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Evaluation of Microbial Load in Abattoirs and Retail Meat Outlets in Osun State, Nigeria

By

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Abstract

The study was carried out to evaluate the microbial load in abattoirs and retail meat outlets in Osun State. The microbial analysis were carried out on swabs of clothes, tables, knives and samples of meat and water were collected in six Abattoirs and retail meat outlets in six towns and cities to evaluate the microbial loads which include Total Viable Count (TVCs), Total Faecal Count (TFCs), and Total Coliform Counts (TCCs). The result of microbial analyses revealed that TVCs was highest (269.00 log_{10} CFU/cm/g/ml) in Ede and lowest (153.00 log_{10} CFU/cm/g/ml) in Ile Ife. TFCs was highest (45.00 log10 CFU/cm/g/ml) in Osogbo and lowest (1.10 log10 CFU/cm/g/ml) in Iwo.TCCs was highest (680.00 log10 CFU/cm/g/ml) in Ila Orangun and lowest (108.00 log10 CFU/cm/g/ml) in Ilesa. In conclusion, the result obtained from the study shows that there was higher microbial load in abattoirs and retail meat outlets. This is as a result of animals being processed in unsanitary environment, low level of hygiene and sanitation conditions of tools and material used for processing. The higher microbial log means values TVCs, TCCs, and TFCs from swabs and samples analysed are indication of meat contamination and making it a potential source of food spoilage and food borne infections. From the study, it can be deduced that contamination was present right from Abattoirs and retail meat outlets before it's get into the hands of consumers.

Keywords: *Microbial load, Abattoirs, Retail meat outlets, Total Viable Count (TVCs), Total Faecal Count (TFCs), Total Coliform Counts (TCCs).*

INTRODUCTION

Total viable count (TVCs), total coliform count (TCCs), and total fecal coliform count (TFCs) of mesophilic bacteria are examples of indicator organisms present in meat and meat products that may be used to determine the safety of raw meat and its products (Moore and Griffith, 2002). The coliform group of bacteria, which is extensively found in nature and includes several genera of bacteria within the enterobacteria family, is one example of the microorganisms that TVC offer a qualitative knowledge (Moore and Griffith, 2002).

We have the following hygienic and sanitary indicators based on the bacteriological test of meat and its products: *Salmonella, Bacillus aureus, Clostridium perfringens,* anaerobe twins, coliform, *Enterococcus*, and *Staphylococcus* bacteria that positively coagulate (Gebrie *et al.*, 2015).

Escherichia, Enterobacter, and *Klebsiella* are coliform bacteria that are essential to food microbiology. Coliform bacteria are significant microbiological hygienic indicators that emphasize the value of cleanliness in product handling and processing. In certain cases, it highlights the various heat treatments (pasteurization type) used to meat and its derivatives. *Escherichia coli, Enterobacter*, and *Klebsiella* are the main product bacteria that are essential to food microbiology, according to extensive study that was spurred by the widespread food poisoning epidemic (Hunter *et al.*, 2002).

The atmosphere of the slaughterhouse and retail beef stores has a significant impact on meat contamination. Since it impacts the quality of meat, site selection and the availability of high-quality portable water are crucial considerations when choosing locations for retail establishments or abattoirs (Fesanmi *et al.*, 2010). According to Fesanmi *et al.* (2010), contaminated water, unsanitary handling techniques, the use of contaminated tables to display meat meant for sale, and the use of contaminated knives and other cutting tools are the main

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causes of meat contamination in abattoirs and retail meat outlets. The length of time animals are held at the abattoir before slaughter can affect the pathogen load by increasing the probability of exposure and infection. Sanitation of walk ways, pen floor, failings, feed and water affect the pathogen load (Galland, 2007).

Dirty soil, body discharge and excreta from animals in holding pens or lairage primary sources of contamination of carcasses in the later stages of the operation. This happens irrespective of whether or not the animals are fits and have passed ante mortem inspection. (Jeffery *et al.*, 2003) Adzitey *et al.*, (2011) reported the possible source of contamination arising from the cutting knives, intestinal contents, chopping boards, hides, meat handlers, containers, vehicles for transporting carcasses and the meat selling environment. It has been reported by Ali *et al.*, (2010) that knives, wooden boards and weighing scales from retail shops are sources of bacterial contamination particularly *Staphyloccus aureus* and *Shigella* species.

