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Microbiological Quality and Safety of Raw Meat at Slaughterhouse and Butchers' Shop in Assosa Town, Benishangul Gumuz Regional State, Western Ethiopia

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Abstract: Meat and meat products are suited for microbial growth and it becomes contaminated with a variety of microorganisms during the slaughtering and dressing process and some of which are pathogens. The objective of this study was to count, isolate, and identifies different pathogens & indicators in beef samples at Abattoir and Retail outlets in Assosa town. A cross-sectional study was done on a total of 70 samples of raw meat (beef); 35 samples from butchers' shop in the town and 35 samples at Abattoir from May 2018 to February 2019. Mean bacterial counts in beef were compared by one way ANOVA through SPSS 20. Significance of differences held at $p<0.05$. The range count of aerobic mesophilic bacteria at Butchers shop and Abattoir was 2.75 - 7.52 $\log_{10}$cfu/g and 2.49 - 5.16 $\log_{10}$cfu/g, respectively. Similarly, the count range of *S. aureus* at the Butchers shop and Abattoir was 2.74 4.84 $\log_{10}$CFU/g and 2.71 4.72 $\log_{10}$cfu/g, respectively. 13 (37.1%) at Abattoir and 17 (48.6%) at Retail outlets were contaminated to *E. coli* whereas 9 (25.7%) and 12 (34.3%) of the sample from Abattoir and retail outlets were contaminated with *Salmonella spp.*, respectively. Coliforms were absent at 11 (31.4%) and 5 (14.3%) of the total samples from Abattoir and Retail outlets, respectively. Only 13 (38.71%) and 6 (17.14%) of the samples at Abattoir and Retail outlets, respectively were satisfactory for *S. aureus*. While 80% at the Abattoir and 57.7% at Butchers shop of the samples were satisfactory for AMB. The handling and environmental hygiene of butchers' in the town showed that 2 (77.1%) and 29 (82.9%) of the meat contact surface and the carcass; were unprotected and easily exposed to flies, respectively. Only (2, 12.5%) workers in the slaughterhouse had been taken training on food hygiene & safety, and (3, 18.8%) wore hand gloves during slaughtering. The majority of the food samples were within acceptable and some at satisfactory quality range but still it indicates high microbial contamination of the raw meat especially those from butchers. There were also some difficulties to achieve slaughtering in the working area due to a shortage of work-related facilities. Therefore, the town administration office and other concerned bodies should fulfill facilities and adequate training for butchers/workers on their hygiene, sanitation and handling of the raw meat.

Keywords: Abattoir, Butchers' Shop, Pathogens, Raw Meat

1. Introduction

Raw meats are defined as any kind of uncooked muscle tissue of an animal used for food and it supports the growth of both spoilage and pathogenic bacteria, this is often due to its high moisture contents, has fermentable carbohydrate, a rich source of protein and fat, favorable pH; and related growth factors [1]. Bacteria, toxins, viruses, protozoa, and parasites are biological hazards in meat; however, the foremost important is bacteria since bacteria cause an outsized proportion (approximately 90%) of all foodborne illnesses [1]. On the other hand opposite hand, microbial contamination of meat and meat products must not exceed levels that would adversely affect the period of the product; if it is, it renders the meat unwholesome and unfit for human consumption [9]. As an example, the study conducted by Clarence et al. [2] showed that the mean microbial load on the fresh meat ranged from $3x10^3$cfu/g to $1.5x10^4$cfu/g and

$7x10^3$ to $2.8x10^4$cfu/g which taken from two different sites while meat taken from another site was $3x10^4$ to too numerous to count (TNTC). Risks for human illness related to consumption of meat are often reduced through controlling points of potential contamination within the field, during harvesting, processing and distribution, or in retail markets, food service facilities, or within the home [3].

Moreover, the consumption of meat and meat products in Ethiopia has been associated with both cultural and religious practices. Of all, cultural and religious considerations have played a big role within the preparation and consumption of raw meat, and therefore the stews also are made mainly from beef, lamb, and chicken [4]. In turn, large numbers of meat retail shops are available in Assosa town and the majority of consumers buy and eat raw meats as the type of *"Kitfo", "Kurt"* or *"Gored gorid"* at which food hygiene and safety conditions aren't assured and through which contaminated meat is one of the foremost sources of foodborne illness.

Ensuring a safe meat supply has been one of the main challenges and concerns for producers, consumers, and public health officials in both developing and developed countries. This is often because meats excessively contaminated with spoilage and pathogenic microorganism can cause food borne illness. Pathogenic bacteria like Salmonella species, Staphylococcus aureus, Listeria monocytogens, Campylobacter spp., and Escherichia coli (E. coli O157:H7) have been implicated in some food borne illnesses [5]. Similarly, the study conducted by Clarence et al. [2] revealed that six genera of the isolated bacteria were observed from fresh meat includes Staphylococcus, E. coli, Klebsiella, Pseudomonas, Bacillus, and Enterococcus.

