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Assessment of Hygienic Practices and Microbial Quality of Meat at Slaughterhouses and Butcher's Shops in West Hararghe Zone, Ethiopia

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ABSTRACT

The objective of the study was to assess the hygienic practices and microbial quality of meat at slaughterhouses and butcher's shops in West Hararghe Zone, Oromia, Ethiopia. A cross-sectional study design was used during April 2019 and August 2019 with a sample size of 52 study participants who worked in a slaughterhouse and/or meat retailing outlets in Chiro and Hirna towns. The data were collected using semi-structured questionnaire followed by laboratory analysis. The safety of meat products was determined by counting Total Viable Bacterial, Total Coliform, *Enterobacter*, and *Staphylococcus* spp. The result of this study showed that meat handlers were mostly uneducated working without protective cloths. Slaughtering and post slaughtering process in many premises were unhygienic, which causes a high risk of cross-contamination and is hazardous for public health. Microbial load both in slaughterhouses and butcher's shops were higher than the recommended standards. Overall the mean total bacterial counts, coliform counts, *Enterobacter* and *staphylococcus* spp. values were 7.01±0.25 log10CFU/cm^2, 6.02±0.29 log10CFU/cm^2, 6.950±0.16 log10CFU/cm^2 and 6.36±0.2 log10CFU/cm^2, respectively. This might be due to cross-contamination through poor personal hygiene, lack of demarcation between dirt and clean met products in the slaughterhouses, evisceration, and dressing on an unhygienic floor.

Keywords: Butcher's shop, Hygienic Practices, Microbial quality, Meat, Slaughterhouse.

INTRODUCTION

The quality of livestock products in Ethiopia especially red meat is substandard. This is due to poor handling, transportation, production practice in slaughterhouses and unhygienic butcher house facilities, and inadequate hygiene of workers. Poor quality meat results in defects in processing properties, functional and eating qualities and is less likely to be accepted by consumers (Ferguson & Warner, 2008). Besides, the major factor for the emergence of food borne illness is eating habits of the community, poor handling, unsanitary slaughterhouse facilities, unsafe food storage conditions, and transportation (Kebede et al., 2014). Contaminated raw meat is one of the main sources of food-borne illnesses. The risk of transmission of zoonotic infections (Anthrax, Avian influenza, Leptospirosis, etc.) is also associated with contaminated meat. A study conducted in Morocco (Cohen et al., 2006) has reported that food-borne diseases still represent one of the main causes of morbidity.

In Ethiopia, with a limited scope of study and lack of integration between the producer and quality control authority, it is difficult to alleviate the burden of food-borne pathogens on public health hazards, and under-reporting of the disease was overshadowed the problem of food borne pathogens (Oosterom, 1991).

Improving awareness about hygienic production practices and proper implementation of meat inspection procedures during slaughtering are vitally needed part of the national public health protection program to address a day-to-day threat to consumers. Because of continuous consumer demand for meat products, especially the consumption of raw meat as part of the culture, it is necessary to ensure good quality, safe meat products through regular assessments of hygienic production practices, the microbial quality of meat products, and adequate waste management systems. However, there have been few studies undertaken on the evaluation of hygiene, microbial quality, safety, soundness, and wholesomeness of meat in Ethiopia. Therefore, the current research study was designed to assess hygienic practice and microbial quality of meat at slaughterhouse and butcher houses in West Hararghe Zone, Oromia, Ethiopia.

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MATERIALS AND METHODS

Description of Study Area:

The study was conducted from March 2019 to June 2021 in West Hararghe Zone, Oromia National Regional State. The study area is located 325 km far from Addis Ababa, the capital city of Ethiopia, The study area are located between 7° 52' 15''- 9° 28' 43'' N latitude and 40° 03' 33''– 40° 34'' 13'' E longitude with an altitude of 1200-3600 m above sea level. The mean annual rainfall of the area is between 650 and 1500 mm; the average temperature is 20.5˚C and 24˚C from West Hararghe Zonal Agriculture and Natural Recourse Office.

Study Design:

A cross-sectional study was carried out and data was collected from slaughterhouses and butcher'shouse/meat retailing area of Chiro and Hirna towns. A semi-structured questionnaire was used to conduct the survey concerning facilities, equipment, the current status of food hygiene and sanitation practices in slaughterhouses and butcher shops. A systematic random sampling technique was employed to select each butcher's shops and evaluate meat quality and safety.