Akinro *et al.*, (2009) reported that inadequate slaughtering and disposal facilities, the abattoir become sources of infection and pollution, attracting domestic and wild carnivores, rodents and flies, which are vector of disease. Refrigerator or freezers are essential storage facilities used to prevent spoilage of meat following prolonged storage at room temperature and hence keep meat safe for long period of time.

MATERIALS AND METHODS

Study Area

Osun State was carved out of Oyo State on 27th of August, 1991 with Osogbo as the State Capital. The State shares boundaries with Kwara State in the North, Ogun State in the South, Oyo State in the West and Ondo State in the East. The State has a land mass of about 9.251km². It is currently made up of 30 Local Government Areas (LGAs) spread across six main zones namely Osogbo, Ede, Iwo, Ikirun, Ilesa and Ile-Ife. These zones were further divided into 3 Agricultural zones by Osun State Agricultural Development Project (OSSADEP) which are Osogbo, Iwo and Ife/Ijesa. The State is situated in the Western part of Nigeria and lies on latitude 8º to the North and longitude 6º to the South. Then it is marked by longitude 4º to the West and longitude 5º to the East. It exhibits the typical climate prominent wet and dry seasons with fertile soil which encourages the production of crops and livestock. The rainy season generally occurs between April and October while the dry season occurs between November and March. Osun State has tropical humid climate (www.osungov.ng).

Collection of swabs of equipment/tools and samples of water and meat and Biochemical analysis for microbial identification and load and determination of Total Faecal Counts (TFCs), Total Viable Counts (TVCs) and Total Coliform Counts (TCCs)

Swabs and samples collection techniques

The surface swabs from abattoirs and retail meat outlets handling equipment/ tools were collected using sterile moistened cotton wool swabs by rubbing firmly over the predetermined surface area using parallel stroke lines with slow rotation with respectively chosen template surface area to be swabbed In the abattoir and retail meat shops, the moistened sterile cotton swab surface area of weighing pans, butcher knives, chopping tables and meat wood cutting block whereas in abattoir the moistened sterile cotton wool swabs were used to swab knives and clothes The swabs were immediately transferred to the respective capped sterile tubes containing 10 ml normal saline and labeled. The swabs were agitated up and down in the tubes to aid on rinsing the bacteria from the surface of the swabs. Samples were packed in cool box and transported immediately the same day to laboratory for microbial analysis.

i. Meat samples

Raw meat samples were collected directly from different regions of the animal. About 500 grams of meat samples were collected in abattoir such as flank and neck region and in retail meat outlets hanged piece of meat. All the samples were packed in cool box and then transported to laboratory for microbial analysis.

ii. Water samples

Tap and well water were collected. Water samples was collected directed with sterile bottles, labeled, placed in ice boxes with peptone water and transported to laboratory for further microbial analysis study.

Laboratory Media Preparation Nutrient Agar

The nutrient agar base contained 5.0g/l of gelatin peptone, 3.0g/l of beef extract and 15.0 g/l of bacteriological agar. The media was prepared by dissolving 23 grams of medium in 1 litre of distilled water. The mixture was agitated and boiled for two minutes until completely dissolved, then sterilized in the autoclave at 121°C for 15 minutes, cooled at 45°C and poured into sterile petri dishes ready for inoculation.

i. MacConkey Agar

The MacConkey agar was prepared by dissolving 52 grams of the medium in one litre of distilled water. The mixture was agitated and boiled for two minutes until completely dissolved and sterilized in the autoclave at 121°C for 15 minutes. Cooled at 45°C and poured into sterile petri dishes ready for inoculation.

ii. Normal saline preparation

In order to make a Phosphate buffered saline. 8.5 gram of sodium chloride was through mixed with distilled water. Several test tubes were filled with normal saline solution and sterile autoclave at 121°C for 15 minutes.

