



Assessment of Hygienic Practice on Camel Meat Handlers, and Identification of Bacterial Contamination in Abattoir and Butcheries of Nagelle Town, Southern Oromia, Ethiopia.

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Abstract

A cross-sectional study was conducted to assess the hygienic practice during handling of raw camel meat and identification of the major source of bacterial contamination at abattoirs and butcheries of Nagelle town. To achieve the objectives of this study, the data were collected from 68 camel meat sample and 60 from swab samples both from abattoir and butchers workers and semi-structured interview questionnaire, and site observation checklist were used. Descriptive statistics were used for data analysis. The study isolated and identified that all the tested positive camel meat samples were subjected to *E. coli* count, *Staphylococcus aureus* count and aerobic plate count (APC). The *S. aureus*, *E. coli* and *Salmonella* spp were detected from the total of collected raw camel meat sample 12 (35.3%), 16 (47%) and 8 (23.5%) at abattoirs and 19 (55.9%), 22 (64.7%) and 10 (29.4%) from at butcheries respectively. Mean *S. aureus* counts for camel meat were 2.76 and 3.07 log₁₀ CFU/g while mean *E. coli* counts were 2.81 and 3.94 log₁₀ CFU/g, from abattoirs and butcheries respectively. There were no significant differences ($p > 0.05$) between the *E. coli* at abattoirs and butcheries and *S. aureus* count at abattoirs and butcheries, respectively. Mean aerobic plate counts of camel meat from abattoirs (4.67 log₁₀ CFU/g) were not significantly different as compared to APC values of butcheries (5.49 log₁₀ CFU/g). The isolated bacteria were in decreasing order *E. coli*, *S. aureus* and *Salmonella* spp were detected from swab sample such as person hand, environment, cutting board and knife at abattoirs and butcheries respectively. Thus the present study reveals the fact that raw camel meat is heavily contaminated with the high incidence of bacterial pathogen and the major source of bacterial contamination were in decreasing order person hand, environment, cutting board and knife respectively. It is concluded that the major source of bacterial contamination of raw camel meat at butcheries house than abattoirs in Nagelle town. Therefore there is an urgent necessity to minimize the contamination of camel meat handling at abattoirs and sold at butcheries house by implying proper general hygienic and equipment sanitation practices.

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1. Introduction

Based on the estimates of, there is 25.4 million camel's population in the world [1]. The majority of the camel's in the world are one-humped Arabian or dromedary

camels (*Camelus dromedaries*) with about 85% of them in Africa. Sudan, Somalia, Ethiopia, and Kenya accounts for about 60% of the global Camel population and the top ten countries with the highest camel's population are Somalia, Sudan, Ethiopia, Niger, Mauritania, Chad, Mali, Kenya, Pakistan and India [1]. Currently, camel's population in Ethiopia is estimated to be 4.5 million and the one-humped camel dromedaries (*Camelus dromedarius*) are found in the pastoral and agro pastoral areas [2].

Camels slaughtered worldwide in 2009 produced around 373,565,000 tons of meat; most of them were produced in Somalia, Sudan, Saudi Arabia and Egypt [3]. Camel meat is a good source of food to meet the growing needs for meat in developing countries, especially for pastoral and agro pastoral community groups. However, unlike other food animals, consumption of camel meat is not that common in Ethiopia [3].

Although muscles of healthy animals do not contain microorganisms, meat tissues get contamination during the various stages of slaughter and transportation to the butchery. Camel Meat is an excellent source of protein in human diet and is highly susceptible to microbial contamination due to its nutritious characteristics. Contamination of camel meat can occur in multiple steps along the meat production chain including production, processing, distribution, retail marketing and handling or preparation [4].

The microbiological quality of meat and meat products is strongly influenced by the conditions of hygiene and sanitation practice prevailing during their production and handling. Without proper hygiene control, the environment in slaughterhouses and butcher shops can act as an important source of microbiological [5].

Unhygienic meat handling practices in abattoirs and post-process handling at the butchery level are associated with potential health risk to consumers due to presence of pathogens in meat and contaminated equipment and utensils. Equipment used in the slaughtering and dressing operations (knives, saws and hooks) make significant contributions to the overall contamination through direct contact with hides and hair as well as by contact with steels, knife, hands and clothing of abattoir operators [6].