Data Collection:

A survey using direct observation and a questionnaire was carried out to acquire data on meat hygiene, food safety knowledge, and handling practices of slaughterhouse and meat retailers. For this study, retailers selling mainly meat of goat and beef were considered. All of the workers in the two slaughterhouses were considered for the interview and a total of 20 meat retailers (10 from each town) were recruited using a simple random sampling technique.

A total of 100 meat samples were collected from the slaughterhouse and various meat selling locations and the types of meat (goat and beef) were taken proportionally. About 20 meat samples (10 from each town slaughterhouse on two non-consecutive days) were taken randomly throughout the research period and 80 meat samples (in two rounds i.e. 40 in each, however, the average value was considered) were taken randomly from previously surveyed meat retailers to carry out a microbial analysis. Samples were collected between April and August 2019; and transported in cold sterile screw-cap bottles kept in an ice-filled icebox to Oda Bultum University College of Agriculture, Animal Science Laboratory for microbial analysis.

Sample Collection and Preparation:

For microbiological analysis, 25 g of meat sample from selected meat cuts were transferred aseptically into 225 ml of sterile distilled water and homogenized for 1-3 minutes. On the other hand, each tube containing swab samples (10 ml of 0.1% saline water) was vortexed for10 s to ensure a mixture of the sample. A tenfold serial dilution was prepared by transferring 1 ml of the homogenized sample (both, meat and swab) to 9 ml diluents. From appropriate serial dilutions, 0.1 ml aliquots were plated on various types of media for microbial counts (Gurmu & Gebretinsae, 2013).

Microbiological Analysis:

The microbiological quality and safety of meat and meat products were conducted to determine the Total Viable Bacterial Count (TVBC), Total Coliform Count (TCC), *Enterobacter* count, and *Staphylococcus aureus* Count using Plate count agar, Violet Red Bile Agar, Mac Conkey agar, Mannitol Salt Agar, and Salmonella-Shigella agar respectively.

Total Viable Bacterial Count:

The total bacterial count of all samples was determined using standard plate count agar. A 0.1 ml of sample from appropriate dilution was pipetted and spread on a standard pre-solidified plate count agar medium. Inoculated plates were incubated at 32 °C for 48-72 hrs. After incubation, plates with colonies between 30-300 were counted (International Organization for Standards, 2009).

Total coliform count:

A 0.1 ml of homogenate from appropriate dilution was pipetted and spread on Violet Red Bile Agar, after incubating inoculated plates at 32^{o}C for 24 hrs and counts were made on typical dark red colonies normally measuring at least 0.5mm in diameter on uncrowned plates (Richardson, 1985).

Enterobacteria count:

To count the members of Enterobacteriaceae, 0.1 ml from appropriate serial dilution of the samples were spread plated on MacConkey agar (SRL Diagnostics) supplemented with glucose and incubated at 35^{0}C for 24 h. All reddish purple/pink colonies were counted as members of Enterobacteriaceae (American Public Health Association, 2012).

Staphylococci count:

For staphylococci count, Mannitol Salt Agar (MSA, OXOID) were surface plated with 0.1ml of the homogenate. The inoculated plates were incubated at 35 ± 2^{o}C for 36 hrs. Then, golden yellow color colonies were counted as staphylococci. After counting and recording bacterial colonies in each Petri dish, the number of bacteria in a milligram of meat was calculated by the formula given by (Food Drug Administration, 1998).

$$N = \frac{\sum C}{[(1 \times n_1) + (0.1 \times n_2) \times (d)}$$

Where:-

N = Number of colonies per ml of meat sample
ΣC = Sum of all colonies on plates counted
n_1 = Number of plates used in lowest dilution counted
n_2 = Number of plates used in highest dilution counted
d = dilution factor of the lowest dilution used.

Data Analysis:

Data collected from the survey were summarized on a Microsoft excel sheet and analyzed using descriptive statistics (mean and percentage) by using statistical package for social sciences, version 20. The log-transformed values were analyzed using the General Linear Model for least square mean in Statistical Analysis Software. Mean comparisons with Duncan's Multiple Range Test were used to see the mean difference between sampling sources and confidence level was held at 95% and statistical analysis was considered significant at $p<0.05$.

RESULTS

Observation Survey of Butcher Shops:

According to the survey results less than half of food handlers (42.5%) were illiterate, almost half (47.5%) of them completed elementary level education. However, only 10% of them had completed their secondary school education (Table 1). Based on observation, only 25% of the butcher shops were found in good sanitary condition and the rest were in a poor state 75%.

