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Bacteriological quality of beef-contact surfaces, air microflora and wastewaters from major abattoirs located in Benin City, Southern Nigeria

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Abstract

The bacteriological quality of beef produced from most abattoir located in southern Nigeria has always been questionable. This work therefore investigated the bacteriological quality of abattoir facilities from both government and private owned abattoirs located in southern Nigeria. The results of our findings revealed that the total heterotrophic counts and total coliform counts exceeded the recommended standard for sanitary practices. Total heterotrophic counts from air flora ranged from 14.50 x 10^6 to 42.50 x 10^6 cfu. Beef-contact surface ranged from 26.50 x 10^6 to 592.50 x 10^6 cfu while total colony counts obtained from wastewaters from both government and private abattoirs ranged from 140.00 x 10^6 to 1206.75 x 10^6cfu/ml. The total coliform counts also ranged from 14.25 x 10^3 to 33.75 x 10^3 for air flora and 76.00 x 10^3 to 195.00 x 10^3cfu/ml for wastewaters. Eight bacterial isolates were consistently isolated during this study, and they included; *Escherichia coli*, *Staphylococcus aureus*, *Staphylococcus* sp., *Citrobacter* sp., *Alcaligenes paradoxus*, *Klebsiella* sp. and *Enterococcus faecalis* with varying percentage of frequency across the sampling points. The presence of indicator organisms as well as possible pathogens in this study is of special concern and stakeholders should be encouraged to review the processes involved in the establishment as well as operation of abattoir in southern Nigeria.

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Introduction

Beef is meat that is produced from cattle. It is produced and consumed worldwide, with South America, Africa, Asia and Australia being the highest consumers of the product (Frank, 2001). Its production therefore is increasing like that of many other commodities, as it is needed by both individuals and operators of fast food centers (Gill and Jones, 2005). There is a link between per capita consumption of beef and the fortune of different nations (Marriott, 2004). However, per capital consumption of beef has increased tremendously worldwide since the early 1980s. This is mainly attributed to the decrease stagnation of per capita disposable income, the price advantage of beef over poultry and the influence of non-economic factors such as product consistent, product quality, food safety, health and nutrition concerns and convenience (Featherstone, 2003). Boll (2009) reported that red meat consumption trend is determined by changes in tastes and preferences associated with socio-demographic trends of consumers, and the changing livestock population system. The price of beef has mainly been influenced by these trends, thereby increasing the rate of consumption as well as its rate of production in abattoirs. Norte and Noudie (2009) also reported that the processing of beef is driven by a number of factors, such as climate conditions, overall economic growth, private consumption expenditure and the continued deregulation and liberalization of the agricultural sector.

Beef is processed in abattoir, and the design of abattoirs varies from person to person and from state to state including ownership but they are principally a place where livestock are slaughtered (Marriott, 2004). A number of slaughter facilities are found in an abattoir, whether stationary or mobile. These facilities could be a source of contamination to the slaughtering processes. It has been reported that abattoir is not 100% hygienic (Gill and Jones, 2005). Different factors could contribute to the contamination of beef products processed in abattoirs especially during processing and manipulations such as skinning, evisceration, storage and distribution at slaughter houses and retail establishment (Doxon *et al*., 1991). In most developing countries, their traditional methods of handling, processing and marketing of meat undermine quality whereas poor sanitation leads to considerable loss of product as well as the risk of food-borne disease (Garcia, 2007). Bacteria which are responsible for food borne diseases contaminate meat directly and indirectly especially from animal excreta at slaughter process (Emswiller *et al*., 1976). They can also be transferred from beef-contact surfaces, utensils and other slaughtering equipments (Yen, 2003). The external contamination of meat constitutes a major problem in most developing countries' abattoirs where they are potential sources of infection as microbial surface contamination of carcasses has been repeatedly reported to have a significant effect on the meat shelf life of beef. Moreover, contaminants may also include pathogens such as *Salmonella*, *Vibrio cholerae*, *Escherichia coli* and *Listeria* sp. which can contaminate the meat thereby causing severe problem for consumers (Elmossalami, 2003). Faecal matter is a major source of contamination and could reach carcasses through direct deposition as well as by indirect contact through contaminated and unclean carcasses equipment, surfaces, workers, installations and air (Borch and Arnder, 2002). Fortunately, most of the bacterial colonies which have been isolated from beef carcasses are said to be non-pathogenic, except for few human pathogens such as *Salmonella* sp. *Campylobacter* sp. and *Listeria* sp. which have been isolated in a number of cases (Emswiller *et al.,* 1976).

The importable water, unclean carcasses equipment, contaminated surfaces and air have also been reported to pose serious threat to consumers of beef and beef products especially in developing countries. Wastewater from such Abattoirs are usually disposed

indiscriminately on terrestrial and aquatic environment, thereby posing a serious health risk to the public. Most importantly, it has also been observed that most of the operators and patrons of abattoirs do not have any knowledge of sanitary practices which further makes the consumers more vulnerable to microbial infections (Elmossalami, 2003).

