also observed.

Table 1: Biological intrusions on Oyo, Ogun and Lagos state pig abattoirs

Intruder State	Human	Chicken	Dogs	Cattle Egrets	Stray pigs	Lizards	House flies
Oyo	Yes(+++)	Yes(++)	Yes(+)	No	Yes(+)	Yes(+)	Yes(+++)
Ogun	Yes(+++)	Yes(+)	Yes(+)	Yes(+++)	No	Yes(+)	Yes(+++)
Lagos	Yes(+)	No	No	Yes(++)	No	Yes(+)	Yes(+++)

+ Occasional, ++ Frequent, +++Always.

Questionnaires

The findings on the demography and training of abattoir workers on animal welfare, pork processing and hygiene from the questionnaires shows that most of the workers in Oyo state are female (92.86%) which is in contrast to the predominantly male workers in Lagos (75%) and Ogun state (80%). People with various religious affiliations and sentiments are involved in pig slaughtering in the three locations although with a higher proportion being Christians. Most of the workers were between 20 and 60 years of age (Table 2). There is currently no form of formal training or prequalification for abattoir workers involved in pork processing and inadequate periodic enlightenment trainings (Table 3).

Table 2: Demographic characteristics of abattoir workers in Oyo, Ogun and Lagos states

		Oyo	Ogun	Lagos
Sex	Male	1(7.14%)	16(80%)	18(75%)
	Female	13(92.86%)	4(20%)	6(25%)
Total		14	20	24
Religion	Christianity	8(57.14%)	13(65%)	17(70.83%)
	Islam	5(35.71%)	7(35%)	7(29.17%)
	Traditional	1(7.14%)	0(0%)	0(0%)
	Non			
Total		14	20	24
Age(Years)	21-30	1(7.14%)	4(20%)	3(12.5%)
	31-40	3(21.4%)	12(60%)	9(37.5%)
	41-50	6(42.9%)	3(15%)	7(29.2%)
	51-60	3(21.4%)	1(5%)	4(16.7%)
	61-70	1(7.14%)	0(0%)	1(4.2%)
Total		14	20	24

Table 3: Formal training of abattoir workers on animal welfare, pork processing and hygiene in Southwestern Nigeria

	Oyo	Ogun	Lagos
Formal training on proper animal handling and welfare	Non	Non	Non
Formal training on pork processing	Non	Non	Non
Periodic enlightenment training on public health	Non	Yes	Yes
The use of uniforms, coveralls and protective gears	Non	Non	Non

Focus Group Interviews

The representatives of the focus groups were interviewed after due informed consent on the limitations to optimal functioning of the abattoirs. The first group comprised of four representatives of the abattoir workers on each of the three locations. They highlighted the different factors that were limitations to their optimal productivity, responsible for the poor state of facilities and poor hygiene of the abattoirs. These included:

1. Long period of neglect of the facilities and inadequate intervention of the government in the running of the abattoirs.
2. Poor state of basic amenities such as waste disposal facilities, electricity and water supply.
3. No compensation for owners of condemned carcass: The abattoir workers believe it was not fair for them to bear the loss of condemned carcass as they would have paid the farmers or suppliers fully.
4. High cost of transportation of the animals to the abattoir.

The second group comprised of two health officials (veterinarians and animal health officers) on each of the abattoirs. They discussed limitations to their optimal performance as it relates to the meat inspection and abattoir hygiene. They highlighted the recent interest of the government in upgrading the abattoirs and future plans to build more modern facilities for pig slaughtering. They also highlighted limitations they encounter in the line of their duty to include:

1. Inadequate number of staff relative to animal traffic on the abattoirs.
2. Poor state of available facilities due to long period of neglect which makes enforcement of standard abattoir practices difficult.
3. Lack of modern abattoir equipment.
4. Poor compliance of abattoir workers to laid down rules on individual and public health due to weak system of enforcing compliance.
5. General apprehension of abattoir workers to partial or total condemnation of carcasses.