Risk of Contamination and Hygiene at Slaughterhouses:

The production of good quality food is accomplished through implementation of quality control measures by workers who have adequate educational level, training on personal hygiene and food handling and who practice environmental and food contact surface hygiene. These are among the top priority areas to have a positive impact on food quality and public health. These factors were considered among slaughterhouse workers (respondents) and are presented in Table 2.

Table 1: Educational status, infrastructure and meat handling practices of informants in Butcher's shop

Variable	Category	Frequency n (%)
Educational status	Illiterate	17 (42.5)
	Primary level	19 (47.5)
	Secondary level	04 (10.0)
Work experience	0 - 4 years	11 (27.5)
	5- 10 year's	27 (67.5)
	11 - 20 years'	02 (5.0)
	Above 20 years	0 (0.0)
Meat transporting vehicle	Yes	33 (82.5)
	No	07 (17.5)
White coat and head cover	Yes	23 (57.5)
	No	17 (42.5)
Meat chopping material(wood/ plastic	Wood	28 (45.0)
	Plastic	12 (30.0)
Hygiene of chopping block	Good	21 (52.5)
	Poor	19 (47.5)
Cleaning and sterilization technique	Yes	09 (22.5)
	No	31 (77.5)
Paper money handling	Yes	32 (80.0)
	No	08 (20.0)
Presences of flies	Yes	28 (70.0)
	No	12 (30.0)
Visible skin rash, boils, cuts, or wounds	Yes	05 (12.5)
	No	35 (87.5)
Health certificate	Yes	03 (7.5)
	No	37 (92.5)
Training	Yes	06 (15.0)
	No	34 (85.0)
Refrigerator usage	Yes	29 (72.5)
	No	11 (27.5)

Table 2: Education status, infrastructure and meat handling practices of informants in Slaughterhouse

Variables	Category	Frequency n (%)
Educational level	Illiterate	3 (25.0)
	Primary level	4 (33.3)
	Secondary level	2 (16.7)
	Tertiary level	3 (25.0)
Work experience	0 - 4 years	2 (16.7)
	5- 10 year's	6 (50.0)
	11 - 20 years'	4 (33.3)
	above 20 years	0 (0.0)
health certificate	Yes	7 (58.3)
	No	5 (41.7)
White coat and head cover	Yes	8 (66.7)
	No	4 (33.3)
hygienic condition of coat	Good	5 (62.5)
	Poor	3 (37.5)
Available of adequate Water in Slaughterhouse	Good	9 (75.0)
	Poor	3 (25.0)
Washing and sterilizing of knives after skinning and evisceration	Yes	8 (66.7)
	No	4 (33.3)
Frequency of cleaning and disinfection	Daily	12 (100)
	Twice weekly -	0 (0.0)
	Thrice weekly	0 (0.0)
inspection	Yes	8 (66.7)
	No	4 (33.3)
Demarcation between the dirty and clean	Yes	10 (83.3)
	No	2 (16.7)
carcasses and offal come into contact with floors	Yes	3 (25.0)
	No	9 (75.0)

Table 3: Means (± S.E) of microbial counts (log10CFU/ cm^2) meat collected from slaughterhouse and Butcher's shop

Variables With sources	Number of samples (n)	TVBC	TCC	*Enterobacter*	*Staphylococcus*
Chiro Butcher shop	(20)	7.5725 ± 0.554^{a}	6.8117 ± 0.785^{a}	7.199 ± 0.258^{b}	6.0973±0.343c
Hirna Butcher shop	(20)	7.2037 ± 0.554^{a}	6.1329 ± 0.785^{b}	7.016 ± 0.258^{b}	6.7290±0.343b
Chiro slaughterhouse	(10)	6.40 ± 0.219^{a}	5.5407 ± 0.681^{a}	6.910 ± 0.333^{b}	5.938 ± 0.251^{c}
Hirna slaughterhouse	(10)	6.8462 ± 0.024^{b}	5.6094 ± 0.682^{a}	6.453 ± 0.335^{b}	6.661 ± 0.434^{b}
Overall mean	(60)	7.01 ± 0.25^{c}	6.02 ± 0.29^{c}	6.950 ± 0.16^{c}	6.36 ± 0.2^{b}

All of the Means followed by different superscripts within columns are significantly different ($P < 0.05$), TVBC= Total Viable Bacteria Count, TCC= Total Coliform Count.

