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Assessment of Good Hygienic Handling Practices and Microbial Load of Meat and Its Contact Surfaces in Bedele Town, Buno Bedele Zone, South West Ethiopia

Amanu Nuguse*, Shimelis Mengistu, Dinaol Belina

College of Veterinary Medicine, Haramaya University, Haramaya, Ethiopia

Email address:

hundaaroob@gmail.com (Amanu Nuguse)

*Corresponding author

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Abstract: The study was carried out from September 2021 to February 2022 to assess good hygienic handling practices and microbial load of meat and its contact surfaces in butcher shops in Bedele town. To demonstrate this, samples for laboratory analysis were taken from all 25 butcher shops and 40 butchers were administered with study questionnaires in the area. All microbiological samples were inoculated to general and different differential and selective media for bacterial counting. Data were analyzed using IBMSPSS statistics 20 version using descriptive statistics and one way ANOVA. A total of 125 samples from Meat cutting boards, Hands, Knives and Meat hanging hooks and meat were collected and analyzed for total viable counts and obtained as $6.44 \pm .67 \log_{10}/cm^2$, $6.12 \pm .66 \log_{10}/cm^2$, $6.08 \pm .87 \log_{10}/cm^2$, $6.20 \pm .86 \log_{10}/cm^2$ and $6.26 \pm .87 \log_{10}/g$ in that order. A mean counts for *Enterobacteriaceae,* total *E. Coli* and total *Staphylococcus* counts were $5.32 \pm .65 \log_{10}$, $5.19 \pm .86 \log_{10}$ and $5.05 \pm .75 \log_{10}$ respectively. From surveyed 25 butcher shops, none of them had refrigerator and cleaned the butcher shop surfaces using sanitizers and disinfectants. About 67.5% of butchers wore white coat always at work and 52.5% butcher men had no head cover and the rest wore sometimes. None of butcher shops had separate cashier and only 42.5% of butchers had valid health certificate and follow medical checkup at six months interval. There was no set time for cleaning frequency in all butcher shops. Majority of butcher shops surfaces and workers protective clothes were found to be poor. The result indicated that, butchers activities and all meat contact surfaces might have served as sources of contamination. Hence, rigorous management practice and good hygienic practices should be introduced in order to heighten the overall safety and hygienic quality of meat.

Keywords: Beef, Microbial Load, Beef Contact Surface, Enterobacteriaceae, Butcher Shops, Bedele

1. Introduction

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 [50]. WHO estimated that, annually, about 2.2 million deaths occurred as a result of food-borne and water borne diseases combined [56]. These food-borne diseases occur because of the prevailing poor food handling and sanitation practices, inadequate food safety laws, weak regulatory systems, lack of financial resources to invest in safer equipment and lack of education for food-handlers particularly in developing countries [55].

The full extent and cause of unsafe food has been unknown. Due to lack of accurate data on the full scope and cost of food-borne diseases has been a major obstacle to address food safety issues [7]. Specially, in developing countries it is difficult to evaluate the burden of food-borne pathogens because of the limited scope of studies and lack of coordinated epidemiological surveillance systems [45]. Particularly in Ethiopia, because of under-reporting of cases and the presence of other diseases considered to be of high priority may have overshadowed the problem of food-borne pathogens [20]. Even in Ethiopia, the cases of food-borne

illnesses are rarely investigated in detail and it does not seem to cover wider geographic areas [58].

Food-containing harmful contaminants are responsible for more than 200 diseases ranging from diarrhea to cancers and microorganisms are the leading cause [57]. Specifically in meat industry, the main sources of these microorganisms are skin of the animal, the meat contact surfaces (tables, logs, hooks, balances and knives) and the clothes and hands of personnel involved in the meat processing operation [31]. Workers come in contact with these micro-organisms may be transferred to food during processing, packaging, preparation and service by touching, breathing, coughing or sneezing [12] and that's why butcher shop workers are considered as the largest source of contamination, if they do not follow sanitary practices [40].

Diseases which result from pathogenic microorganisms are of two types: infection caused by the ingestion of food containing live bacteria which grow and establish themselves in the human intestinal tract and intoxication caused by ingesting food containing toxins formed by bacteria which resulted from the bacterial growth in the food item [4]. These food borne illnesses occurs as a result of the contamination starting from inadequate preservation methods, unhealthy handling practices, cross-contamination from food contact surfaces, or from persons hiding the microorganisms in their nails and on the skin [10].

Due to the lack of food safety regulation and the existing limited analytical capabilities at national and regional levels, Ethiopia has yet to develop a food-borne diseases surveillance system coordinated at a national level [11]. Due to these, measures such as registration, licensing, inspections and supervision of butcheries and enforcement of legislations by the relevant authorities are not routine [21]. And all these situations could hinder government and other stockholders to accurately apply measures on the impact of food contamination problems to public health and makes achieving basic meat hygiene difficult due to lack of necessary sanitation infrastructure.

