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Assesment of Microbiological Quality and Meat Handling Practices in Butcher Shops and Abattoir Found in Gondar Town, Ethiopia

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Abstract: A cross sectional study was conducted from November 2016 to March 2017 to determine the major bacterial contaminants along the line of meat production value chain, to isolate major pathogenic bacteria present on meat sample and to assess the knowledge and practices of meat handlers in Gondar northwest region of Ethiopia. A total of 159 swab samples (53 swab samples from tables, knives and hands of workers each) were collected and examined for microbial load, analyzed and the mean bacterial count was computed and obtained as 6.52, 7.84 and 6.96 log10 CFU/cm^2,respectively. The results obtained in this study indicated that the meat quality from the butcheries exceeded the acceptable range of bacterial load (< 5 log10 CFU/cm^2) over the study period. The samples were also inoculated into different differential and selective growth media for isolation of major bacterial contaminants. *E. coli* was the predominant bacteria 20 (37.74%) followed by *Staphylococcus*spp. 13 (24.53%) and *Salmonella* spp. 11 (20.75%). The least bacterial isolate was *Streptococcus*spp. with a frequency of 8 (15.09%) out of 53 swab samples. All the risk factors assessed in this study had almost equal contribution for microbial contamination of meat ($p > 0.05$). Therefore, to prevent the occurrence of foodborne illnesses and meat spoilage, it is important to ensure that foods products are safe and in good hygienic condition.

Key words: Abattoir · Bacterial Load · Butcher Shops · Gondar

INTRODUCTION

Ethiopia has the largest cattle population in Africa about 53.99 million heads, 24- million sheep and 18 million goats [1] and contributes 40% to the annual agricultural output and 15% total gross domestic product. Cattle produce a total of 1.5 million tons of milk and 0.331 million tons of meat annually [2].

Meat, an excellent source of protein in human diet, is highly susceptible to microbial contaminations, which can cause its spoilage and foodborne infections in humans, resulting in economic and health losses [3]. It is the most perishable of all important foods since it contains sufficient nutrient needed to support the growth of microorganisms. The beef meat contains 70-73% of water, 20-22% of protein and 4.8% of lipids. This chemical composition exposes beef meat to the contamination by spoilage and pathogenic bacteria when adequate hygienic measures during the preparation, transport and marketing are not respected. In fact, tissue from healthy animals are sterile, however, it has been pointed that during slaughter, dressing and cutting, microorganisms came chiefly from the exterior of the animal and its intestinal tract, but that more added from knives, cloths, air, carts and equipment in general [4].

Furthermore, meat is sold in the open markets on tables that are not well cleaned and disinfected. Thus, exposing meat to a number of microorganisms, this may be pathogenic or non-pathogenic. During the slaughtering process, the stages of skinning and the dressing were identified to be the critical points for carcasses microbiological contamination [5]. Food safety is a matter of great concern and of public health importance in particular when the environment in which the food handled is heavily contaminated. Most of fresh food especially that of animal origin like beef is highly vulnerable to microbial invasion and food poisoning [6]. Contamination of meat can occur in multiple steps along the food production chain including production, processing, distribution, retail marketing and handling or preparation [7].

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The abattoir environment and slaughtering processes play a vital role in the wholesomeness and meat safety. Unhygienic practices in abattoirs and post-process handling are associated with potential health risk to consumers due to presence of pathogens in meat and contaminated equipment [8]. Effluent from slaughter houses are known to contribute in contamination of both surface and ground water since during processing in abattoir blood, fat, manure, urine and meat tissues are discharged to the waste water streams [9].