Microbial Quality of Meat:

The current results of TCC, *Enterobacter, and Staphylococcus* count are presented in Table 3. The meat samples were collected from Chiro and Hirna municipal slaughterhouses and butcher shops. The mean TVBC, TCC, *Enterobacter*, and *Staphylococcus* counts obtained in this study were 7.01 ± 0.25 log10cfu/g, 6.02 ± 0.29 log10cfu/g, 6.950 ± 0.16 log10cfu/g, and 6.36 ± 0.2 log10cfu/g, respectively. The mean bacterial load was not significantly different ($p < 0.05$).

DISCUSSION

The Division of Food and Nutrition, World Health Organization, (1996) stated that food handlers should wear clean and proper clothing and should wash their hands with soap and water after any activity that is likely to introduce hazards. Moreover, Ethiopian Ministry of Agriculture (2010) recommends that personal clothing can carry microorganisms (germs) that have been gathered from a wide variety of sources into the meat or meat handling facility. However, nearly

half of the butcher houses workers or meat handlers did not wear protective clothes though they had more than 5 years of work experiences. In fact, the educational status of informants was relatively low as compared to the meat handlers from Gondar town in Ethiopia (Yenealem, et al., 2020). Therefore, the level of personal hygiene and the surrounding environment plays a significant role to produce a food product free from microbial contamination that fit for human consumption.

In the present study, it was noticed that one-third of the shops had clean washrooms located in reasonable distances from meat display sites. Moreover, two-thirds of the butcher houses were flies free associated with wooden chopping material under poor hygienic condition. The result of this investigation showed that nearly 80% of the butcher shop had a separate cashier which might had a significant value for meat quality. On the contrary, Zerabruk, et al. (2019), Gurmu and Gebretinse (2013) from Ethiopia, and Chepkemoi et al. (2015) from Kenya states that more than 90% of the butchers were handled money concomitantly selling meat. This condition might increase the chance of contamination; therefore, the butcher shops play a remarkable role to fight foodborne illness by avoiding such practice.

In spite of the fact that personal and environmental hygiene is a potential source of contamination; the workers by themselves can be a probable source due to illness. Out of the interviewee meat handlers, about 92.5 % had no health certificate and periodic health status checkups, Bersisa, et al. (2019) reported a similar finding from Bisheftu, Ethiopia. Conversely, periodical health checkups and availability of respective certificates was reported from Addis Ababa Ethiopia Zerabruk, et al. (2019). Although training on personal hygiene and food handling is important to safeguard the consumer against foodborne illness, 85% of the respondents were untrained in the present study. However, more than 60% of the workers had training access (Bhandare et al. 2009; Haileselassie et al. 2013; Zerabruk, et al. 2019).

To reduce the growth and replication of microorganisms, 72.5% of the butcher house had a refrigerator to keep the unsold meet at the end of the day. However, in Tanzania, 85% and 76.7% of butcher shops in Morogoro and Arusha lack refrigerators (Nonga et al. 2010). In fact, only 11% of the butchers had stored beef in refrigerators (Chepkemoi et al., 2015) and no refrigerators in retail meat outlets (Zerabruk, et al. 2019; Nonga et al. 2010; Ntanga et al. 2014).

Education of labor proportionally associated with the level of the hygienic condition of the slaughterhouse operations (Mothershaw et al., 2006). In the present study, 33.5% of informants were uneducated. However, 44.4% and 22.2% of the respondents completed primary and high school education, respectively. However, majority of slaughterhouse operators from Gondar, Ethiopia and Kaduna State, Nigeria had secondary school completed (Birhanu, et al. 2017; Gali et al. 2020). Moreover, Ethiopia's Food, Medicine, and Health Care Administration and Control Proclamation (No. 661/2009) state that anyone working in food catering must have a certificate of competence from the appropriate organization.

Concerned to the work experience, more than half of the respondents had five to ten years of work experience which is similar to the report from Nigeria (Gali et al. 2020). In the present study, 22.2% of the slaughterhouse worker did not have health certificate which might results in potential source of public health hazard such as diarrhea, sore throat, fever, cold or open skin lesions. However, health checkups for slaughterhouse workers at the time of employment and every six months were reported in Debrezeit, Ethiopia (Aynewa et al. 2021). In fact, it was suggested that food handlers must undertake medical examinations before employment to assess their general health (Ziady et al. 1997).