Sample preparation and inoculation of surface swabs

In the laboratory each test tube and universal bottle with surface swabs and water samples were opened aseptically by flaming of the mouth part of test tubes and universal bottle. The samples were taken using sterile pipette and further diluted serially (10 folds dilution) into 10 test tubes. The diluents were mixed well and then one milliliter of diluted sample were poured into various sterile Petri dishes and covered with 20 millitres of sterile nutrient agar or

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MacConkey agar. Each plate was swirled gently taking care not to spill its contents and allowed to set. All samples inoculated with nutrient agar was incubated at 37°C and 44°C for 24 hours for TCC and for TFC counts respectively (Bhandare *et al.*, 2015).

i. Meat samples

Meat sample weighing one gram was ground to fine particles using mortar and pestles and mixed with the normal saline solution to make 10 millitres and diluted serially into several test tubes using sterile pipette and poured into sterile petri dishes. Then 20 millilitres of sterile nutrients agar or MacConkey agar was poured into each sterile petri dish, distributed and mixed evenly throughout the petri dishes with molten inoculated media were allowed to solidify. All samples inoculated in nutrient agar were incubated at 37°C for 24 hours in order to TVC while inoculated in MacConkey agar were incubated at 37°C and 44°C for 24 hours for TCC and TFC counts respectively (Bhandare et al., 2015).

ii. Water samples

A serial dilution of water sample was poured into several test tubes. One millitres of inoculums was taken from the test tube using a pipette and poured in sterile petri dish. Then 20 ml of sterile nutrient agar or MacConkey agar was added into sterile petri dish, distributed and mixed evenly throughout the petri dish and allowed to solidify. All samples inoculated in nutrients agar were incubated at 37°C for 24 hours in order to get TVC while sanples inoculated in MacConkey agar were incubated at 37°Cand 44°C for 24 hours for TCC and TFC counts respectively (Bhandare *et al.*, 2015)

Interpretation of microbial growth

Petri dishes containing 30 - 300 colonies on nutrients agar plate were selected and colonies that appeared pinkish on MacConkey plate were considered to be Coliforms. These were counted using colony counter, enumerated and expressed in $\log_{10}$CFU/g/ml of meat and water samples respectively

Biochemical analysis for microbial identification and load and determination of Total Faecal Counts (TFCs), Total Viable Counts (TVCs) and Total Coliform Counts (TCCs)

Nutrient and MacConkey agar were used to identify the microbes present and to determine TFCs, TVCs and TCCs in the surface swab and samples collected from butcher knives, clothes, meat chopping and evisceration tables, meat and water. The number of microbial colonies that grew on each agar plate was counted by colony counter and multiplied by the "dilute factor" to get the estimated number of bacteria in the original sample. The solution was placed on a constant temperature magnetic stirrer for 20 minutes for proper mixing to form a solution. The solution was later placed on a stainless-steel steam pressure disinfecting sterilizer for about 15minutes at 121 degrees Celsius.

Ethanol was used to disinfect the table to be used and other materials. 9m/s of distilled water was put into a test-tube and 1gramm of the sample was put in the water and shake thoroughly, a micro-pipette was used to mix the sample with distilled water in the test tube and the dilution was at -3 and -5 were used for the microbial count, nutrient agar of 1000ml was added to the samples in a petri dish, it was covered and mixed the samples. This is being carried out by the procedure of Sanchez, (2002), microbial profile and antibiotic susceptibility of *Camplobacter spp* and *Salmonella spp.*

i. Total Viable Counts (TVCs)

Total viable count is a test that estimates the total numbers of microorganism, such as bacteria, yeast or mould species that are present in water and meat samples. TVCs may also be expressed as aerobic colony count. Total viable count (TVCs), gives a quantitative estimate of the concentration of microorganism such as bacteria, yeast or mould spores in a sample. The count represents the number of colonies forming units (CFU) per g or per ml of the sample. TVCs is commonly used to assess the microbial load or contamination level in food, water, air and other samples

ii. Total Coliform Counts (TCCs)

The TCCs is the enumeration of all coliform bacteria present in a given sample, usually water or food. Coliform bacteria are a collection of relatively harmless microorganism that live in large numbers in the intestines of humans and animals and are found in soil, plants and surface water. TCCs is a key microbiological parameter used to assess the microbial quality and safety of water and food TCCs is a crucial metric for assessing the microbial quality of water and food. Its measurement helps ensure that water and food supplies are safe for consumption and free from harmful pathogens. Regular monitoring and adherence to regulatory standards are essential to protect public health.

iii. Total Faecal Coliform Counts (TFCs)

Total Faecal Coliform Counts (TFCs) is a microbiological parameter used to measure the concentration of faecal coliform bacteria in a given sample. These bacteria are subset of total coliform and are more specifically associated with faecal contamination. The presence of faecal coliforms in water indicates possible contamination by pathogens that can pose a risk to human health. TFC is a critical measure for assessing the faecal contamination of water and other samples. By monitoring TFCs, health authorities and environmental agencies can identify potential health risks, ensure the safety of drinking and recreational waters, and take appropriate measures to protect public health.