Meat is considered to be spoiled when it is unsuitable for human consumption. Spoilage can be caused by a wide variety of factors, such as improper handling, exposure to air and high temperature or conditions that trigger chemical reactions or microbial contamination, although the most common cause is the presence of microorganisms together with metabolite production. Spoiled meats and meat products are inedible mainly due to off -odor and flavor, but consumer rejection is also due to discoloration, blown packages, souring, surface slime and other alterations of meat quality. However, meat may also contain pathogens without showing signs of deterioration [10]. With this regards consumption of contaminated foodstuffs especially from animal products such as meat from infected animals or carcasses contaminated with pathogenic bacteria such as, *Salmonella* spp., *Staphylococcus* spp., *Streptococcus* spp. and *E. coli.* precedes many foodborne illnesses with human health consequences ranging from illness to death [11].

Foodborne microbiologic hazards are responsible for as many cases of illness as possible each year and are thus an important food safety challenge [12]. Foodborne diseases occur commonly in developing countries particularly in Africa because of the prevailing of poor food handling and sanitation practices, inadequate food safety laws, weak regulatory system, lack of financial resources to invest in safer equipment and lack of education for food handlers [13].

In spite of the increased consumer demand on food safety standards for beef, there are still poor hygiene and sanitary practices along the food production chain which contribute to unacceptable level of microbial load in meat [14]. Ethiopian meat production and marketing system has been plagued by lack of quality and sanitation, prevalence of disease and unqualified meat production process. There is limited information on the microbial quality or microbial load level of Ethiopian beef that is being retailed in different outlets and this poses a health risk to consumers [15]. Food contamination with antibiotic resistant bacteria can be a major threat to public health as the antibiotic resistance determinants can be transferred to other pathogenic bacteria potentially compromising the treatment of severe bacterial infections [16].

Assessment of sanitation and hygiene of meat handling practices would help to point out the avenues for microbial meat contamination and hence intervention strategy for hygienic meat handling to reduce meat losses is recommend. Determination of microbial quality of meat would create awareness on the microbial safety of meat and propose mitigation measure to reduce meat contamination and hence meat losses. Determination of weight loss in beef would help to determine economic losses for the butchery operator; at the same time point out the factors influencing beef losses hence recommend possible ways of reducing beef weight losses in butcheries in the study area.

Therefore, the objectives of this study were:

- To determine the major bacterial contaminants along the line of meat production value chain in the study area.
- To isolate major pathogenic bacteria present on meat sample in the study area.
- To assess the knowledge and practices of meat handlers in the study area.

MATERIALS AND METHODS

The study was conducted from November 2016 to March 2017 in Gondar town which is the capital city of North Gondar administration zone of the Amara regional state, which is 740 km Northwest of Addis Ababa and has an area of 40.27 km^2. It is located at 12°36' 28'' N latitude and 37°.46' 67'' E longitude, with an elevation of 1500-2300 m.a.s.l, Average rainfall 1000 mm and Average temperature 22°C. Based on the 2015 national census conducted by the Central Statistical Agency of Ethiopia (CSA), Gondar had a total population of 207,044, of whom 98,120 were men and 108,924 women. The majority of the inhabitants follow Ethiopian Orthodox Christianity, with 84.2% reporting that as their religion, while 11.8% of the population said they were Muslim and 1.1% were Protestant[17]. The information obtained from Gondar town Customers office tells us that, Gondar has 12 sub-cities, which is a home to 93 hotels, 72 restaurants, 82 butcher houses, 1 abattoir and 105 cafeterias.

The Study Subjects Were Butcher Knives, Workers' Hands and Chopping Tables: A cross sectional study design was used to answer questions concerning the current status of food hygiene and sanitation practiced in

butcher shops. Bacterial analysis of swabs taken from meat cutters, workers' hand and cutting boards with the intension of colony count and identifying of pathogenic bacteria were conducted. Hygiene and sanitation of butcher shops was determined by the use of structural questionnaire survey and through direct observation of the hygienic status and practices in butcher shop workers.