Statement of the Problem

In Ethiopia, the demand for meat products is dramatically increasing and the consumption of raw meat becomes a symbol of status and many people now a day find it more preferable eating at restaurants than at their respective homes because of many reasons [52]. On the contrary, the full value chain of meat supply from abattoirs, distribution, butcher shops to final consumers are not properly handled to ensure the microbial quality, safety, soundness, and hygiene [51]. Also, meat handlers have been reported to lack meat safety knowledge, adequate training and observed to be frequently engaged in poor handling practices a long meat value chain [27].

In this country, food processing plants and food safety practices issue didn't get any concern yet. Thus, final consumer has limited information on quality and safety of the meat consumed regularly. Particularly, there is no study conducted concerning the assessment of hygienic meat handling practice and microbial load of meat and its contact surfaces in butcher shops in the area. However, these shops might be a source of meat-borne diseases and food poisoning among the population as they hardly adhere to any hygienic practices. Specially, Enterobacteriaceae such as; *E. Coli*, salmonella spp, shigella spp, enterobacter and etc. could easily contaminate meat since they use intestinal tract of warm blooded mammals asa natural habitat and ubiquitous [32]. For this high profile pathogenic bacteria (e.g. enterohemorrhagic *E. Coli*) red meat is principal source and it could contaminate meat at any stage of the value chain: during slaughtering, transportation to the retailers, at the retailers' shops or/ and during handling by the consumer [23]. In addition, poor personnel hygienic practices of food handlers and poor sanitation practices in meat processing plants are another major cause of contaminations [2].

Ideally, butchers should have a good understanding on meat hygiene and basic infrastructural facilities should be made available to them. Consequently, the aim of the study was, to figure out hygienic meat handling practices and the overall status of microbial load of meat and its contact surfaces in the area. So, the research work will help to highlight the area that needs improvement to reduce contamination with pathogens in butcher shops and during the distribution of carcasses. The results will inform the policy makers/local authorities/on areas that need reinforcement with regulations and an appropriate action plan.

Main Objective

To assess good hygienic handling practices and determine microbial load of meat and its contact surfaces in butcher shops in Bedele town, Buno Bedele zone.

Specific Objectives

1. To assess hygienic meat handling practices of butcher shops workers and associated causes of meat contamination in the area.
2. To determine microbial load of total viable count *Enterobacteriaceae*, total *E. Coli* counts and total *Staphylococcus* counts.

2. Materials and Methods

2.1. Study Area

The study was carried out on butcher shops in Bedele town. Bedele is an administrative town of Buno Bedele zone, Oromia regional state. It's located in the south-west of Ethiopia, 480 km from the capital Addis Ababa. Bedele town lies between latitude: 8°45' North and longitude: 36°35' East and altitude: 1990.00m/6528.87ft. Two municipal slaughter houses are present in the town intended to serve both Christians and Muslims. These two slaughter houses are found in the same compound in a very close proximity. However, currently Muslims are not using municipal abattoir for slaughtering. About 17 cattle slaughtered on average per day and slaughtering of shoats in municipal abattoir is not started yet. So slaughtering of small animals (sheep and goats) in warehouse/kitchen room and at the back of the

restaurant is common in the study area. About 25 butcher shops are present in the town. From these 25; 5 Muslim's and the rest are Christian's butcher shops. Bedele town has one district and two kebeles [18].

2.2. Study Design

A cross sectional study design was conducted from September 2021 to February 2022 in Bedele town to assess good hygienic handling practices and microbial load of meat and its contact surface in butcher shops. To demonstrate this, administering butcher shop workers with structured questionnaire survey and collection of microbiological samples from meat and meat contact surfaces was conducted.

2.2.1. Study Subjects

The subjects are meat, meat cutting boards, knives, workers' hands, meat hanging hooks and butcher shop workers. Different risk factors including age, educational level, work experiences, access to training, availability of infrastructures and etc. were considered as study variables.

2.2.2. Inclusion and Exclusion Criteria

Butcher shop workers who are available at the time of data collection and involved in meat handling practice, willing to participate in the study and ready to give the required information were included in the study. Those who are not involved in meat handling/processing or not willing to give the required information were excluded.

2.2.3. Sample Type and Sample Size Determination

Data on food handling practices was collected using face-to face interviews of butcher shop workers in the study area where as, samples for laboratory analysis were collected from meat and meat contact surfaces (swab samples). Hence sample size for questionnaire survey and microbiological investigation was determined differently. However, all butcher shop workers in the area were included in the study and samples for laboratory analysis were collected from all butcher shops. Accordingly, from the total of 25 registered butcher shops, in the town, 40 butchers were included in the study for interview and a total of 125 (25 meat samples and 100 environmental samples) were collected and analyzed.