Many scientific findings state that meat handlers are the main cause of microbiological contamination; hence wearing protective clothing protects the meat from contamination. A substantial percentage of the slaughterhouse workers wore a white coat and head cover among those about 62.5 % of them could keep the hygienic condition of their coat, which was similar to the report of Bersisa, et al. (2019) and Aynewa et al. (2021) from Bisheftu, Ethiopia. Therefore, correct practices of using aprons, white coats, boots, and hair masking was appropriate at each slaughterhouse and it was critical to shield both the personnel and the meat from exposure to pathogens.

In the present study, bleeding, de-hiding, and evisceration of the carcass were carried out on the floor which indicated the substandard hygienic condition. Similar findings were reported from different parts of Ethiopia, Nigeria, Tanzania, and India (Gutema et al., 2021; Haileselassie et al., 2013; Adzitey et al., 2011; Nnenna et al., 2021). The lack of training for food handlers regarding basic concepts and requirements of personal and environmental hygiene could be the main reason for substandard hygienic condition. However, the reason of poor implementation of government control of the system cannot be ignored. In this regard, the UK Audit Commission suggested a strong link between food-borne illness with poor hygienic practices and low level of training. Therefore, Higher and more urgent intervention is required from the food regulatory agency can help

maintain the unhealthy practice that leads to a risk of human infection.

Access to water is indispensable for hand and knife washing to remove potential surface contaminants and to prevent further cross-contamination of meat. It was noticed that the municipal slaughterhouse had plenty of water for washing and sterilizing knives after skinning and evisceration, to fulfill the general principles of food hygiene (Codex Alimentarius Commission 2020). On the contrary Bersisa et al. (2019) reported that Bisheftu butcher shops had poor hygienic conditions and insufficient access to washing and sanitizing facilities, (Bhandare et al., 2007; Komba et al., 2012). To produce wholesome and fit-for-human-consumption meat and meat products, the building should be well-constructed and well-maintained, and the floors should be kept waterproof and thoroughly wiped clean and disinfected immediately after slaughter. Therefore, establishing slaughterhouses ready with important centers and simple infrastructures might enhance the hygienic manufacturing in slaughterhouses especially in government-based municipal slaughterhouses in Ethiopia.

In the present study, all slaughterhouses were wiped clean daily, in line with all personnel. Some of the respondents reported the temporary demarcation and availability of meat inspector in slaughterhouses. However, no demarcation and regular meat inspection in the slaughterhouses was noticed during study period. In fact, it was reported that many slaughterhouses and slaughter slabs in developing countries are poorly designed and have insufficient slaughter as well as meat inspection amenities. In addition to this, qualified meat inspectors are always in short supply (Komba et al., 2012). Moreover, performing skinning and evisceration on the ground without separating the dirty and clean areas increases the risk of cross-contamination during meat processing, putting meat consumers at risk of foodborne illness.

Concerning on bacterial load found in meat samples collected in this study was failed to comply with the standard given for raw meat intended for direct human consumption. Cross-contamination of carcasses that occurs during slaughtering /processing and handling, such as skinning, evisceration, storage, and distribution at slaughterhouses could be the probable reason of the cross contamination. However, reason of retail establishments and personal hygiene cannot be ignored for cross-contamination. In fact, slaughtered animals may have relatively few bacteria (Kagambèga et al., 2011) but the meat surface exposed to contamination during slaughter, evisceration, and other post slaughter operations, transportation conditions and exposure during vending operations could lead to contamination (Kagambèga et al., 2011).

Among Chiro and Hirna towns, count of TVBC and TCC was lower in slaughter hourse and higher in butcher shope of Chiro town as compared with the Hirna town. However, results of the present study showed the higher limit than the permissible limit as indicated by FAO/WHO (2005) and Codex (2011). Similar higher ranges of bacterial load was reported in Uganda and Egypt (Bhandare et al., 2007; Elsharawy et al., 2018). However, bacterial load in prescripbed range by FAO/WHO (2005) and Codex (2011) was noticed in slaughterhouse of Bahir Dar, Adama, Jijiga and bisheftu towns of Ethiopia (Gebeyehu et al., 2013; Tafesse et al., 2014; Azage and Kibret, 2017; Bersisa et al., 2019). The reason for such higher limits of bacterial load could be due to the unhygienic conditions or improper handling carried out during slaughter as well as post slaughter activity.