In order to calculate the sample size of study targets (Workers' hand, knives, tables and meat) the number of the sample size required for this study was determinedaccording to Thrusfield M 2007. The sample size was calculated as follows [18].

$$n = \frac{(1.96)^2 \text{ X } 50\% (1- 50\%)}{(5\%)^2} = \frac{3.8416X0.5X0.5)}{(0.05)^2} = \frac{0.9604}{0.0025} = 384$$

where n = is sample size at 50% prevalence, n* = required sample size for this study, N = known population (Numbers of butcher houses found in Gondar town), P_{exp} = expected prevalence of bacterial contaminants, d = absolute precision (Or error), Z-value = 1.96.

Sample Collection

Swab Samples from Workers' Hand and Equipment: Swab samples from workers' hand and equipment of butcher shops and ELFORA abattoir of Gondar town were collected aseptically for a period of three months using sterile moistened cotton wool swabs. An area of $1cm^2$ was used for swabbing and the swabbed sample was soaked into 10 ml buffered peptone water. The swab samples were kept in this sterilized broth in icebox cooler and transported to microbiological laboratory for bacteriological analysis study.

Methods:

Sample Preparation and Inoculation

Representative samples were taken aseptically using sterile moistened cotton covered swabs and the swabbed sample was immersed into the test tube containing approximately10 ml buffered peptone water. The test tubes were labeled respectively and transported to the microbiological laboratory with an icebox. Then the samples were cultured onto macConkey agar, Manitol salt agar, blood agar, brilliant green agar and incubated at 37°C for 24-48hrs [19]. Colony morphology on the plates was observed and colony Sub-culturing was done to obtain pure colonies for biochemical tests.

Isolation and Identification of Bacterial Pathogens Samples collected from different butcher shops and the abattoir were cultured on nutrient agar and blood agar (General media) macConkey agar, manitol salt agar and brilliant green agar as a differential and selective medium for isolating E. coli., Staphylococcus spp., Streptococcus spp. and Salmonella spp. and these medium were prepared and sterilized according to their respective manufacturers' instructions.

Inoculation was done by spread plate method [20]. Incubation of samples was done at appropriate temperatures (37°C) and duration (24-48hrs) [21]. Colonies Identified as discrete colonies were carefully examined microscopically using compound microscope for bacterial characteristics such as shape and color. Gram staining as well as an appropriate biochemical tests such as lysine test, TSI test, catalase test, indole production test and citrate utilization test were all performed following the standard protocol [22]. The isolates were identified by comparing their morphological and biochemical characteristics with standard reference organisms with those known taxa as described by Bergy's manual for determinative bacteriology [23].

Determination of Total Viable Cell Counts: Serial dilutions were prepared from 1ml of the sample and 9ml of tryptone water[24].Serial dilution of a sample containing viable microorganisms was plated onto a sterilized petri dishes and the suspension suitable growth medium (Plate count agar) was spread onto the sample and shake well to evenly distributed the sample on the petri dishes (Spread plate method)and allowed to solidify. The petri dishes then incubated for 48hrs at 37°C.Then the colonies of bacteria grown on plate count agar were counted using colony counting chamber. The number of distinct colonies on each plate was counted as (Colony forming unit CFU) per ml of sample volume and was calculated by using dilution factor of its concentration and converted to log10 CFU/cm^2 values. Mean values of total viable counts in log10 CFU/cm^2 of replicates were determined and reported as means±standard division (SD) [25].

Statistical Analysis: The collected data, microbiological findings from swab samples and questionnaire, were entered into a Microsoft Excel spreadsheet and analyzed with Statistical Package for Social Sciences (SPSS) version 16 statistical software and descriptive and regression analysis results were interpreted in order to draw a conclusion. A 95% confidence interval at P value 0.05 and less than 0.05 was considered statistically significant.