During selling in butchery shop, further contamination can occur through contact with handling contaminated equipment and utensils (tables, logs, hooks, meat chopping board, weighing balances and knives), insects, contaminated air and butchery operators. Generally, failure to observe good sanitation and personnel hygiene practices such as washing of hands, use of potable water, wearing of protective clothing, cleaning and sanitization of butchery equipment and utensils, transportation of meat in clean containers and

storage of meat at appropriately low temperatures can lead to microbial contamination [6].

In developing countries, unhygienic handling and sanitation practice of camel meat at abattoir and butcheries operation can compromise food safety and hygienic practices in pastoral area. Meat products from such condition often pose a health hazards like food borne illness results in diarrheal disease which can have serious effect on children, pregnant women, elders, and Immune compromised (HIV) patient [7].

The Standards and Trade Development Facility, World Trade organization on Specific Sanitary and Phytosanitary market access constraints in East African Community countries states that the high perishability and post-harvest losses of meat are due to unhygienic meat handling practices and facilities [8].

Bacterial contamination during handling of raw meat at abattoir and butcheries also constitutes a major problem in most developing countries due to lack of different technological application used for hygienic processing of meat, lack of trained man power and economically poor. Especially, in Ethiopia, the Abattoirs and butcheries are potential sources of bacterial contamination which includes meat borne pathogens such as *Staphylococcus Aureus*, *Escherichia coli*, and *Salmonella spp.* reported have significant effect on the meat shelf life, public health and economical lose [9].

Staphylococcus aureus is the most important species among the Coagulase Positive Staphylococcus. *Staphylococcus aureus* present everywhere, in the air, dust, in surfaces, as well as in humans and animals. Due to human, animal and environmental contamination, many of them are present in food. It will occur naturally in raw meat and poultry as a frequent component of the skin microflora. The presence of small numbers of *S. aureus* on foods is common [10].

Contamination by food handlers is also probably a frequent occurrence in view of the high rate of human carriage. Since large numbers, typically $> 10^6$ CFU/g colonies are required for the production of enough toxins to cause illness; contamination is necessary but is not alone sufficient for an outbreak to occur. In particular, the responsible factor like temperature and time conditions must also be provided that allows the organism to grow.

The highest incidence of disease usually occurs in people with poor personal hygiene, overcrowding and in children. Food poisoning by *S. aureus* is characterized by a short incubation period; typically 2-4 h. Consumption of food with preformed toxin usually leads to rapid (6-12 hours) onset predominant upper gastrointestinal symptoms. The symptoms can be very acute, depending on individual susceptibility

to the toxin, the amount of contaminated food eaten, the amount of toxin in the food ingested and the general health of the victim. The most common symptoms are prostration, nausea, vomiting and abdominal cramping [10].

Escherichia coli are responsible for food-borne gastroenteritis in humans. The bacteria are gram negative, rod shaped, non-spore forming, motile (use peritrichous flagella) or non-motile. They grow on MacConkey agar (colonies are 2-3 mm in diameter and red or colorless) [11].

Camel and their environment are important sources of *E. coli*. Contamination of meat and meat products occurs during operations at abattoir and butchers facilities. USA identified six main transmission routes of *E. coli*. These, in a decreasing order of importance, are 52% food-borne, 21% unknown, 14% person-to-person, 6% recreation water and 3% drinking waterborne, 3% animal contact, and 0.3% laboratory related [11].

Escherichia coli are common in the intestinal microflora of warm blooded animals. It is routinely shed into the environment through faeces and can contaminate water and soil. Meats are also a common source of *E. coli* contamination, which may be acquired during slaughter through faecal contact. *E. coli* outbreaks have been associated with meat (especially group beef) and dairy products. The pathogen is generally present in the intestine of animals, particularly in cattle, without causing disease. *E. coli* also have been isolated from the faeces of chicken, goats, sheep, pigs, dogs, cats, and sea gulls [12].

Salmonellae are small, gram-negative, non-spore forming rods distributed in nature, with humans and animals being their primary reservoirs. The primary habitat of *Salmonella* species is the intestinal tract of animals such as birds, reptiles, farm animals, and occasionally insects and humans. They may also be found in other parts of the body and environments including water. Once infected with these organisms, an individual can act as a common shedder of the organism, usually through feces, but unnoticed. Such distribution of *Salmonella* in the environment, their increase in prevalence in the global food chain, and their virulence and adaptability properties cause easy transmission, resulting in enormous medical, public health and economic impact worldwide [13].