Presently, little or no inspection/supervision is being carried out by Veterinary and public health officers on the operations of abattoir and many of them are located in isolated areas across the metropolis. Since there is an increasing demand for beef and beef products, there is therefore need to investigate the bacteriological quality of beef contact surfaces and other related facilities used in major abattoirs in the metropolis.

Materials and methods

Sample collection

Samples were collected from four major abattoirs (2 government owned abattoir and 2 private abattoirs) within the metropolis over a period of one year. Samples were collected from beef-contact surfaces where the animal is slaughtered, air flora and wastewater from the abattoirs after which samples were taken to the laboratory under aseptic condition at 4^{o}C for investigations.

Bacteriological investigations

Total heterotrophic and coliform counts

Total heterotrophic count was done according to the method described by Wogu *et al*., (2011), while total coliform counts were analyzed as described by Enabulele and Uriah, (2009).

Isolation and identification of bacterial isolates

Samples were inoculated onto Nutrient agar, Blood agar, MacConkey agar, Salmonella Shigella agar and then incubated at 37^{o}C for 24hr. After the incubation time, the different culture plates were examined for microbial growth. Sub-cultures were made, to get discrete colonies, and different morphological tests were performed on the colonies, which were then stored in a slant at 4^{o}C for further biochemical investigations. Bacterial isolates were then identified using Bergey's manual of determinative bacteriology (Buchanan and Gibbons, 1974).

Statistical analysis

Data were analyzed using the general linear model procedure and ANOVA with SPSS software 17th edition.

Table 1. Results of the bacteriological analysis obtained from both government and private abattoirs.

Sampling point	Total colony counts (x 10^6)			
	Government Abattoirs		Private Abattoirs	
	GA1	GA2	PA1	PA2
Air-flora	14. 50 ± 8.3^{a*}	42.50 ± 19.3^{b*}	22.5 ± 19.0^{a*}	25.5 ± 9.1^{b*}
Beef-contact surface	318.00 ± 58.7 ^{a*}	592.50 ± 107.2 ^{b*}	26.50 ± 16.7 ^{a*}	28.75 ± 13.1 ^{b*}
Wastewater	140.00 ± 61.3 ^{a*}	1206.75 ± 141.6 ^{b*}	376.88 ± 74.8 ^{a*}	190.00 ± 15.5 ^{b*}
	(x 10^3)		Total coliform counts	
Air-flora	30.23 ± 10.5 ^{a*}	33.75 ± 11.3	14.25 ± 8.3 ^{a*}	32.75 ± 26.9
Beef-contact surface	110.00 ± 54.7 ^{a*}	338.50 ± 57.5 ^{b*}	25.75 ± 8.6 ^{a*}	18.25 ± 7.8 ^{b*}
Wastewater	195.00 ± 73.2 ^{a*}	130.06 ± 18.2 ^{b*}	83.72 ± 10.7 ^{a*}	76.00 ± 29.4 ^{b*}

GA1: Government Abattoir 1; GA2: Government Abattoir 2; PA1: Private Abattoir 1; Private Abattoir 2. Values with asterisk (*) signifies significant difference at 95% confidence level ($p < 0.05$).

Results

The results of this study showed that the total colony counts obtained from air flora ranged from 14.50 x 10^6 to 42.50 x 10^6 cfu. Beef-contact surface ranged from 26.50 x 10^6 to 592.50 x 10^6 cfu while total colony counts obtained from wastewaters from both government and private abattoirs ranged from 140.00 x 10^6 to 1206.75 x 10^6cfu/ml (Table 1). Total coliform counts also ranged from 14.25 x 10^3 to 33.75 x 10^3 for air flora and 76.00 x 10^3 to 195.00 x 10^3cfu/ml for wastewaters (Table 1). Total coliform counts for beef-contact surface was least at private abattoir 2 (PA2) and highest at government abattoir 2 (GA 2). Eight bacterial isolates were consistently isolated during

this study, and they included; *Escherichia coli*, *Staphylococcus aureus*, *Staphylococcus* sp., *Citrobacter* sp., *Alcaligenes paradoxus*, *Klebsiella* sp. and *Enterococcus faecalis*.

Table 2. Frequency of occurrence of bacterial isolates obtained from both government and private abattoirs (%).

Bacterial isolates	Air-flora				Beef-contact surface				Wastewater			
	GA1	GA2	PA1	PA2	GA1	GA2	PA1	PA2	GA1	GA2	PA1	PA2
Escherichia coli	75	25	45	55	50	15	50	25	75	25	25	25
Staphylococcus sp.	25	90	85	45	25	25	75	90	50	75	25	90
Citrobacter sp.	50	75	75	35	75	50	95	10	25	25	75	15
Enterobacter sp.	35	85	25	75	15	75	50	75	25	75	25	90
Alcaligenes paradoxus	25	65	20	65	75	75	50	50	25	90	25	25
Klebsiella sp.	50	65	20	65	15	75	90	15	15	25	75	15
Staphylococcus aureus	95	75	25	90	50	50	15	90	90	75	10	75
Enterococcus faecalis	15	55	20	75	25	50	75	90	20	25	85	90

GA1: Government Abattoir 1; GA2: Government Abattoir 2; PA1: Private Abattoir 1; Private Abattoir 2.