RESULTS

Microbiological Assessment of Personnel Hands and Equipment: A total of 159 swab samples were collected from 53 tables, 53 workers' hand and 53 meat cutting knives. Swab samples were examined for bacterial load using the standard plat count technique. In the present study, those swab samples showed a colony count between 30 and 300 CFU were considered as statistically reliable for microbial load whereas colonies less than 30 and above 300 were not counted because counting of colonies less than 25/30 is statistically unreliable and inaccuracy and on the other hand counting of colonies more than 250/300 are too much to count and is difficult, tedious and statistically inaccuracy [26].

The actual bacterial loads on the different surfaces were counted and the mean bacterial counts (CFU/cm^2) of table, worker's hand and knives were calculated and were found to be 6.52, 6.96 and 7.84 respectively. Total plate count (TPC) was used to measure the general bacteria load on meat and is a useful tool in monitoring food safety. The results may reflect the hygienic level of food handling and retail storage. In the present study the highest mean log values in the abattoir and butcher shops was recorded on cutting knives which is 7.84 log10 CFU/cm^2.

Table 1: The maximum and minimum colony count and their mean values on each sampling surface

Descriptive Statistics	Number of sample taken	Mean count (10log10cfu/cm^2	Minimum count (10log10cfu/cm^2	Maximum count (10log10cfu/cm^2	SD
Table	53	6.52085	6.49136	8.39794	6.7
Hand	53	6.96218	5.50515	8.38021	6.8
Knife	53	7.84110	6.49136	8.40993	6.7

SD = Standard deviation

Specific Bacterial Isolation and Identification: Swab samples of the surfaces of the tables, knives and workers' hands were subjected to different agar plates to grow in order to isolate and identify major bacterial meat contaminants. Table 2 shows the frequency and percentage of gram positive and gram negative bacterial pathogens isolated from swab samples collected from the butcher shops and the abattoir. *E. coli* was the predominant isolate 20 (37.74%), followed by *Staphylococcus* spp.13 (24.53%) and *Salmonella* spp. 11 (20.75%). The least (n = 8; 15.09%) bacterial isolate was *Streptococcus* species. This study shows that 58.49% of the isolated bacteria from meat cutter, worker's hands and tables of butcher shops and abattoir of Gondar town were found to be enteric bacteria in food contact with hand, cutting board and other equipment.

Table 2: Sample source surfaces and the frequency of isolation of major bacterial meat contaminants

	Sample source surfaces			
Isolated bacteria	Table	Hand	Knife	Total
E. coli	8 (15.09%)	5 (9.43%)	7 (13.21%)	20 (37.74%)
Salmonella spp.	3 (5.66%)	4 (7.55%)	4 (7.55%)	11 (20.75%)
Staphylococcus spp.	5 (9.43%)	6 (11.32%)	2 (3.77%)	13 (24.53%)
Streptococcus spp.	3 (5.66%)	2 (3.77%)	3 (5.66%)	8 (15.09%)
Total	19 (35.85%)	18 (33.96%)	16 (30.19%)	52 (100%)

Questionnaire Survey

Response to Different Categorical Variables

In the present study, 53 abattoir and butcher shop workers were interviewed to collect information which can directly or indirectly contribute to the contamination of meat. Out of the total (n= 53) interviewed, 9 (17%) were female and 44 (84%) were male. Based on their educational status of respondents 2 (3.8%) were illiterate, 11(20.8%) primary school students, 23(43.4 %) secondary school students, 3 (5.7%) bachelor science, 12 (22.6%) diploma and 2 (3.8%) of the respondents were doctor of veterinary medicine. On the hand, out of the total interviewees (N = 53), 35 (66.04%) didn't take training about meat handling practices and personal hygiene.

Among the 53 respondents, 43 (81.1%) didn't have apron but use gown, 11 (20.8%) did not cover their hair and 24 (45.3%) of the respondents handled money while receiving from their customers. Moreover, 9 (17%) of the respondents were complained that sometimes the meat from the abattoir has contact with animal hair which inevitably contribute to microbial contamination (Table 2). In the present study, there was no statistical significant

association (P > 0.05), between all the risk factors listed in Table 2 below and the number of bacterial load in CFU/cm^2. This indicates that all the risk factors play a part equally in the contamination of meat, processing equipment and butcher workers' hand by pathogenic bacteria (Table 2).