The non-typhoid *Salmonella* comprises of non-host preferences serovars, pathogenic to humans and animals, so they are considered food borne agents that cause gastroenteritis and develop into a poisoning syndrome in 12-14 hrs. High levels of *Salmonella* in meat may arise from animal production practices at the rearing stage as well as from cross-contamination after

slaughter either at the abattoir or at the butcheries house [14].

The study done on camel meat safety is very limited on the published documents especially in Ethiopia, however; there is a poor food handling and sanitation practices, inadequate food safety laws, weak regulatory systems, lack of financial resource to invest in safety equipment and lack of training for food handlers and there is limited surveillance and quantitative data on sanitation and hygiene practice, and presence of pathogen along the raw camel meat value chain [15]. In the study area there is no adequate study conducted on this subject, and there is limited surveillance and quantitative data on sanitation and hygiene practice, and presence of pathogenic bacteria along the raw camel meat safety along value chain. Therefore, this study was aimed to isolate and identification of the three bacterial species: *Staphylococcus aureus*, *Escherichia coli*, and *Salmonella spp.* from raw camel's meat and swab sample at abattoir and butcheries; to determine the bacterial load count from tested positive camel meat at abattoir and butcheries; to determine the Aerobic Plate Count from all camel meat at abattoir and butcheries; to identify the main source of bacterial contamination of camel meat at abattoir and butcheries; to assess the hygienic practice during camel's meat handling at abattoir and butcheries.

2. Materials and Methods

2.1. Study Area

Study was carried out from December 2018 to December 2019 in Nagelle town, Guji Zone, Southern Oromia region, Ethiopia (Fig 1). Nagelle town is the zonal capital of Guji zone which is located between 5° 20' - 39° 35' N latitude and 5.333° - 39.583° E longitude geographical grids; and it has a distance of 595km from capital city Addis Ababa. The area has a bi-modal type rainfall regime ranging on average from 400 mm to 600 mm annually. The maximum of the rainfall occurs from March to May and the minimum from September to November [16].

Currently, the population of camels in Ethiopia was estimated to be 4.5 million and the one-humped camel dromedaries (*Camelus dromedarius*) are found in the pastoral and agro pastoral areas. According to Guji zone department of planning and economic development bureau, the total camel population of was estimated to be about more than 450, 570 and also about 30,113 camel populations were found in the Nagelle town [2].

2.2. Study Population

The study subject was camels slaughter at municipal abattoir while the sampling units were camel carcass, workers/owners and participant who were directly

involved in the slaughtering, inspecting, and handling of raw camel meat in the abattoir and selling at butcheries house.

2.3. Study Design

Cross sectional study comprises of semi structured questionnaires', checklist observational survey, and laboratory techniques was conducted to assess hygiene practice handling of raw camel meat and to identify major source of bacterial contamination at abattoir and butcheries house of Nagelle town from December 2018 to December 2019.

2.4. Sample Size

The sampling for raw camel meat was using the Category I food sampling method. The raw camel meat sample were collected "N=60" and tested for *S. Aureus*, *E. coli* and *Salmonella spp* [17,18]. Accordingly, a total of 68 raw camel meats were collected to increasing the precision (34 from abattoir and 34 from six butcheries house) in Nagelle town.

The number of swab samples was determined using data from USDA (2012) with at least 2-10 samples from each sampling site. Totally, 60 swab samples were collected from abattoir (10 environment, 10 person hands, 10 knives) and from six butcheries house (10 person hands, 10 knives and 10 cutting table) in Nagelle town.

Questionnaire survey sample size approximation was based on 5% standard Error (SE), in 95% confidence intervals. When interest was in a population mean the total number of respondent required (N) was calculated by the formula reported [19].

$$N = 0.25 / SE^2$$

Therefore, the total calculated sample size (N) was 100 semi structured questionnaire was prepared for abattoir workers, supervisor and butcheries workers and owners. The number of questioner prepared for the interviewer was estimated 100 respondents were calculated by the formulae mentioned in the above paragraph. Accordingly, in this survey studies 50(50%) respondents were interviewed from abattoir workers, supervisor and butcheries sellers and owners.