2.2.4. Sample Collection Techniques and Procedures

Based on the information obtained from Bedele town municipality, the number of registered butcher shops and on active butchering operation were identified as 25. Hence, all the butcher shops found in the Bedele town were included in the study purposively. Then, butcher shops owners/workers were communicated for their willing to participate in the study and collection of microbiological samples. Also, we informed the objective of the study and confidentiality to participate in the study as stated in ethical approval letter. This way, following the interview, meat and swab samples from workers' hand, meat hanging hooks, meat cutting board and knives were collected aseptically using sterile moistened cotton wool swabs. An area of 20cm^2 was used for swabbing and cotton wool was slowly rolling over an area for 5-10 seconds to ensure the time of contact with the surface. Turning the direction of swabbing and apply the same procedures. The collected samples were soaked in to test tube containing 10ml of saline peptone water and labeled with appropriate information's. Meat sample weighing 1g weighed in a weighing scale was grinded to fine particles/fillet/ using knives and added to the solution. Then, collected samples were kept in the sterilized ice box cooler and transported to Bedele regional Veterinary laboratory soon after collection for bacteriological analysis as indicated [39].

Regarding assessments on food safety and handling practices, questionnaire survey (observational checklist) was administered to all butcher shops (Annex 1). Visual inspection and observations were applied mainly to determine the processing steps that are likely to introduce microbial contamination and also to have a fair idea about the general hygienic practices of butchers.

2.3. Study Methodology

The study methods include questionnaire survey and laboratory analysis of microbiological samples.

2.3.1. Questionnaire Survey

Data was collected by administering butcher shop workers with structured questionnaires. It was guided by a checklist on items. The main items on the checklist included the general conditions of the butcher shops, butcher shops facilities and general hygienic conditions, processing practices, personnel, equipment, transportation, demographic information's of the participants and etc. Before commencement of the data collection, the questionnaires were translated to Afaan Oromoo and then interview was conducted using local language.

2.3.2. Laboratory Analysis

Meat and swab samples collected from different study subjects were analyzed for total viable counts, *Enterobacteriaceae*, total *E. Coli* counts and total *Staphylococcus spp*. counts. All samples were subjected to general (nutrientagar, HIMEDIA) for total viable count, different differential and selective media (Violet red bile glucose agar (OXOID, UK) for *Enterobacteriaceae* counts, Macconkey agar (HIMEDIA) total *E. Coli*c ounts and Mannitol salt agar (HIMEDIA) for total *Staphylococcus* counts. All media were prepared according to manufacturer's instructions. Colonies identified on nutrient agar were carefully examined macroscopically for cultural characteristics such as the shape, color, size and consistency and compared with standard reference organisms of known taxa [13]. In addition, all appropriate biochemical tests were carried out according to standard procedures for further identification [46].

(i). Sample Preparation and Inoculation

In the laboratory, each test tube with meat and surface swabs samples were opened aseptically by flaming of the mouth part of test tubes. The samples were taken using sterile pipette and further diluted serially into 10 test tubes. The

diluents were mixed well and then 0.1ml of diluted sample was spread onto growth medium [48].

(ii). Enumeration of Viable Cell

Petri-dishes containing 30-300 colonies on agar plate were selected and the number of microbial colonies that was grown on each agar plate was counted manually. The number of distinct colonies on each plate was counted as colony forming unit per ml of sample volume and calculated by using dilution factor of its concentration and converted to log10cfu/cm^2 values. The mean values of total viable counts in log10cfu/g/cm^2 was determined and reported as means ± standard deviation [30].

(iii). Determination Total Viable Count

The total viable count was determined using nutrient agar by spread plate method. Serial dilutions of 10^{-1} to 10^{-10} were prepared by diluting of sample in to 9ml of sterilized distilled water. Then, 0.1ml of diluted sample was spread over solidified growth medium (agar). The plates were incubated at 37°C for 24 hours and all grown colonies were counted.

(iv). Detection of Enterobacteriaceae

Enterobacteriaceae was enumerated by spread plate method on violet red bile glucose agar (VRBG). Serial dilutions of 10^{-1} to 10^{-10} were prepared by diluting of sample into 9ml of sterilized distilled water. Then, 0.1ml of diluted sample was spread over solidified growth medium (agar). The plates were incubated for 24hours at 37°C and colonies seen to be pink to red, purple were counted.

(v). Detection of Staphylococcus Species

Staphylococcus species were enumerated by spread plate method on mannitol salt agar (MSA). Serial dilutions of 10^{-1} to 10^{-10} were prepared by diluting of sample into 9ml of sterilized distilled water. Then, 0.1ml of diluted sample was spread over solidified growth medium (agar). The plates were incubated for 24 hours at 37°C. After incubation yellow and light red colonies were counted as *Staphylococcus spp.* counts.