Table 3: Association of the number of bacteria in CFU/cm^2 determined for each of the categorical variables

Variables	Categories	Number of respondents (%)	CFU/cm^2 <30	30-115	115-235	x^2	P value
Sex	Female	9 (17%)	0	9	0	2.52	0.28
	Male	44 (83%)	2	34	8		
Age	Below 18	2 (3.8%)	0	2	0	4.41	0.62
	18-30	28 (52.8%)	2	20	6		
	31-40	16 (30.2%)	0	15	1		
	Above 40	7 (13.2%)	0	6	1		
Educational status	BSc	3 (5.3%)	0	3	0	5.05	0.89
	Diploma	12 (22.6%)	1	14	3		
	DVM	2 (3.8%)	0	2	0		
	Illiterate	2 (3.8%)	0	2	0		
	Primary school	11 (20.8%)	0	11	1		
	Secondary school	23 (43.4%)	1	18	4		
Occupation	Abattoir employee	13 (24.5%)	0	12	1	1.61	0.81
	Butcher shop employee	17 (32.1%)	1	13	3		
	Butcher shop owner	23 (43.4%)	1	18	4		
Position in abattoir	At butcher shop	40 (75.5%)	2	31	7	1.72	0.79
	Butcher	10 (18.9%)	0	9	1		
	Meat inspector	3 (5.7%)	0	3	0		
Hair cover	No	11 (20.8%)	1	1	11	1.37	0.5
	Yes	42 (79.2%)	1	7	42		
Apron	No but gown	43 (81.1%)	2	34	7	0.8	0.67
	Yes	10 (18.9%)	0	9	1		
Number of apron	They don't have	43 (81.1%)	2	34	7	0.8	0.67
	Two	10 18.9%)	0	9	1		
Types of shoes	Closed	22 (41.5%)	2	15	1	5.11	0.27
	Open sandals	18 (34%)	0	16	0		
	Rubber boots	13 (24.5%)	0	12	12		
Access to training	No	35 (66.04%)	2	28	5	1.09	0.58
	Yes	18 (33.96%)	0	15	3		
Frequency of training	Monthly	10 (18.87%)	0	9	1	2.44	0.88
	Not provided	35 (66.04%)	2	28	5		
	Twice per year	7 (13.2%)	0	5	2		
	Yearly	1 (1.89%)	0	1	0		
Appling of their skill	No	40 (75.5%)	2	33	5	1.42	0.49
	Yes	13 (24.5%)	0	10	3		
Skin hair contact with carcass	No	44 (83%)	1	7	7	1.68	0.43
	Yes	9 (17%)	1	36	1		
Meat selling	Have a cashier	16 (30.2%)	1	13	2	2.14	0.71
	Have contact with money and meat	24 (45.3%)	0	18	5		
	Have no contact with money		13 (24.5%)	1	12	1	

DISCUSSION

The primary focus of this study was to ensure that meat products are safe, wholesome and fit for human consumption. This study was carried out to assess, bacterial load of meat contact surfaces by swab sampling, the meat cutter safety, knowledge, practice in meat handling by workers and identify pathogenic microbes. This study reported that the standard viable plate count obtained from abattoir and butcher's knives after

processing was 7.8±6.7 log10 CFU/cm^2. This mean value obtained from cutting knives in this study was higher than the values obtained by [27, 28] who reported that the total aerobic viable count of 6.7±5.3 log10 CFU/cm^2 in Russia and 5.52±0.03 log10 CFU/cm^{2}in India, respectively. But it is less than 12.04±0.06 log10 CFU/cm^2 which was reported by [29] from meat seller knives from various markets in Ibadan, Nigeria. The high microbial load on the knife is an indication of an inadequate cleaning and poor or absence of sterilization, continues use of a single knife despite contact with dirty or contaminated material surfaces and lack of separation between dirty and clean processes.