2.5. Sampling Techniques

A nonrandom sampling method was employed at municipal abattoir and at all six butcheries. The camel meat sample was collected from daily slaughtered camel carcasses and the swab sample from meat contact surface at abattoir and butcheries during sampling times for 60 consecutive days. In addition to that, the questionnaires' interview were prepared and collected from all abattoir workers, supervisor and for butcheries workers and owners.

2.6. Sample Collection Procedure

The raw camel meats samples were collected from slaughtered camel carcass of 100g sampling unit by using sterile surgical blade, forceps and tissue handle. Accordingly, 68 camel meat samples were collected from both municipal abattoir and butcher house in the study area. The camel meat samples were placed in sterile stomacher bag, and then placed in icebox. Finally, the collected samples were aseptically transported to the Bule Hora University, Department of Animal and Range Science, microbiology laboratory using ice box in cold chain. Up on arrival, the samples were stored in refrigerator at 4°C for 24hrs and then processed for Bacteriological analysis.

Surface swab samples were taken from knives, environment, wood cutting tables and hands of person at abattoir and butcheries by the use of sterile cotton tipped swab, (2X3 cm) fitted with shaft, was first soaked in an approximately 10 ml of buffered peptone water diluents (Oxoid Ltd., Hampshire, England). The sterile cotton swab was rubbed first horizontally and then vertically several times on the contacted surface. After completion of the rubbing process, the shaft was broken by pressing it against the inner wall of the test tube and disposed leaving the cotton swab in the test tube. Accordingly, 60 swab samples were collected from abattoir and butcheries in Nagelle town. Finally, the samples were transported to the Bule Hora University, Department of Animal and Range Science, microbiology laboratory using ice box in cold chain. Up on arrival, the samples were stored in refrigerator at 4°C for 24hrs and then processed for bacteriological analysis.

Semi structured questioners data mainly focused on if the personnel working in the abattoir and butcheries were taken trainings, tested for food borne disease, wearing of personnel protective equipment and manner of hand washing and others related were collected to assess the hygienic practice employed during camel meat handling.

Semi structured questioners was administered to abattoir workers and butcheries house to assess the general hygienic practice. All practice in the abattoir, which could have impact on meat hygienic practice (Appendix 1 and 2) were included in the questioners. Cleaning procedure used in abattoir and butcheries was evaluated by interviewing of the supervisor (Appendix 1 and 2).

2.7. Method of Data Analysis

All data analysis was performed using by SPSS Software. Isolated bacteria were expressed as percentage was calculated. Microbial counts were calculated and expressed as mean and Standard Deviation compared by a one way of ANOVA. Descriptive statistics were used to describe the

frequency and the percentage of the questionnaire survey result were finally summarized and presented by Microsoft excel version 2007. The value of $p < 0.05$ was considered statistically significant.

2.8. Data Quality Control

All laboratory procedure including media preparation, procedure of each testing techniques was done according to manufacturer production guide line. Sterilization procedure and collection and handling of specimen were carried out in accordance with standard protocol [20].

3. Results

3.1. Isolation and identification of bacterial contaminants

3.1.1. Isolation and Identification of *S.aureus*

At the present study, an overall *Staphylococcus aureus* positive detected of (47.6%) was recorded. *Staphylococcus aureus* positive samples were significantly higher for camel meat butcheries house as compared to abattoirs (55.9% vs 35.3%), respectively. Positive presence was higher in butcher house than abattoirs camel meat sample as shown in (Table 1).

Table 1. Isolation and Identification of *Staphylococcus aureus*

Isolated bacteria	Sample source	Sample Type	Sampling site	No. sample	Laboratory result			
					Detected (+ve) (%)			
<i>Staphylococcus aureus</i>	Abattoir	Raw meat	Camel carcass	34	12 (35.3)			
			Person hand	10	6 (60)			
		Swab	Knives	10	3 (30)			
			Environment	10	2 (20)			
	Butcheries	Raw meat	Camel carcass	34	19 (55.9)			
			Person hand	10	10 (100)			
		Swab	Knives	10	5 (50)			
			Cutting board	10	4 (40)			
			Total	-	-	-	128	61 (47.6)

* Sign shows that ($P < 0.05$) was statistically significant different.