Statistical Data Analysis

The quantitative analysis was carried out using the analysis of Variance (ANOVA). Duncan's New multiple Range Test was used to compare the means. The experimental design for this study is Complete Randomized Design (CRD).

RESULTS

Total viable counts (TVCs) of the samples of beef contact surfaces from selected abattoirs and retail markets in Osun State (x 10^4 CFU/cm/g/ml).

The TVCs found on the beef contact surfaces is presented in Table 1. The highest TVCs was found at Ede abattoir and retail meat outlets with the total number of (2.69×

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10^4CFU/cm//g/ml) while Ile -Ife has the lowest TVCs (1.53 × 10^4 CFUcm//g/ml).

Table 1: Total viable counts (TVCs) of the samples of beef contact surfaces from selected abattoirs and meat retail outlets in Osun State (x10^4 CFU/cm/g/ml).

Location	TVCs (mean $\log_{10}$)	SEM
Osogbo	220.00^{ab}	0.27
Ilesa	230.00^{ab}	0.26
Iwo	267.00^{a}	0.20
Ila – Orangun	195.00^{bc}	0.22
Ile Ife	153.00^{c}	0.20
Ede	269.00^{a}	0.23

[abc] Means with different superscript along the column are significantly different at (P < 0.05)
SEM= Standard Error Mean

In the Table 2, the highest TVCs in abattoir and retail meat outlets in Osogbo were on the meat with 300.00 $\log_{10}$ CFU/g and lowest on water with 110.00 $\log_{10}$ CFU/ml.

The highest TVCs in abattoir and retail meat outlets in Ilesa were on meat with 268.00 $\log_{10}$ CFU/g while the lowest TCC were found on water with 168.00 $\log_{10}$ CFU/ml

The highest TVCs in Iwo abattoir and retail meat outlets were on water with 291.00 $_{10}$ CFU/ml and lowest on cloth with 227.00 $\log_{10}$ CFU/cm^2.

The highest TVCs in Ila-Orangun abattoir and retail meat outlets were found on water with 217.00$_{10}$ CFU/ml while the lowest TCCs were found in meat with 159.00 $\log_{10}$ CFU/g respectively.

The highest TVCs in Ile Ife were found in the knife and the lowest in cloth with 193.00 $\log_{10}$ CFU/cm^2 and 126.00 $\log_{10}$ CFU/cm^2 respectively.

The highest TVCs in Ede were found in the water with the lowest in knife with 340.00 $\log_{10}$ CFU/ml and 191.00 $\log_{10}$ CFU/cm^2 respectively.

Table 2: Mean value for TVCs (mean CFU/cm^2/ml/g) of the samples from selected abattoir and retail meat outlets in Osogbo, Ilesa, Iwo, Ila- Orangun, Ile- Ife and Ede

Locations	Knife (CFU/cm^2)	Table (CFU/cm^2)	Cloth (CFU/cm^2)	Water (CFU/ml)	Meat (CFU/g)	SEM
Osogbo	285.00^{b}	204.00^{c}	207.00^{c}	110.00^{d}	300.00^{a}	60.84
Ilesa	249.00^{ab}	225.00^{b}	242.00^{b}	168.00^{c}	268.00^{a}	56.81
Iwo	254.00^{ab}	276.00^{b}	227.00^{c}	291.00^{a}	290.00^{a}	46.97
Ila Orangun	193.00^{b}	200.00^{ab}	216.00^{a}	217.00^{a}	159.00^{c}	49.97
Ile Ife	193.00^{b}	130.00^{c}	126.00^{c}	139.00^{c}	179.00^{b}	40.68
Ede	191.00^{d}	220.00^{c}	331.00^{a}	340.00^{a}	267.00^{b}	52.25

[abc] Means with different superscript along the same row are significantly different at (P<0.05)
SEM= Standard Error Mean

Total Coliform Counts (TCCs) of the samples of meat contact surfaces from selected abattoirs and retail markets in Osun State (x 10^4 CFU/g)

The total number of TCCs found on the surfaces of meat samples was presented in Table 3. The highest TCCs was found at Ila - Orangun abattoir and retail meat outlets with the TCCs of (6.80× 10^4CFU/g) while Ilesa has the lowest TCCs (1.08 × 10^4 CFU/g).