(vi). Detection of Escherichia coli

Escherichia coli were enumerated by spread plate method on solidified Mac Conkey agar. Serial dilutions of 10^{-1} to 10^{-10} were prepared by diluting of sample into 9ml of sterilized distilled water. Then, 0.1ml of diluted sample was spread over solidified growth medium (agar). The plates were incubated for 24 hours at 37°C. After incubation, red and dark pink colonies were counted as *E. coli*.

2.4. Data Management and Analysis

The collected data was enter into a Microsoft Excel spread sheet and analyzed with Statistical Package for Social Sciences (SPSS) version 20. All bacterial counts were normalized to cfu/cm^2/g and converted into Log10 values. Descriptive statistics and one way ANOVA were computed at P-value<0.05 in order to draw a conclusion.

3. Results

3.1. Survey Result

3.1.1. Socio-demographic Characteristics of Participants

All participants were males with age up to 40 years. Concerning level education, 32.5% had primary (1-8) school education, 60% had secondary (9-12) school education and 7.5% tertiary (college) level of education. Secondary level was the leading educational level and all study participants had at least basic education. Majority (72.5%) of respondents had an experience of less than five years and the rest 27.5% lies in between 5-10 years. None of respondents had attended any training on meat hygiene and food handling (Table 1).

Table 1. *Socio-demographic characteristics of butcher shop workers.*

Characteristics	Interviewee	Frequency (%)
Gender	Male	40 (100%)
	Female	0
Age	18-30 years	18 (45%)
	31-40 years	22 (55%)
Experience	0-4 years	29 (72.5%)
	5-10 years	11 (27.5%)
Level of educations	Primary educ.	13 (32.5%)
	Secondary educ.	24 (60%)
	College	3 (7.5%)
Hygiene and sanitation training	Trained	0
	Untrained	40 (100%)

3.1.2. Hygienic Practices of Butchers

As presented in table 2, majority (67.5%) of butchers always use white coat at work and 32.5% of workers wore protective clothes sometimes. In addition, about 52.5% butcher men didn't use head cover and the rest 47.5% wore sometimes (even if they had head cover they didn't wear it at work). Regarding hand washing, 75% of workers were washing their hand with soap and the rest 25% of them washing their hand with water only. Concerning medical certificate/checkup follows, 42.5% butchery attendants had valid health certificate and follow medical checkup at six months intervals and 57.5% had no medical checkup schedule and visit hospital when sick only. In terms of hygienic conditions of butcher men protective clothes, 70% were found in poor hygienic

conditions (presence of visible dirty and grease) and only 30% were found in good hygienic condition (absence of visible dirty and grease).

Table 2. *Hygienic practices of butchers.*

Characteristics	Activity	Description	Frequency (%)
Personal hygiene	Use of white coat	Always	27 (67.5%)
		Sometimes	13 (32.5%)
	Head cover	Always	-
		Sometimes	19 (47.5%)
		Never	21 (52.5%)
	Hand washing	With water and sanitizers	-
		With water and soap	30 (75%)
		With water only	10 (25%)
	Medical check up	Six months interval	17 (42.5%)
		No medical check up follow	23 (57.5%)
Hygienic conditions of butchers protective clothes	Cleaning	Good	12 (30%)
		Poor	28 (70%)

3.1.3. Hygienic Practices in Butcher Shops

Table 3. *Hygienic practices in butcher shops.*

Characteristic	Description	Frequency (%)
Meat selling time	5-8hrs	2 (8%)
	9-12hrs	17 (68%)
	Above 12hrs	6 (24%)
Meat transportation to sale points	Push trucks	6 (24%)
	motorbikes/Bajaj/	15 (60%)
	Manpower	4 (16%)
Flies and other insects prevention techniques	Glass window	15 (60%)
	No physical prevention	10 (40%)
Frequencies of cleaning butcher shops surfaces	Twice per day	7 (28%)
	At the end of the day	18 (72%)
Time set for cleaning	Yes	-
	No	25 (100%)
Money handling	Butcher	25 (100%)
	Cashier	-
Meat cutting equipment sterilization	With hot water	-
	No	25 (100%)
Presence of refrigerator for meat preservation	Present	-
	Absent	25 (100%)
Hygienic condition of meat chopping boards	Good	7 (28%)
	Poor	18 (72%)

Current study revealed that, none of butcher shop had separate cashier. Moreover, regarding equipment hygiene, none of butcher shop uses hot water (82°C) in order to sterilize knives and other meat cutting equipment. All butcher shop workers reported to sell unchilled meat since all of butcher shops had no refrigerators in their shops. Majorities (72%) of meat chopping tables were too dirty with some pieces of meat on it and found in a poor hygienic condition. About 60% of retail meat outlets were preventing flies and other insect flies in their shops using glass window. The remaining butcher shops didn't consider the importance of flies and other insect prevention i.e the shop is stay open through the day without any physical and chemical mechanism of controlling flies and other insects. Concerning selling time, majority (68%) of butcher shops reported to finish selling meat within (9-12hrs) and 24% had finished after one day. Only 8% had finished within 8hrs. What is more, in terms of frequencies of cleaning butcher shops surfaces, majority (72%) cleaning at the end of the day and 28% cleaning butcher shops premises twice per day. Regarding meat transportation from abattoir to their respective butcher shops, majority uses motor bikes/bajaj while 24% and 16% of butcher shops uses push tracks and manpower (basins on the head, hands and shoulder) respectively (Table 3).