Figure 1: Lagos state abattoir: Means of transportation (Bus) and restraint method (Snout to hind limb)



Figure 2: Oyo state abattoir: Indoor flaying and viscera cleaning area, predominantly female butchers, biological intrusions (Humans and Stray dog), floor and table carcass processing , poor hygiene, water supplied in buckets.



Figure 3: Lagos state abattoir: Simultaneous slaughtering, jugular slit without nuchal cut, no personnel uniform/protective clothing, flaying on cemented floors with hot water sourced from drums.



Figure 4: Lagos state abattoir: Biological intrusions (farmer/supplier, buyer, onlookers), restraint with rope and identification by shaving, weight evaluation (with snout to hock restraint), inconsistent use of protective gears, floor slaughtering with no clear cut slaughter clean or dirty area.



Figure 5: Ogun state Abattoir: Mechanical stunning, Nuchal ligament slit, floor processing.



Figure 6: Ogun state abattoir: Farm structures of adjacent pig farming village, Biological intrusions (cattle egrets, house flies), effluent flows directly into adjacent stream, floor slaughtering.



Figure 7: Ogun state abattoir: Water source, no uniform/protective clothing, flaying and cleaning, floor processing, poor slaughter area boundaries.



Figure 8: Oyo state abattoir: Predominantly female abattoir workers with their babies, Floor slaughtering, Water supplied in buckets.

Discussion

This study highlights pig slaughtering activities in Southwestern Nigeria, its peculiarities and inadequacies which are of animal welfare concerns and public health implications. The slaughter facilities available were observed to be inadequate, poorly managed and the personnel were never formally trained. The systems adopted and currently in operation were therefore arrived at by the use of individual intuitions, apprenticeship and also by trial and error practices.

The practices that are of animal welfare concerns identified include inadequate transportation facilities and practices, inhumane restraint practices which are sometimes applied over prolonged transport periods, poor lairage facilities which usually subject pigs to prolonged fast periods and the brute means of physical stunning. These observations amount to excessive stress and poor animal welfare. These practices are a reflection of the orientation of pig handlers on animal welfare in Southwestern Nigeria. Poor animal welfare on the farm, through the production stage of the pigs may be a significant contributor to sub-optimal output from pig husbandry in Nigeria as high stress level predisposes to myriads of disease conditions (Thomson and Friendship, 2012). These cruel practices observed with pigs have also been reported in other livestock in Nigeria (Adeyemo *et al.*, 2009).

The practices that are of public health implications observed include widespread embrace of floor pig slaughtering, inadequate water supply and sub-optimal water use, improper demarcation of slaughter areas, excessive biological intrusions, poor environmental hygiene, poor waste disposal and the failure of abattoir workers to use protective clothing which increases the risk of meat contamination and exposes workers to injuries and infection.

Floor animal slaughtering which is widely practiced in Southwestern Nigeria (Figure 1-8) is also practiced in abattoirs in Northern Nigeria and other parts of Africa as flaying, evisceration and splitting of carcass are carried out on unhygienic floors (Lawan *et al.*, 2013; Fearon *et al.*, 2014). This practice may lead to a higher microbial load of meat and meat products, thereby constituting a source of high risk to the public (Warriss, 2000 Adzitey *et al.*, 2010). There is therefore need for urgent intervention by the government who owns most of the abattoirs and relevant stakeholders to reduce the public health effects of these unhygienic practices.

Inadequate water supply to the abattoirs encourages improper cleaning during pig slaughtering. The practice of scavenging for water observed in Oyo state abattoir (Figure 2 & 8) is of significant public health implication as it increases the potential of water borne disease agents being transferred to meat products. This finding is similar to that of Lawan *et al.*, (2013) who observed that in four abattoirs surveyed in northern Nigeria, there was no regular supply of portable water and electricity. Water was usually obtained from truck pushers, who sold water from unidentified sources for carcass washing. Occasionally the butchers sourced water from nearby streams. The meat inspectors in the study of Lawan *et al.*,(2013) adduced this deplorable state to government's insensitivity and lack of concern towards general management of abattoirs.