Table 3: Total Coliform Counts (TCCs) of the samples of beef contact surfaces from selected abattoirs and meat retail outlets in Osun State (× 10^4 CFU/cm/g/ml.).

Locations	TCCs (mean log_{10})	SEM
Osogbo	530.00 ^{c}	13.00
Ilesa	108.00 ^{e}	12.04
Iwo	430.00 ^{d}	9.07
Ila –Orangun	680.00 ^{a}	10.07
Ile Ife	610.00 ^{b}	9.04
Ede	450.00 ^{cd}	10.90

[abc] Means with different superscript along the same column are significantly different at (P < 0.05)
SEM= Standard Error Mean

In table 4, the highest TCCs in Osogbo abattoir and retail meat outlets were on tables and the lowest on cloth with 201.00 $\log_{10}$ CFU/cm^2 and 4.00$\log_{10}$ CFU/cm^2 respectively.

The highest TCCs in Ilesa abattoir and retail meat outlets were on table on thelowest on cloth with190.00 $\log_{10}$CFU/cm^2 and 2.00$\log_{10}$ CFU/cm^2 respectively.

The highest TCCs in Iwo abattoir and retail meat outlets were on knives and the lowest on cloth with 5.00 $\log_{10}$ CFU/cm^2 and 0.04 $\log_{10}$ CFU/cm^2 respectively.

The highest TCCs in Ila -Orangun abattoir and retail meat outlets were on table and the lowest on meat and knives with

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18.00log$_{10}$ CFU/cm^2 and 3.00log $_{10}$ CFU/g/cm^2 respectively.

The highest TCCs in Ile Ife abattoir and retail meat outlets were on table and the lowest on water with 18.00 log$_{10}$ CFU/cm^2 and 2.00 log$_{10}$ CFU/ml respectively.

The highest TCCs in Ede abattoir and retail meat outlets were on meat and the lowest on clothes with 8.00 log$_{10}$ CFU/g and 2.00 log$_{10}$ CFU/cm^2 respectively.

Table 4: Mean value for TCC (means CFU/cm^2/g/ ml) of the sample from selected abattoir and retail meat outlets in Osogbo, Ilesa, Iwo, Ila-Orangun, Ile Ife and Ede.

Locations	Knives	Tables	Cloth	Water	Meat	SEM
Osogbo	6.00^b	201.00^a	4.00^b	9.00^b	5.00^b	2.62
Ilesa	4.00^b	190.00^a	2.00^b	3.00^b	5.00^b	2.66
Iwo	5.00^b	2.48^a	0.04^c	0.05^c	0.05^c	2.14
Ila orangun	3.00^b	18.00^a	4.00^b	4.00^b	3.00^b	2.34
Ile Ife	1.00^c	18.00^a	4.00^b	2.00^b	3.00^b	2.06
Ede	3.00^c	7.00^b	2.00^c	7.07^b	8.00^b	2.40

^{abc} Means with different superscript along the same row significantly different at (P < 0.05)
SEM= Standard Error Mean

^{abc} Means with different superscript along the same column are significantly different at (P <0.05)
SEM= Standard Error Mean

Total Faecal Counts (TFCs)

The TFCs found on the contact surfaces of meat samples is presented in Table 5. The highest number of TFCs was found at Osogbo abattoir and retail meat outlets with the total number of (4.50× 10^4CFUcm/g/ml) while Iwo had the lowest TFC (1.10 × 10^4 CFUcm//g/ml).

Table 5: Total Faecal Counts (TFCs) of the samples of beef contact surfaces from selected abattoirs and meat retail outlets in Osun State (x 10^4 CFU/cm/g/ml).