3.2. Microbial Load of Meat and Its Contact Surfaces in Butcher Shops

The present study revealed that, total viable count was ranged between 4.31-8.27$\log_{10}$ over the study period and overall mean count was 6.22 ± .78. Mean load of total viable count in all sample types; Meat cutting boards, Hands, Knives, Meat and Meat hanging hooks were 6.44 ± .67$\log_{10}/cm^2$, 6.12 ± .66$\log_{10}/cm^2$, 6.08 ± .87$\log_{10}/cm^2$, 6.26 ± .87$\log_{10}/g$ and 6.20 ± .86$\log_{10}/cm^2$ in that order. The highest microbial load was obtained from meat hanging hook, while the lowest was from workers hands (table 4).

Table 4. *Total viable counts.*

Sample sources	Number	Minimum	Maximum	Mean±SD
CB	25	4.99	7.57	6.44 ± .67
H	25	4.31	7.20	6.12 ± .66
K	25	4.66	7.88	6.08 ± .87
M	25	4.80	7.45	6.26 ± .87
HH	25	4.84	8.27	6.20 ± .86

CB (Cutting Board), H (Hands) K (Knives*),* M (Meat), HH (Hanging Hook), SD (Standard Deviation).

As shown in table 5, out of 125 samples analyzed for *Enterobacteriaceae*, 52% were contaminated with *Enterobacteriaceae*. In similar way, 38.4% and 28.8% of samples were contaminated by total *E. Coli* and total *Staphylococcus* species respectively. A mean counts for *Enterobacteriaceae,* total *E. Coli* and total *Staphylococcus* counts were 5.32± .65, 5.19± .86 and 5.05± .75 respectively.

Table 5. *Load counts of selected bacteria.*

Sample Source	Number	Minimum	Maximum	Mean±SD
TEB	65	3.85	6.97	5.32 ± .65
TEC	48	3.65	7.30	5.19 ± .86
TS	36	3.49	6.43	5.07 ± .75

EB (*Enterobacteriaceae*), TEC (Total*E. Coli*) TS (Total *Staphylococcus species),* SD (Standard Deviation).

Table 6. *Concerned bacterial load per sample sources.*

Sample	*Enterobacteriaceae*			Total *E. Coli*			Total *Staphylococcus spp.*		
Sources	Min	Max	Mean±SD	Min	Max	Mean±SD	Min	Max	Mean±SD
CB	4.32	6.97	5.31 ± .64	3.86	7.14	5.19 ± .94	3.57	6.39	4.66 ± .81
H	3.85	6.00	4.97 ± .66	3.65	5.92	4.65 ± .87	4.10	6.43	5.36 ± .68
K	3.90	6.25	5.20 ± .68	4.03	5.87	5.00 ± .63	4.64	6.40	5.33 ± .64
HH	4.35	6.73	5.58 ± .79	4.28	5.89	5.27 ± .66	4.69	4.78	4.73 ± .06
M	4.86	6.43	5.52 ± .51	3.74	7.30	5.46 ± .91	3.49	5.55	4.81 ± .79

CB (Cutting Board), H (Hands), K (Knives), HH (Hanging Hook) and M (Meat), SD (Standard Deviation).

As presented in table 6, the highest *Enterobacteriaceae* load was counted in meat chopping boards and the lowest was from workers hands. In similar way, *E. Coli*, was high in meat samples and the lowest in workers hands. Concerning, *staphylococcus* counts. The highest load was detected in workers hands and lower was recorded in meat sample.

4. Discussion

All butcher shop workers included in this study were male. It is uncommon to see when females involved in slaughtering of animals and meat cutting activities in this country. This job is considered as a man's trade since it's a physical job-actually being able to lift these large animals. That is why uncommon to see females in butcheries anywhere in the world. This is similar with the study conducted in Kampala, Uganda in which all study participants were male [40] and well supported by study conducted in Kenya Nairobi, Limuru and Eldoret sites where 98.98% of study participants were male [32]. Regarding age of participants, 45% of them had an age between 18-30 years and the rest 55% aged between (31-40) years. It's usual to perceive adult man in this industry because; straggling with large animal is not simple task and need to be mature enough especially in slaughtering of animals. This is comparative with study reported in Rwunge district, Tanzania where majority of participants (about 50%) were aged 20-30 years and about one third were between 31-40 years and the least involved age group was that above 40 years (1.6%) [35].