The ownership of most abattoirs in Nigeria belongs to the government. The three tiers of government (federal, state and local government) participate in meat inspection, however the local government authorities (LGA) are allowed legally to own slaughter sites and abattoirs within their boundaries, subject to the approval of the supervising veterinary division (Adeyemo 2002). The three locations in Southwestern Nigeria have veterinary officers and animal health officers assigned to each abattoir but the number was grossly inadequate compared with the slaughter population. The government officials stated that the inadequacy of the abattoir facilities hampers their thoroughness in meat inspection. They stressed the need for government to put stricter measures in place in order to enforce compliance to the judgment of meat inspectors. The butchers often resist partial or total condemnation of diseased carcasses in order to avoid bearing the financial losses of pigs purchased.

Excessive biological intrusions appear to be a major source of risk in pig slaughtering in South-western Nigeria. There are no clearly demarcated limits of access to external humans and also poor control of stray animals. This is similar to reports from the northern part of Nigeria where movement in and out of the abattoir by human and animals were uncontrolled. Stray dogs and hawkers were allowed access to the abattoir premises (Ogbaje *et al.*, 2012). These biological intrusions are of public health implications as they may be involved in transmission of food borne diseases or zoonotic agents to the pork products.. Scavenging animals such as dogs, cattle egrets,

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lizards, chicken, pigs and house flies were observed in varying frequencies on the three surveyed locations. These should be prevented to improve the wholesomeness of pork products.

Poor hygiene and deficient waste disposal are common problems observed in the three abattoir locations. This was arrogated by the abattoir workers to poor provision of basic facilities by the government. The urban location of these abattoirs and the direct release of untreated waste into the environment and water bodies pose a direct public health threat. This practice of poor waste disposal is similar to the findings in other locations in Nigeria (Bello and Oyedemi 2009; Lawan, 2013). Some of the peri-abattoir water bodies in which waste is released into also serve the dual purpose of drinking water for the butchers and others working in the abattoir, and for dressing of the carcasses to be sold for human consumption (Adeyemo, 2002). Livestock waste contamination is known to increase the level of nitrates in ground water, which causes methaemoglobinemia or “blue baby syndrome” (Meadows, 1995).

The personnel in all the locations were observed to place little premium on personal protection as protective gears were not worn. This exposes the abattoir workers to injuries and risk of contraction of zoonotic diseases. There are a number of endemic bacterial, viral and parasitic diseases of livestock in Nigeria that are of zoonotic importance which can be readily acquired from meat and handling of food animals (Adeyemo, 2002). Aworh *et al.* (2013) reported a high sero-prevalence of human brucellosis among abattoir workers in the two busiest abattoirs in Abuja, Nigeria. Similar findings have been documented from studies done in South west Nigeria, Tanzania and Egypt (Cadmus *et al.*, 2006; Swai *et al.*, 2009 and El Kholy *et al.*, 2009). Among the various categories of abattoir workers that were screened by Aworh *et al.*, (2013), butchers had the highest seropositivity rate. The missing factor of personnel education and enlightenment on hygiene and biosecurity in an abattoir system which is labor driven greatly contributes to the high incidence of zoonotic diseases among abattoir workers. Proper training of abattoir workers and enforcement of safe practices by the government will greatly reduce this alarming occurrence.

Pig slaughtering in Oyo state abattoir is almost an exclusive preserve for female butchers (92.86%). Many of the women were observed to be of child bearing age and some had babies strapped to their back as they slaughtered pigs This practice exposes these children to infections. Prejudice in relation to pig slaughtering is fading as people with various religious sentiments are observed to be involved in the processing in the three locations studied.

The pig slaughtering practices, personnel training and facilities in Southwestern Nigeria re observed to be grossly deficient. There is therefore urgent need for the intervention of government and relevant stakeholders in the area of personnel training on best practices, provision of modern facilities and basic amenities in the abattoirs in order to ensure the wholesomeness of pork products and protection of public health.

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