Locations	TFCs (mean log_{10})	SEM
Osogbo	4.50^a	1.50
Ilesa	1.20^c	1.40
Iwo	1.10^c	1.00
Ila-Orangun	1.60^c	1.20
Ile Ife	3.40^b	1.10
Ede	3.20^b	1.20

In the table 6, the highest TFCs in Osogbo were on meat and lowest on water with 300.00 log$_{10}$ CFU/g and 110.00 log$_{10}$ CFU/ml respectively

The highest TFCs in Ilesa abattoir and retail meat outlets were on meat and lowest on water with 298.00 log$_{10}$ CFU/g and 168.00 log$_{10}$ CFU/ml respectively

The highest TFCs in Iwo abattoir and retail meat outlets were on water and lowest on cloth with 291.00 log$_{10}$ CFU/ml and 227.00 log$_{10}$ CFU/cm^2 respectively

the highest TFCs in Ila-Orangun abattoir and retail meat outlets were on meat and lowest on water with 217.00 log$_{10}$ CFU/ml and 159.00 log$_{10}$ CFU/g respectively

The highest TFCs in Ile Ife were on Knives and lowest on Cloth with 193.00 log$_{10}$ CFU/cm^2 and 110.00 log$_{10}$ CFU/Cm^2 respectively

The highest TFCs in Ede were found on water and lowest on table with 340.00 log$_{10}$ CFU/ml and 220.00 log$_{10}$ CFU/cm^2 respectively.

Table 6: Mean value for TFC (mean CFU/cm^2/g/ml) of the sample from selected abattoir and retail meat outlets in Osogbo, Ilesa, Iwo, Ila Orangun, Ile Ife and Ede

Locations	Knife	Table	Cloth	Water	Meat	SEM
Osogbo	285.00^b	204.00^c	207.00^c	110.00^d	300.00^a	3.18
Ilesa	249.00^b	225.00^c	242.00^c	168.00^d	268.00^a	2.98
Iwo	254.00^c	276.00^b	227.00^d	291.00^a	290.00^a	2.44
Ila Orangun	193.00^a	200.00^a	216.00^c	217.00^c	159.00^b	2.62
Ile Ife	193.00^a	130.00^d	126.00^d	139.00^c	179.00^b	2.64
Ede	191.00^d	220.00^c	331.00^a	340.00^a	267.00^b	2.15

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[abc] Means with different superscript along the same row are significantly different at ($P < 0.05$)
SEM= Standard Error Mean

DISCUSSION

Total Viable Counts (TVCs)

In this present study, the highest TVCs mean log values in abattoir and retail meat outlets in Osun State were found in Ede water, workers clothes and evisceration tables. The highest mean log was found in water, followed by clothes and lastly on tables. The lowest log means value in Ede was found on Knives. Differences in bacterial counts in water, clothes worn during operation and processing and tables could be due to the sources of water, the hygienic condition of the workers clothes and the evisceration tables, if good processing practices and good handling practices of meat are not consistent. This report is in support of the work of Bhandare et *al.,* (2009) which found that higher level of TVCs was observed on abattoir floor, transporting van floor, wall and knives.

Levels of TVCs were lowest in Ila- Orangun meat, Ile -Ife and Osogbo clothes. Adeyemo *et al.,* (2002) found that the TVCs of 4.3 log_{10}CFU/ml in water used at the main abattoir in Ibadan was lower than what was found in the present study. The range of the results for TVCs in fresh meat samples in abattoir was similar to Nervy *et al.,* (2011) who reported contamination at the range of 4.93 - 8.1 log_{10}CFU/g. Tarwate *et al.,* (2003) reported lower means values for TVCs compared to what was reported in the present study on knives, walls and water.

In Iwo abattoir and retail meat outlets, the higher log mean values of TVCs were observed on water samples and lowest mean values were observed on cloth. This is due to lack of good handling practice and sanitary standard operating procedures. The values obtained on tables, knives and clothes were lower. This result is in support of Ahmad *et al.,* (2013) who reported that swab samples from tables, knives showed higher count of food contaminants microorganisms. There was a marked growth of TVC in meat samples collected from Ede abattoir and beef retail outlets with the highest values of isolation in the abattoir suggesting that there were unusual amount of contamination and growth of natural flora. This is due to poor hygienic practices of handling meat and poor environmental working condition. According to Hailesselassie *et al.,* (2012), poorly organized farm, poor production chains and poor standard operational procedures practiced by the abattoir personnel were some risk factors which contributed to the high microbial load.