None of the study participants took training regarding sanitation and hygienic food handling practices. This is indicates the absence of attention given by local authority or any stakeholders in the area. However, training of food handlers concerning basic concepts and requirements of personal hygiene plays a key role for ensuring safe food. This result is unlike of study reported in Bishoftu where 41.67% of study participants were took training concerning food safety [1] and hygiene and in Addis Ababa where 65.5% of butchers were took training concerning food safety and hygiene food handling practices [33]. This difference is may be due to better compliance to food safety standards and sanitation and hygienic practices is better in these two study sites.

Present study revealed that, majority (60%) of butcher shop workers were graduates of secondary school and 32.5% of participants were primary (1-8) school graduates followed by college graduates (7.5%). This finding is almost similar with the study conducted in Kenya, Nairobi where 74% of Small Medium Enterprises butchery operators had secondary school level of education and 10% had not gone to school [17] and in Accra, Ghana in which 50% and 35% of participants included in that study were secondary and primary school graduates respectively [38]. About 72.5% of butcher shop workers had an experience of less than 4 years and only 27.5% of butchers had an experience of more than four years. However, none of butcher man was permanently employed. This shows that, there are no formal hiring procedures and no written agreement between employer and employee. So, everything is in the hands of the owner. This is similar with research finding reported in Kenya where none of the butchery attendant was permanently employed except where the owners coupled as butchery attendant [32].

The current study shows that, only 42.5% of the participants had valid health certificate. This indicates that, there is a possibility of selling meat by sick butchers who could be a threat to food safety and the importance of regular medical checkup is not common in the area. However, the food processing staff should include healthy individuals who

donot have any diseases, and they should undergo regular medical check-ups. In addition, food processing plants should have to adhere to CAC recommendation, 'Persons who come in to direct or indirect contact with edible parts of animals or meat in the course of their work should maintain appropriate personal cleanliness and behaviour, and should not be clinically affected by communicable agents likely to be transmitted by meat'[15].

The study finding showed that, all butchers hold money while serving consumer/customer/or there is no separate cashier. This is the same with findings reported in Bahirdar where all butchers were handling money with bare hands [34] and in Addis Ababa in which only one butcher shop had separate cashier [33]. However, handling of carcasses and money with the same unwashed hands could be good sources of contamination [43]. In addition, research finding showed that, currency notes can serve as vehicles for transmission of enteric diseases and other organisms which may be pathogenic [41]. This is a serious problem which needs to be corrected by local authority and the owners since paper currency is highly contaminated and easily transfer microbial to meat from handlers.

The present study shows that, 67.5% of butchers wore white coat always at work and the rest 32.5% wore sometimes. In addition, about 52.5% butcher men had no head cover and the rest wore sometimes. None of butcher men uses head cover at work always. This shows most of the workers in butcher shops had no habits of wearing protective clothes and there is no strict regulatory follow up or no understanding on its importance. However, the practice of wearing protective clothes during selling of meat is important since it helps to reduce the burden of contaminants in meat processing [44]. Hygiene practices that should be performed by food processing workers include precise adherence to personal hygiene regulations and the wearing appropriate work attire [16]. Unless, practices like wearing dirty clothes and uncovered hairs during operation in the butcher shops could lead to cross contamination with pathogenic microbes making the meat unsafe to the consumer.

Regarding hand washing, 75% of workers were washing their hands with soap and the rest 25% of them washing their hand with water only. Despite to their answer, none of butcher shops had running water in their butcher shops premises and majority lacked soap for washing and no sanitizer's facility at all in retail meat outlets in the study area. However, according to the CDC, hand-washing is the single most important procedure for preventing the spread of infection [6] and it is well known that proper personal hygiene is the best way to mitigate the risks associated with contamination by most of the bacteria generally seen as being responsible for food-borne diseases [53]. In addition, study showed that, a 44°C water hand rinse removed 90% of microbial contamination from workers hands [9]. Thus, adopting hygienic practice of washing hand with lukewarm water and soap before and after sale of meat could reduce microbial contamination of meat ensuring safe meat products to the consumer.

The study conveyed that, none of butcher shops used disinfectants/sanitizers/ for cleaning butcher shop surfaces or for personal hygiene and none of butcheries had set time for cleaning shops or meat cutting equipment. This may be unaware due to lack of knowledge on effect safe food sanitizers on microbial load reduction/elimination/. Similar finding was reported in Kenya Nairobi, Limuru and Eldoret sites where none of the butchers used a disinfectant while washing the surfaces in contact with meat because they claimed it was expensive and none of butcheries had set time for cleaning equipment at all [32]. Nevertheless, regular and an effective cleaning procedure may lead to a significant reduction (of up to 99.8%) of bacteria occurring on the food processing equipment [19].