As per the FAO/WHO (2005) and Health Protection Agency (2009), meat and meat products are unaccepted for human consumption if coliform count is greater than 25log10CFU/cm^2 and 4log10 CFU/g, respectively. The result of the present study, coliform count was greater than the prescribed limits in slaughter and butcher shop of Chiro and Hirna towns of Ethiopia. Similar report was reported in Uganda and Ghana (Bogere & Baluka, 2014; Hughes et al., 2015). Observations indicated low adherence of butcher men in wearing protective clothing and the same people who handled meat received money and these could be the reasons for high microbial load contamination at butcheries (Chepkemoi et al., 2015). In a related study, hands were found to be a major source of infection from microorganisms in foodstuff (Kahraman et al., 2010). The butcheries were located along the roadside and this exposed the meat to dust raised by automobiles (Bogere & Baluka, 2014). In the study, several butcheries were located next to each other and the butcher men shared weighing scales, stones, and cutting tools and besides the microbial load increased with a longer stay of meat at the butchery (Obeng et al., 2013). Some butcheries share refrigerators with retail shops hence meat is kept with other commodities such as beverages, water, and other ready-to-eat foods (Mirembe et al., 2015) and this can be a source of contamination.

Concerned with *enterobacter*, the bacterial load reported in this study was much higher than the recommended standards. The recommended standard for *enterobacter* counts should be les than 2.5log10cfu/g (FAO/WHO 2005; Health Protection Agency 2009). Similar higher limts of *enterobacter* load was reported in some of the butcher's shop in Addis Ababa, Ethiopia. (Zerabruk et al. 2019). Javadi & Safarmashaei,

(2011) have reported harboring of enterobacter could be due to improperly handled food products and that their presence on meat can be a result of cross-contamination from the animals´ intestine hides and slaughterhouse environment and it is also true in the present study where poor handling and production was noticed. In the current study it was noticed that there is no demarcation between the dirty and clean and a higher possibility of contacting the floor, hide, blood, and green offal's, which leads to a potential risk for community health hazards. Moreover, the high occurrence of *Enterobacter spp*., which are indicators of fecal contamination, further confirms the high level of meat contamination (Akano et al., 2013; Ukut et al., 2010). Staphylococcus spp. count reported in the present study was higher than the standard set by Codex Alimentary Commission (2005). Similar higher staphylococcus spp. load was reported from Addis Ababa and Adama towns of Ethiopia (Teshome et al. 2020; Gebeyehu et al. (2013). Risk factors study by Adugna et al. (2018) reports a high prevalence of *Staphylococcus* from swap samples collected from cutting tables, knives and hooks support the study. According to Okonkwo et al. (2008), Iroha et al. (2011), the presence of Staphylococcus spp. on raw meat is a consequence of cross-contamination from meat handlers, their clothes as well as processing equipment to the raw meat which is true in the present study too. The ubiquity of Staphylococcus spp. lends more support or credence to this. A high incidence of Staphylococcus spp. may affect the taste, smell, and physical appearance of the meat. *Staphylococcus aureus* is an important food poisoning agent. In addition, some strains of *Staphylococcus aureus* produce enterotoxin. Staphylococcal enterotoxin is heat stable and can withstand boiling for thirty minutes. Ingestion of this toxin may cause sudden onset of illness within 3 to 4 hours, which is often characterized by nausea, vomiting, and diarrhea Okonkwo et al. (2008).

In conclusion, poor personal hygiene along with low educational status, lack of training on food handling, personal and environmental hygiene, poor sanitation of the butcher shops and slaughterhouses are among the predominant factors those led to the contamination of beef meat and seriously compromise the quality of the meat products. In addition, there were no veterinary laboratory, sterilization facilities, hot water service, and hazard analysis and critical control point. In spite of the fact that most of the meat retailer houses had access to a refrigerator, it has a significant effect to reduce microbial growth on unsold meat during the day time, the overall hygienic standard of the meat outlet and slaughterhouse is below the standard of the general principles of food hygiene (Codex Alimentarius Commission 2020). The microbial quality of meat in the study area was below standard set by WHO and European commission. Therefore, hygienic production and distribution of meat are vital to eliminate or reduce public health risks and prevent zoonotic disease and economic losses due to premature spoilage of meat caused by cross-contamination. Besides, the concerned organizations should create awareness among meat handlers and slaughterhouse workers about the importance and ways of hygienic meat processing practices and proper handling and finally the government should create awareness establish standard slaughterhouse appropriate location outside the town with hygiene design facilities, large slaughter capacity, proper meat inspectorate services, and effective implementation of food safety measures through application of hazard analysis and critical control point and, and employ well train butchers so that cross-contamination at slaughterhouse level should be reduced.

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COMPETING INTERESTS

The authors have declared that they have no competing interest.

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