The values obtained in the current study were lower compared to what was reported by Haileselassie *et al.,* (2012) in which the mean values of microbial load of abattoir meat and butcher shop were 5.04 and 5.75 log_{10}CFU/g respectively. In general, the result obtained from meat samples, floor, evisceration table and water in abattoir and also those obtained in beef retail outlets from meat samples, knives, and wood cutting block are higher exceeding the recommended set standard of less than 6.00 logs per $g/^2$by the ICMSF (2017). According to FAO (2007), total viable count exceeding 100.00/g (10^5 per ^{2} or 5.0 log_{10}) on fresh meat are not acceptable and had alarm signals on meat hygiene along the slaughtering and meat handling chains. The presences of TVC in abattoir and retail meat outlets were attributed to unhygienic slaughtering practices and handling of meat.

Total Coliform Counts (TCCs)

The highest mean values of TCCs were observed on knife, table and water samples from Osogbo and Ilesa and the TCCs lowest log mean values were on samples collected at Iwo. It was observed that tables and in water had higher values of TCCs compared to other samples. The variations of TCCs observed in different reported studies were due to lack of good processing practices, good handling practices and sanitary standard operating procedures of meat along the beef production chain. Absence or lower level of microbial in the water in the abattoir suggested that water was clean. During this study, there was low growth of TCCs in samples of water and meat from Iwo, Ede, Ila-Orangun and Ile Ife. In general, the result obtained from meat samples from the study are high exceeding the recommended set standard of coliform bacteria counts of less than $3.0log_{10}$ CFU/g by FAO (2007) which is not acceptable and hygiene level along the production chain must be improved.

Total Coliform Counts (TFCs)

The presence of coliform is an indicator of poor sanitary condition in the abattoir and retail meat outlets since these microorganisms originate from faecal microbiota. The result revealed the highest log mean values for TFCs was found at Ile Ife followed by Ede, Ila Orangun, Ilesa, Osogbo and the lowest was Iwo. The study revealed higher TVCs mean values on Ile Ife knives and Ede meats. This to be compared to what was reported by Bhandare *et al.,* (2009) with corresponding mean values at log_{10} of 4.68 ± 0.38, 4.00 ± 0.30, 3.80 ± 0.15 and 3.72 ± 0.43 log_{10} CFU/^{2} respectively

In the abattoir and retail meat outlets in Osun State, the highest mean value of TFCs was observed on knives, followed by tables, clothes, water and meat samples. The result from this study revealed that the knives and tables were having higher mean values of TFCs compared to results obtained by Bhandare *et al.,* (2009). Also, the results obtained was supported by Fakolade*et.al.,* (2017) that the usual practice observed when visiting abattoirs was that the butchers took off their cloth and put on the usual daily operating cloth that is stained with dirt, dark bloods which may have microbes from previous use during slaughtering. It was observed that the level of bacterial load could be due to lack of sterilization points, continuous use of single knife despite contacts with dirty or contaminated surfaces and use of unclean cloth.

The variations of microbial load in different reported studies were due to lack of good animal husbandry and handling practices, standard operating procedure of meat along beef

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production chain. The high value of bacteria loads on knives for cutting meats in abattoir and retail meat outlet may be contributed by the fact that knives are neither washed nor sterilized. Blood deposit on it also serves as an ideal medium for growth and multiplication of microorganisms. According to FAO (2007), coliform bacteria count exceeding 1000/g (5.0 log_{10}) on fresh meat are not acceptable.

The result from this study showed that there was higher TFCs in samples exceeding the recommended set standard by FAO (2007) and hence meat hygiene along the beef production chain should be improved. This indicates that the presence of TFCs in abattoirs were due to hygienic practices as results of contamination in abattoir and retail meat outlets.

CONCLUSION

The results obtained from this study shows that there was microbial load in abattoir and retail meat outlets in Osun state. This may be due to inadequate infrastructural facilities and equipment and because the carcasses were processed on the unsanitary environments. The low level of hygiene and poor sanitation could also be responsible for the high TVCs on the meat. Also contaminations arise from equipment and tools used in the abattoirs, the higher microbial log mean values (Total viable count (TVCs), Total Coliform counts (TCCs) and Total Faecal counts (TFCs) from the samples analyzed are an indication of poor meat quality and making it a potential source of food borne infections and food spoilage.

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