Staphylococcus aureus positive samples were significantly higher for swab sample butcheries house as compared to abattoirs (36.7% vs 63.3%). Positive presence was higher in butcher house than abattoirs swab sample as shown in Table 1).

3.1.2. Isolation and Identification of *E. coli*

In this section, presence of *E. coli* overall and at every sampling type from the abattoir and butcheries house was reported. Overall presence of *E. coli* at the abattoir and butcheries house (61.7%) showed the same result as presence in the camel meat at the abattoir (47%) and

at butcheries house (64.7%). *Escherichia coli* positive samples were relatively higher for camel meat butcheries house as compared to abattoirs (64.7% vs 47%), respectively (Table 2).

Similarly, presence percentage at the majority of individual sampling source were not different from each other, ranging from (80%) in person hand, (20%) knives and (90%) in environment at the abattoir and (90%) in person hand, (70%) knives and (60%) cutting board at butcheries house (Table 2).

Table 2. Isolation and Identification of *Escherichia coli*

Isolated bacteria	Sample source	Sample Type	Sampling site	No. sample	Laboratory result			
					Detected (+ve) (%)			
<i>Escherichia coli</i>	Abattoir	Raw meat	Camel carcass	34	16 (47)			
			Person hand	10	8 (80.0)			
		Swab	Knives	10	2 (20.0)			
			Environment	10	9 (90.0)			
	Butcheries	Raw meat	Camel carcass	34	22 (64.7)			
			Person hand	10	9 (90.0)			
		Swab	Knives	10	7 (70.0)			
			Cutting board	10	6 (60.0)			
			Total	-	-	-	128	79 (61.7)

* Sign shows that ($P < 0.05$) was statistically significant different.

Table 3. Isolation and Identification of *Salmonella spp.*

Isolated bacteria	Sample source	Sample Type	Sampling site	No. sample	Laboratory result
					Detected (+ve)/ (%)
<i>Salmonella spp.</i>	Abattoir	Raw meat	Camel carcass	34	8 (23.5)
			Swab	10	5 (50.0)
		Person hand	Knives	10	6 (60.0)
			Environment	10	4 (40.0)
			Butcheries	Raw meat	34
	Butcheries	Raw meat	Swab	10	3 (30.0)
			Person hand	10	4 (40.0)
		Swab	Knives	10	5 (50.0)
			Cutting board	10	5 (50.0)
			Total	-	-

* Sign shows that (P<0.05) was statistically significant different.

Table 4. Samples contaminated by mixed bacteria

Sample source	Sample type	No.	Mixed isolated bacteria from camel meat and swab sample							
			S.A with E.C		S.A with S spp		E.C with S spp		Overall	
			(+ve)	(%)	(+ve)	(%)	(+ve)	(%)	(+ve)	(%)
Abattoir	Raw meat	34	5	14.7	4	11.8	8	23.5	4	11.8
	Swab	30	9	30	5	16.7	8	26.7	3	10
	Person hand	10	5	50	2	20	3	30	2	20
	Knives	10	1	10	2	20	1	10	0	0
	Environment	10	3	30	1	10	4	40	1	10
Butcher	Raw meat	34	14	41.2	7	20.6	10	29.4	7	20.6
	Swab	30	9	30	3	10	2	6.7	2	20
	Person hand	10	3	30	1	10	0	0	0	0
	Knives	10	4	40	2	20	1	10	2	20
	Cutting board	10	2	20	0	0	1	10	0	0
Total		128	37	29	19	14.8	28	21.9	16	12.5

Note: * Sign shows that (P<0.05) was statistically significant different.

S.A - *Staphylococcus aureus*, E.C - *Escherichia Coli*, S spp. - *Salmonella species*.

Table 5. *S. aureus* and *E. coli* count from tested positive camel meat sample at abattoir and butcheries house expressed as Mean (log₁₀ CFU/g).

Load count bacteria	Sample source	Sample type	Tested (+ve)	Mean	Std. Error	Std. Deviation
<i>S. Aureus</i>	Abattoir	Camel meat	12	2.76	0.01916	0.06638
<i>E. coli</i>	Abattoir	Camel meat	16	2.81	0.01460	0.05838
<i>S. Aureus</i>	Butchers	Camel meat	19	3.07	0.00733	0.03197
<i>E. coli</i>	Butchers	Camel meat	22	3.94	0.01070	0.05018

Note: * Sign shows that (P<0.05) was statistically significant different.