Discussion

Meat is the most perishable of all important food since it contain sufficient nutrient needed to support the growth of microorganisms (Magnus, 1981). The results of this study showed that beef-contact surfaces and other parameters studied in government abattoirs had a high microbial load compared to values obtained in private abattoirs, which indicate neglect of the facilities used in government abattoirs. The highest mean values of total colony counts in air microflora, beef contact surface and wastewater were obtained from government abattoir (GA2) with values of $42.50 \times 10^6 \pm 19.33$ cfu, $592.50 \times 10^6 \pm 107.23$ and $1206.75 \times 10^6 \pm 141.60$ for air microflora, beef-contact surface and wastewaters respectively (Table 1). Meanwhile, government abattoir (GA1) also had the lowest mean bacterial counts ($14.50 \times 10^6 \pm 8.33$ cfu) in its air flora. The highest coliform counts ($33.85 \times 10^4 \pm 57.53$ cfu) was obtain from beef contact surface in Government abattoir (GA2) while the lowest coliforms counts ($18.25 \times 10^3 \pm 7.85$ cfu) was obtained from private abattoir (PA2) (Table 1). These values indicate high microbial contamination of abattoir facilities with faecal material, either from man or from the animals as reported by (Lawrie, 2003). The results obtained from this study also indicated that the microbial population of abattoir facilities was greater than values recommended for sanitary practices of such products and its processing facilities. The high microbial content of the wastewater is also an indication that the water used during the processing of beef in abattoir is not sterile or fit for consumption (Denpster and Cody, 2001). The bacteria populations isolated from this study were identified as *Enterococcus faecalis, Citrobacter* sp, *Klebsiella* sp, *Enterobacter* sp, *Alicaligenes paradoxus, Escherichia coli* and *Staphylococcus aureus* by comparing their morphological and biochemical characteristics with standard reference organisms (Cheesbrough, 2003). Their frequency of occurrence in the different samples across the sampling points is presented in Table 2. The presence of these organisms in abattoir facilities could be attributed to the fact that meat contains an abundance of nutrient required for the growth of microorganism (Magnus, 1981). The high total viable counts recorded in this study showed the microbial diversity in the different Abattoirs and the hygienic practice employed by meats sellers and butchers. This determined the variation of bacterial contamination. On comparing the bacteria contamination between the abattoirs, the results obtained is on the high side. This is an indication of recontamination in food handling and hygiene techniques (Clarence *et al.*, 2009). A total of 8 isolate comprising of Gram negative and Gram positive bacteria were isolated in this study. This showed that both Government and Privates abattoirs contributed equally to the microbial diversity reported in this study. Microorganisms isolated from abattoir facilities in this study have been earlier found in foods, environments and other places, as reported by Enabulele and Uraih (2009).

Nkanga and Uraih (1981) in a study reported high prevalence rate of *E. coli* in raw meat samples from abattoir and traditional open markets, with a

prevalence rate of 85.65%. The presence of these organisms in abattoir facilities depicts a deplorable state of poor hygienic and sanitary practices employed in the slaughtering, processing and packaging of fresh meats. This agrees to previous reports by Okonko *et al.* (2008). Most of the organisms found in this study are those commonly found in soil and water. The presence of *Escherichia coli* and *Enterobacter* sp is an indication of faecal contamination of the meat. This might be due to possible contamination of fresh meats or meat products itself during slaughtering or beef processing or unhygienic handling of the meat right from the slaughtering, butchering plants or due to contamination from the skin, mouth, nose of the handlers which can be introduced directly into foods by process line workers, with lesions caused by *S. aureus* on hands and arms coming into contact with the food, or by coughing and sneezing (Sobukola *et al.,* 2009 ; Okonko *et al.,* 2008). In addition, the isolation of *Enterobacter* sp. may be as a result of poor environmental conditions due to dust and contamination of the water used during slaughtering, because *Enterobacter* sp. are also inhabitants of dairy products, as reported by Talaro, (2006).

Fresh meats sold to the public in open markets are grossly contaminated with coliform bacteria as well as other bacteria forms. The finding of this study revealed that all the Abattoirs in Benin City, Edo state are contaminated with pathogenic Gram positive and negative bacteria. The possible source of contaminants, are due to the unhygienic manner of handling meat in abattoirs, the environment upon which the meat is slaughtered as well the water used in the processing of the meat. This also implies that these meats are viable source of various diseases. Some of these diseases could spread and acquire epidemic status which poses serious health hazards. Since improper handling and improper hygiene might lead to the contamination of fresh meats and this might eventually affects the health of the consumers (Okonko *et al.,* 2008). Hence, it is therefore suggested that fresh meat processors and patrons of abattoirs should be educated on the adverse effect of contaminations and sanitary practices. The presence of indicator organisms as well as possible pathogens in this study is of special concern and stakeholders should be encouraged to review the processes involved in the establishment as well as operation of abattoir in southern Nigeria. This may explain why most of the abattoirs are located in isolated environment so as to avoid been checked.

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