The mean value 6.96±6.8 log10 CFU/ cm^2 obtained from worker hands is higher than 5.85±0.16 log10 CFU/ cm^2 which was reported by [28] in an abattoir and the meat shops in Mumbai, India. This higher value on workers hand in this study indicates that workers in the butcher shop had got the microbes while handling money, contact with their hair, shake with their friends or customers and absence of adequately washing of their hands before and after processing.

The mean value 6.5±6.7log10 CFU/cm^2 obtained from the processing table in this study was higher than 5.52 log10 CFU/cm^2 which was reported by [30] but it was less than 7.33 log10 CFU/cm^2 which was reported by [31] and 12.05±0.04 reported by [29]from meat sellers tables from various markets in Ibadan, Nigeria. The high TPC recorded in this study was attributed to poor handling and hygienic practices leading to high cross contamination and recontamination of meat [32]. Variations in microbial counts among studies are contributed by factors such as the differences in numbers of collected samples, the manner in which they were collected, the season in which the samples were collected [33] and the same might have applied in the study. The result obtained in the present study exceeds the acceptable range given by FAO. According to [34] total viable plate count numbers exceeding 100, 000 CFU/cm^2 (5.0 log10 CFU/ cm^2) and *Enterobacteriaceae*1, 000 CFU/cm^2 (3.0 log10 CFU/ cm^2) on fresh meat are not acceptable and alarm signals and meat hygiene along the slaughter and meat handling chain must be urgently improved.

Moreover, swab samples from tables, worker's hands and cutting knives showed higher count of food contaminant microorganisms. This higher count may be attributed due to unsanitary practices performed by the plant, employee's ignorance, by personal hygiene and contaminated materials including the floor, which are considered to be important sources of contamination [35]. The workers were also circulated in the establishment thereby disseminating the contamination. Hygienic problem isn't limited to knife and the table, but it is also associated with worker's hands. Shaking of hands, sneezing and handling of money while in food production and processing area may be attributed to the propagation of the bacteria to the equipments and clothings of the butcher men [36, 37]. The presence of the pathogens on the meat during this study may also be accounted for by its association with water, soil and vegetation that the personnel use or come in contact with during the processing or retailing of the product and more so human beings reported to act as carriers of the pathogen [38].

Swab samples taken from different surfaces yielded a remarkable growth of bacteria. The presence of these organisms on meat parts could be attributed to the fact that meat contains an abundance of all nutrients required for the growth of bacteria in adequatequantity. The finding of this study revealed that meat cutting surfaces were contaminated with pathogenic Gram- positive and Gram-negative bacteria, which was in agreement with the finding by [39]. The prominent bacterial contaminants of swab samples in the study were *E. coli*. Salmonellaspp., *Streptococcus* spp. and *Staphylococcus* spp. Similar bacterial contaminants have been reported by other researchers from food, water and environmental samples [40, 41, 42]. In Tanzania, [3] isolated *E. coli, S. aureus and Salmonella* spp. from abattoir and meat shops.

Among bacterial contaminants, *E. coli* and *Staphylococcus* spp. were the predominant bacteria isolated from swab samples in the present study. This finding was in agreement with reports of several researchers [39, 40] where they isolated almost similar organisms from meat, sea foods and other ready to eat foodstuffs.The microbial status of the product that reaches to the consumer in either rawor processed meat will depend on the exposure to contamination and it is controlduring subsequent chilling, processing, handling, distribution and preparation [43]. In order to eliminate or reduce the availability of microbes in foodstuffs, the use of refrigerator is unquestionable. Reduction of refrigeration temperature not only affects bacterial growth, but also the composition of the bacterial flora and may have accounted for the absence of pathogen in the slaughter house and butcher shops [44].