Table 6. Aerobic plate colony count from raw camel meat sample at abattoir and butcheries house expressed as (mean log₁₀ CFU/g).

Sample source	Sample type	Tested sample	Min	Max	Mean	Std. Error	Std. Deviation
Abattoir	Camel meat	34	4	5	4.67	0.017	0.099
Butcher	Camel meat	34	5	6	5.49	0.085	0.466

Note: * Sign shows that (P<0.05) was statistically significant different, Min - minimum, Max - maximum, Std - standard

Table 7. Demographic characteristics of abattoirs workers and butcheries house owners

Interviewed	No	Sex		Age			Educational level					Duration of work				
		M	F	< 18	21-30	31-40	> 40	No Ed	1° Ed	2° Ed	TV ET	Unv	<1 yr	> 1-5yr	> 5-10yr	>10 yr
Abattoir	20	20	0	-	3	15	2	14	4	-	2	-	4	4	10	2
Frequency (%)	20	20	0	-	3	15	2	14	4	-	2	-	4	4	10	2
Butcher	40	40	0	-	6	30	4	28	8	-	4	-	8	8	20	4
Frequency (%)	30	20	10	-	7	18	5	20	10	-	-	-	5	15	7	3
Butcher	30	20	10	-	7	18	5	20	10	-	-	-	5	15	7	3
Frequency (%)	60	40	20	-	14	36	10	40	20	-	-	-	10	30	14	6
Total	50	40	10	-	10	33	7	34	14	-	2	-	9	19	17	5

Note: M - Male, F - Female, Ed - Education, TVET - Training Vocational Education Collage, Unv-University, yr - years. 1° - primary education, 2° - secondary education

3.1.3. Isolation and Identification of *Salmonella* spp.

In this section, presence of *Salmonella* spp overall and at every sampling type from the abattoir and butcheries house was reported. Overall presence of *Salmonella* spp at the abattoir and butcheries house (35.2%) showed the same result as presence in the camel meat at the abattoir (23.5%) and at butcheries house (29.4%). *Salmonella* spp positive samples were not significantly higher for camel meat sample from butcheries house as compared to abattoirs (29.4% vs 23.5%), respectively (Table 3).

Similarly, presence percentage at the majority of individual sampling source were not different from each other, ranging from (50%) in person hand, (60%) knives and (40%) in environment at the abattoir and (30%) in person hand, (40%) knives and (50%) cutting board at butcheries house (Table 3).

3.1.4. Samples Contaminated by Mixed Bacteria Isolates

Overall 16 (12.5 %) samples were contaminated by all the three bacteria as it can be seen (Table 4). The statically significant mixed contamination was observed in camel meat sample collected from butcheries shop 7 (20.6 %) if it compare with the other sample types. But, mixed sample were present in all type of samples however it was statistically insignificant.

3.1.5. Bacterial Load Count from Positive Camel Meat Sample

A total mean *S. Aureus* count log₁₀ CFU/g was found to be 2.76 on positive camel meat sample collected from abattoir and from butcheries were 3.07, for the *E. coli* mean count was 2.81 log₁₀ CFU/g for positive camel meat collected from abattoir and 3.94 log₁₀ CFU/g for tested positive samples collected from butcheries, however there was no statically difference among samples source and bacteria see (Table 5).

3.1.6. Aerobic Bacteria Plate Counts Result

Results of mean APCs of raw camel meat were presented in (Table 6). Abattoirs raw camel meat tested for APCs mean \pm Std. Error values (4.67 \pm 0.017 log₁₀CFU/g) was lower as compared to APC values of butcheries house (5.49 \pm 0.085 log₁₀CFU/g). Mean APCs raw camel meat from abattoirs and butcheries house were calculated statistically not significant different (P > 0.05).

3.1.7. Demographic Characteristics of abattoirs workers and butchers owners

This section deals with the general characteristics of the respondents by sex, age, educational levels and work experience were summarized below (Table 7).

A total of 50 respondents were participated from abattoir (40.0%) and from butcheries shop (60.0%); with majority of the respondents were males (80.0%) and females were (20%). The majority 34 (68%) of respondents having no educations and the majority 33 (60%) of respondents were in the age group between 31-40years. The majority of the respondents 19(38%) were between 1 to 5 years duration of work.