All butcheries stored meat at room temperature, on display table and meat hanging hook for more than 6 hours on average. This is may be due to inadequate financial capacity to invest in safer equipment and lack of engagement in formal trade. However, studies on meat storage have showed an increased microbial load in meat among meat vendors who do not have adequate storage facilities and frozen meat samples had less bacterial load than fresh samples [22]. This is nearly the same with study reported in Adis Ababa 94% of butcher shops had no refrigerator [33].

Regarding meat transportation from abattoir to their respective butcher shops, majority uses bajaj/motor bikes/ while 24% and 16% of butcher shops uses push tracks and man power (basins on the head, hands and shoulder) respectively. This is comparable with some finding where about 75% of the butcher shops use manpower while others used motor bikes for meat transportation [26]. However, such like means of transportations of meat from abattoir to retail meat outlets could be sources of contamination since often lack regular cleanliness and are not well covered leading to contamination by dusts, insects and flies [42]. Bedele Municipality has bought vehicle in 2006 E.C intended to give meat transportation service from abattoir to butcher shops. However, still butcher shops are using Bajaj, push tracks and man power which is not recommended for meat transportation since the vehicle is not providing the service for different reasons. As butchery attendants enunciated, when they request for vehicle services municipality responded that, there is fuel shortage. Even there is no permanently or temporarily engaged worker in slaughtering of animals and incase the butcher shop owners bring their men for slaughtering of animals. Not only bring slaughter men water also for carcass washing since there was no water facility in abattoir at all during the study period.

There was no set time for cleaning premises and equipment used in butcheries and no hot water bath (sink) for knives sterilization and other equipment. Even they don't know the need of sterilizing equipment using hot water bath (80°C). This shows that, absence of compliance with food safety standards and good hygienic meat handling practices in the area. This is the same with research finding reported in Dire Dawa administrative city and Haramaya University, Ethiopia in which the knives used for filleting and cutting were not sanitized at any of the retail houses visited during

the study period [37]. However, warm water approximately 80°C is important in order to kill germs and effectively remove grease from dishes [36]. For example *E. coli* dies at temperature of 70°C [28].

Majority of meat and contact surfaces samples examined for total viable counts were greater than 5log10 and over all mean load microbial count was 6.22 ± .78log_{10}. This is in agreement with some finding where all the samples from butcher shops were classified as unsatisfactory [33]. However, lower microbial load when compared with other scholar finding where a mean APC was 8.3log10/cm^2 from three different study locations around Addis Ababa city, Ethiopia [25] and 9.61log10 total viable counts from beef sample [14]. On the contrary, higher microbial load was recorded in this study compared to study conducted in Selangor Malaysia where 4.77±1.14log/cm^2 was obtained from all contact surfaces [49]. However, according to FAO total viable plate count numbers exceeding 100000/g/cm^2 (5.0log10) on fresh meat are not acceptable and alarm signals and meat hygiene along the slaughter and meat handling chain must be urgently improved [24].

In regard to mean load of total viable count in sample types; Meat cutting boards, Hands, Knives, Meat and Meat hanging hooks were 6.44 ± .67log_{10}/cm^2, 6.12 ± .66log_{10}/cm^2, 6.08 ± .87log10/cm^2, 6.26 ± .87log10/g and 6.20 ± .86/cm^2 in that order. This is almost similar with study conducted in Gondar town where the mean load of meat contact surfaces; meat cutting boards, knives and workers hands as of 6.52, 7.84 and 6.96log10/cm^2 respectively [54] and in Jigjiga, Ethiopia where a mean of knives and hooks, cutting boards and butchers' hands were found to be 6.01±0.07, 6.03±0.15 and 5.90±0.07 respectively [29]. This is may be due to similar infrastructures or facility and activity of butchers. The highest (8.27log10/cm^2) microbial load was obtained from meat hanging hook and the lowest load was from worker's hand. This may be due to hanging hook in convenient to clean and not frequently clean compare to other equipment. Concerning butchers hands, washing hands with soap may be the reason for low bacterial load from workers hands since about 80% of butchers said that, they use soap for washing their hands.