Personnel and butcher house hygiene, training and hygienic regulation of the butcher shops and abattoir were included in this study. In current study, 32 (66.04%) of the respondents of the butcher shop workers had not

taken training concerning food hygiene. This result is comparable to those of other researchers who reported that 61.5% [13] of the butchery operators in Makelle, Ethiopia and 81% [45] and 75% [46] of managers in butcher's premises in the United Kingdom had received no food hygiene training. Similar findings have been reported in other food or meat handling establishment by other researchers. But according to [47] the level of education and training of food handlers about the basic concept and requirements of personal hygiene and its environment plays an important part in safeguarding the quality of food products to consumers.[31] also reported that workers working in the abattoir and butcher shops in most cases in developing countries are untrained and thus, they pay no attention to the hygienic standards and as a result contribute immensely to bacterial contamination.

This study shows that 43 (81.1%) of the butcher shop workers didn't wear apron instead they have been wearing gown [48, 49] also reported that 62.5% of the butchery workers did not use protective clothing while selling meat in Morogoro municipality, Tanzania. On the other hand, 18 (34%) of the respondents wore open sandals. This indicates that workers in the study butcher shops didn't have an understanding about the importance of wearing of a protective cloth. Butaccording to[50] the purpose of proper wearing is to protect both food products and meat handler safety from cross contamination. Twenty four (45.5%) of the respondents in this study were handling money while serving customers (Table 2). This value is less than the value reported by [51] that 87% of the Small and Medium Enterprise (SME)butchery operators in Nairobi handled money concurrently with handling of meat. But this result was almost comparable to the result reported by [13] in Mekelle of Ethiopia who found that 47.9% of the butchery operators handled money while handling meat. The person handling money should not be allowed to handle food during retailing or serving. Since meat handlers are probable source of microbes for food products, it is important that all possible measurements should be taken in order to eliminate or reduce such contamination [52].

Regarding the category of age in the study area, 52.8% of workers had an average age 18-30 years, 31-40 years (30.2%), 10% below 18 years (3.8%) and above 41 years represents (13.2%) of the total interviewed (n =53). Findings from this study were different from what was reported in Ghana by[53] who found 45% of the abattoir workers were within the ages of 41-50 years, followed by 31-40 (23%), 51-60 (16%). This indicates that there was high participation of the youth (20-35 years) in butcher shops in the study area. It has been reported by several authors that meat retailing business requires a lot of physical strength and need to be carried out by more energetic and active youth and middle aged men. [54] reported that the butcher operations were quite energy demanding and may involve a lot of travelling to livestock markets hence, the inability of older men to cope.

Thus to safeguard the public against the risk of foodborne bacterial infection, there is a need to educate and advocate about practicing and good sanitation and meat handling techniques in the butcher shops and reducing the intensity of backyard slaughters.

CONCLUSION

The bacteriological load obtained in this study was above the acceptable value < 5 log10 CFU/cm^2. This high microbial load on the processing equipment surfaces in this study indicated that the presence of poor level of personnel and equipment hygiene in butcher shops. Most of the workers in the butcher shops handle money with their bare hands while processing of meat and serving of customers and shake their customers with their bare hands. It is also suggestive that the environment is the possible sources of microbial contamination. Most of the butcher shops use a metallic board for meat rail and some butcher shops use wooden boards for meat rail which plays its role in meat contamination when the manner of cleaning is inadequate.

Based on the above conclusion the following recommendations are forwarded:

- The butcher shop workers should take training about personnel, food handling practice and generally about good hygienic practices (GHP).
- Workers should wear apron and only the cashiers should be allowed to handle the money.
- Workers should use plastics over the board in order to make it easy to clean and minimize microbial load of meat.
- It is imperative duty for quality tools, such as good manufacturing and hygienic practices and microbiological risk education and quality management to be integrated in the meat processing sector.
- Since there will be many other contaminating bacteria on meat, further study should be conducted.

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