4. Discussions

4.1. Isolation and Identification of *S. aureus*

In this study, *Staphylococci aureus* is a natural flora of skin and mucous membranes of animals and human can cause meat contamination [21]. It was isolated from the raw camel meat (45.6%), which indicates poor sanitary quality of abattoirs and butcheries house.

The result of *Staphylococci aureus* positive camel meat samples in this study was in agreed with the previous findings [22]. Higher level of microbial contaminations including *S. aureus* of meat has also been reported previously [23].

The result of swab sample in this study, was agree with the finding which states that the isolation of *S. aureus* from butcher's knives, hands and cutting board [24,25]. These findings also further support the possible source

contamination of fresh meats or meat products by *S. aureus* were during sales or unhygienic handling of the meat by hand or by coughing and sneezing at abattoir and butchery [26,27].

4.2. Isolation and Identification of *Escherichia coli*

In this study the researcher was detected the *E. coli* from fresh camel meat to estimate the level of hygiene indicator. *E. coli* is a commonly used faecal indicator organism. Its presence in food generally indicates directly or indirectly faecal contamination. Substantial number of *E. coli* in food suggests a general lack of cleanliness in handling and improper storage

The result of this study, was lower than Haileselassie *et al.*, (2013) [28] reported that (27.3 %) *E. coli* in fresh meat from the abattoir and (22.2 %) butchers of Mekele Ethiopia. Percentage of *E. coli* from raw beef at the abattoir (55.9 %), at the butchers (38.2 %) contamination rates was similarly high [29]. This finding is agreed with Aldughaym (2001) and AbdElmutaal (2009) [30,31]; they were isolates *E. coli* from fresh camel meat. These findings also further support the idea of percentage of Hiko, (2017) [29] reported that *E. coli* was isolate 46.2% and 52.6% from personnel hands at the abattoir and at butcheries house in Ethiopia, respectively.

The result of this study indicated that, *E. coli* was isolated from swabs knives were similar and agree with the (25 %) percentage on knives of butchers reported [32].

4.3. Isolation and Identification of *Salmonella* spp.

The result in this study, indicates that the camel meat was contaminated at abattoir during slaughtering or a cross-and recontamination of carcasses during handling and transportation. In the present study findings in raw camel meat at the abattoir and the butcheries house were lower than the 42.8% (Stevens *et al.*, 2006) [35] in meat from slaughterhouses, modern butchers, in Dakar, Senegal.

In contrary to the study of Hiko, (2017) [29], reported that *salmonella* spp. prevalence from raw beef sample at the abattoir (11.8%) in this study was lower than the (32.4%) in raw beef at the butchers. From the study on camel sample considered with (Molla *et al.*, 2004) [33] and (15.9%) prevalence from a Mesenteric Lymph Node was reported.

There is higher contamination in person hand than (38.5%) prevalence from abattoir person hand in Ethiopia [29]. This prevalence, 42.86% from person hands at butcheries in Ethiopia [32]. However, all investigations identified *Salmonella* spp. were contamination of personnel directly unhygienic handling of raw camel meat.

The result of this study, *Salmonella* spp. was identified from knives and it is quite likely that contamination of

knives at the abattoir occurs particularly from evisceration. Workers at the abattoir use a single knife throughout the slaughtering steps. Knives are not cleaned or disinfected throughout a day. On the other hand, this finding for knives at the abattoir was higher than the (7.4 %) of the report by Teklu and Nigussie (2011) [34] for knives used for sheep and goat eviscerations and the (14.29 %) reported by Gurmu and Gebretinsae (2013) [32] for knives used by butchers.

Salmonella spp. was isolated from environment swabs sample at abattoir. This study was indicates that environments are possible sources of contamination during camel meat production. The (50 %) prevalence obtained from cutting board at the butcheries house was lower than the (96.4 %) at permanent markets and the (70 %) on wood and cardboards at district sales shops in Dakar, Senegal [35], and but higher than the (42.86 %) from tables of butchers in Mekelle, Ethiopia [32].

In this study, cutting board that would be the possible source of cross contamination. Different studies have indicated that *Salmonella* spp. survive on surfaces for hours or even days after initial contact with the microorganisms [36].