In terms of prevalence of selected hygienic indicator bacteria, out of 125 samples collected and examined, 38.4% were contaminated by total *E. Coli*. This result is higher compared to some study finding where 23.33% of meat contact surfaces from abattoir and retail meat outlets were positive for *E. Coli* [37] and *E. coli* was detected in 29.17% of samples collected from meat contact surfaces of butcher shops in Addis Ababa [33]. Regarding staphylococci species, of total analyzed meat and contact surfaces samples, 28.8% were implicated with staphylococci species. This result is similar with the study finding reported in Mekele where the same finding of staphylococci species in meat contact surfaces [21] and comparable with other research finding where 24.53% of samples were implicated with staphylococci species [54]. In addition, of total 125 meats and swab samples, 52% were found to be contaminated with *Enterobacteriaceae* and the mean load was 5.32 ± .65log/cm^2 which is exceeded the standard limit set for *Enterobacteriaceae* (3.0log10). This finding is different from the result of the study reported in Selangor where, *Enterobacteriaceae* was found on 75% of the samples at 3.31±1.14log cfu/cm^2 [49]. However, according to FAO *Enterobacteriaceae* counting numbers exceeding 1000/g/cm^2 (3.0log10) on fresh meat are not acceptable and alarm signals and meat hygiene along thes laughter and meat handling chain must be urgently improved [24].

The mean counts for *staphylococci species* was 5.05 ± .75. This is similar with the result of study conducted in Addis Ababa where 5.17±74log mean count for total *staphylococci* in minced meat and meat contact surfaces of selected butcher shops [33]. Similarly, the mean count of *E. Coli* recorded in this study was 5.19 ± .86. However, different from what was reported by some researchers who found 2.67±1.19log10cfu/cm^2 mean bacterial count from retail meat outlets [5] and who reported 2.01±2.09log10cfu/cm^2 mean counts of *E. Coli* in meat samples from different body locations [17]. The difference is may be due to better hygienic practices and facilities in the butcher shops.

In terms of mean load of study subjects, mean of *Enterobacteriaceae* counts were 5.20 ± .68log10cfu/cm^2 and 5.31± .64logcu/cm^2 from knives and cutting boards respectively. Similar to this study, some scholars reported the mean counts of knives and working tables as 5.51 and 5.34log·cfu/cm^2 respectively [29]. However, this finding is unlike of the study result reported in Nigeria where the mean count for *Enterobacteriaceae* and coliform in wooden tables used in sale of meat were found to be 8.81-11.47log10cfu/cm^2 and 8.35±86log10cfu/cm^2 respectively [3]. Mean counts of total staphylococcus from hands, knives, meat cutting boards and meats were 5.36 ± .68log/cm^2, 5.33± .64log/cm^2, 4.66± .81log/cm^2 and 4.81 ± .79log10/g respectively. This finding is comparable with the study conducted in Kolkata where the mean load of total *staphylococci* from workers hands, knives and meat cutting board as of 3.88±0.31, 3.55 and 5.72±0.62 respectively [47]. And mean values of *E. Coli* from meat cutting boards, knives, hanging hooks and meat were 5.19 ± .94log/cm^2, 5.00 ± .63log/cm^2, 5.27 ± .66log/cm^2 and 5.46 ± .91log/g respectively. This finding is almost similar with the study conducted in Aba Metropolis, Nigeria where who reported 6.23log/cm^2, 5.2loglcm^2 and 6.48log/cm^2 from meat cutting tables, hands and meat cutting knives respectively [8]. However, higher load compared to the study conducted in Nairobi where 2.29log/cm^2 and 2.68log/cm^2 in workers hands and clothes respectively [17]. This may be due to poor sanitation and hygienic practices observed in this study.

5. Conclusions and Recommendations

The findings of this study showed that, there was high bacteriological load which is above acceptable level and poor personnel hygiene and sanitation practices in butcher shops in the area. Meat contamination in butcher shops resulted from the use of contaminated equipment and unhygienic practices associated with poor handling practices and lack of

infrastructures, or facilities. Meat transportation from abattoir to sale point is carried out by the mechanisms which enhance meat contamination. The butcher shops never stored meat at an appropriate low temperature and never used sanitizers and detergents in their butcher shops. Additionally, there was no habit of meat cutting equipment sterilization and wearing proper work attire. None of butcher shops worker was attended any course or training regarding hygienic food handling practices. All these situations are evidences that leads to contamination of meat and to various cross-contaminations. Based on the above conclusions, the following recommendations are sends on;

a. The local authority needs to give attention in implementing the quality standard regulations on the sanitation of the butcher shops and over all good hygiene practices.
b. Training should be given for meat handlers/butchery attendants/ at least twice per year by local authority or stakeholders/anyothers/.
c. Butcher men should follow sanitary procedures and always remember to use protective clothes at work.
d. Bedele municipality should be deliver services expected from it and fulfill facilities associated with municipal abattoir as a whole.
e. Further investigations should be conducted to isolate pathogenic bacterial species and serotypes.

List of Acronyms and Abbreviations

ANOVA	Analysis of Variances
APC	Aerobic Plate Count
APHA	American Public Health Association
CAC	Codex Alimentarius Commission
CFU	Colony Forming Unit
FAO	Food and Agriculture Organization
ISO	International Organization for Standardization
WHO	World Health Organization

Conflicts of Interest

There was no conflict of interest.

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