4.4. Bacterial Load Count from Tested Positive Raw Camel Meat Sample

In this study, the mean *S. aureus* counts from tested positive camel meat from abattoirs and butcheries house were 2.76 and 3.07 log₁₀CFU/g respectively. This study was agreed with Khalid (2004) and Ali (2007) [24,25] were also reported the mean values of *S. aureus* count to be 7.2 x 10⁵, 8.2 x 10² and 5.6 x 10⁴CFU/cm² before skinning, after skinning and after preparation and stamping of camel carcasses.

In this study, *E. coli* count in raw camel meat indicates the hygiene qualities of meat. In this study, we only detected and enumerated the *E. coli* irrespective of pathogenic or nonpathogenic strain to estimate the level of hygiene. Mean *E. coli* counts for the camel meat from abattoirs and butcheries house were 2.81 and 3.94 log₁₀ CFU/g respectively. Similar results have also been reported. This may indicate that the major source of contamination at butcheries. High level of *E. coli* counts at the butcheries could be due to poor handling by personnel and exposure to direct air; it could also be from contamination of the vehicle used for transportation of meat from the slaughterhouse to the butchery.

4.5. Aerobic Bacteria Plate Counts from Raw Camel Meat

The aerobic plate count has a great significance for judging of the hygienic conditions under which the meat was produced. It gives a good idea about the keeping quality of meat. The results could reflect the

level of hygiene for fresh meat handling and storage. The total viable count has always been used as indicator to the hygienic condition inside the abattoir and butcheries house.

In this study, the result mean \pm SE of aerobic plate count from camel meat sample at abattoirs and butcheries house was ($4.67 \pm 0.017 \log_{10}$ CFU/g) and ($5.49 \pm 0.085 \log_{10}$ CFU/g), respectively. The higher APCs recorded in this study was attributed to poor handling and hygienic practices leading to cross contamination and recontamination of meat [8].

However, the results of APC obtained from the meat samples in the area butcheries were higher than abattoirs, but lower than the recommended standard of less than $6.00 \log_{10}$ CFU per g/cm^2 set by the ICMSF. A high count of microorganisms exceeding $7.00 \log_{10}$ CFU/g of TPC is an indication for meat spoilage and potential health hazards. The total plate count exceeding $5 \log_{10}$ CFU/g for raw meat was unacceptable and meat hygiene must be urgently improved [37].

In this study, 60% of samples had APC more than $5 \log_{10}$ CFU/g, which indicates highly contaminated meat. Significantly higher mean APCs for the butcheries house as compared to the abattoirs, indicate the excessive unhygienic handling of meat, lower quality of transportation and storage conditions, and supportive environment of butcheries house for the aerobic bacterial to growth.

The results from the current study are highly contaminated than Aldughaym *et al.*, (2001) [30], whose findings recorded mean aerobic plate count on the surface camel carcasses 4×10^3 , 5×10^3 , 6.2×10^3 cfu/cm² before skinning, after skinning and after preparation and stamping respectively. Higher level of aerobic plate count in this study is in accordance with previous studies [38].

Significantly higher level of contamination in the camel meat butchers shops as compared to the abattoir have also been reported previously [12]. This study is agreed with the study of Duffy *et al.*, (2001) [39], although, the microbial contamination of abattoirs was lower as compared to the butcheries, it was higher as compared to reports from developed countries and do not conform to EU specifications. This study is agreed with (Gebeyehu *et al.*, 2013 and Hiko, 2017) [29,40].

5. Conclusions

The finding of this study indicated as there is high contamination rate of camel meat with *S. aureus*, *E. coli* and *Salmonella* spp. in this area. The good hygienic practice at abattoir and butcher house during camel meat handling also indicated as it was poor.

The presence of the three bacteria at environment and person hand that have contact with meat may indicate the source of contamination for camel meat.

To summarized that there was a major source of bacterial contamination of raw camel meat at butcheries house than abattoirs in Nagelle town.

6. Recommendations

Therefore, based on the above conclusion; the following recommendations are forwarded:

- All abattoirs and butcher workers should be trained on good hygienic practice procedures, personal hygiene and on sanitation practices.
- The government should think about to construct other slaughter house for the community of study area which may full fill the standard design and layout and appropriate site selection for abattoir.
- The community of the area should not depend on the raw camel meat in any means.
- Further studies may suggest on other pathogenic bacteria's which may contaminated meat.

7. References

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