Raw or undercooked meat is especially susceptible to contamination. Consistent with the study conducted by Ahmad et al. [6]; E. coli, S. aureus, and Salmonella were detected from a total of 45%, 72%, and 26% samples respectively. And 51% of meat samples had aerobic mesophilic bacteria (AMB) greater than 6 log 10 CFU/cm^2, indicates highly contaminated meat which is a responsible role in spoilage and food-borne illnesses. On the other hand, a study conducted on slaughtered meat quality in Jimma by Anbessa Dabassa [7] revealed that the bulk of meat samples had contaminant microorganisms and a few pathogens. Similarly, the prevalence of Salmonella positive within the meat retail shop was 40.2% [8].

Although healthy animals don't contain microorganisms, the meat gets contamination during the varying stages of slaughtering and transportation as well as shopping of the carcasses [5]. The occurrence of pathogens like Salmonella in beef carcasses varies greatly. The general contamination of meat carcasses with these pathogens not only depends on the prevalence and numbers of the pathogens on the hair, skin, and within the intestinal tract of the animal but also cross-contamination occurring from these sources during slaughter and processing. The meat, available at shops comes through an extended chain of slaughtering and transportation, where each step may pose a risk of pathogen contamination. The sanitary conditions of abattoirs and shops of its surroundings also are major factors affecting the bacterial contamination of meat [9].

This study was conducted to determine the quality and safety of meat at a slaughterhouse and those sold in butchers' shopand assessed food handling practices, knowledge, and also the surrounding environments of the study area Assosa town, Western Ethiopia.

2. Materials and Method

2.1. Study Area Description

The present study was conducted at a Butchers shop and Slaughterhouse (Abattoir) located in Assosa town Benishangul gumuz region which is about 661km far away from Addis Ababa, the capital city of Ethiopia. The study region is found in the northwestern part of the country between 09°17'to 12°06' north latitude and 34°10' to 37°4' east longitude [10] and has a total area of about 50,382-kilometer square [11].

2.2. Study Design, Size, and Collection

A cross-sectional experimental study was conducted from May 2018 to February 2019 to determine the bacteriological quality and safety of raw meat at Slaughterhouse and Retail shops also on assessing the handling practices of raw meat in Assosa town. The study retail outlets were selected randomly.

A total of 70 raw meat samples during which 35 each were collected from different butchers' shops and slaughterhouse using sterile glass containers and every one the samples were transported to Assosa University biology lab and stored in a refrigerator until microbiological analysis was done.

2.3. Sample Preparation

Twenty five grams (25g) of the raw meat sample was chopped and homogenized with 225ml sterilizing buffered peptone water (Oxoid LTD., England) for five minutes in a sterilized flask followed by ten-fold serial dilutions (10^{-1} to 10^{-4}) of homogenates and subjected to microbial enumeration and isolation.

2.4. Bacteriological Analyses of Raw Meat Sample

2.4.1. Aerobic Mesophilic Bacteria (AMB) Enumeration

An aliquot of 1 ml of every serially diluted sample was inoculated into the pre-dried duplicate Petri dishes followed by plate count agar (15-20 ml) was poured on each plate and incubated at 37°C for a maximum of 48 hours [12].

2.4.2. Enumeration of Staphylococcus Aureus

Spread plate count method and Mannitol salt agar plates were used and all plates incubated at 37°C for a maximum of 48hrs [13]. Yellow or orange colonies surrounded by yellow zones due to mannitol fermentation were enumerated and reported as mean log CFU/g.

2.4.3. Total Coliform Count

From previously prepared serial dilution (10^{-1}, 10^{-2} & 10^{-}

^{3}),one milliliter of every dilution was inoculated into triplicate tubes containing sterile Lauryl Tryptose Broth (Blulux Laboratories (p) Ltd, India) with inverted Durham tubes and incubated at 37°C for a range between 24 hours to 48 hours. Then for a confirmatory test, gas positive lauryl tryptose broth tubes at the end of the period were gently agitated and loopful of every culture was transferred to tubes of brilliant green bile (2%) broth (Oxoid, England) with inverted Durham tubes and incubated at 37°C for a maximum of 48 hours.

2.4.4. Isolation and Identification of E. coli

One ml of each serially diluted sample was inoculated to duplicate sterile Petri plates containing MacConkey agar medium and incubated at 37°C for twenty-four hours. For purification and refreshment purposes, suspicion of some colonies having bright and pink color was streaked on a nutrient slant and incubated for a further 24 hours. Then, transferred to Eosin methylene blue agar (EMB) and *E. coli* was confirmed by its transparent green metallic sheen color. A loopful (representative colony) from a culture on EMB agar was inoculated into a test tube with tryptone water and incubated for 24 hours at 44°C. The formation of indole detected by the addition of Kovacs reagent to tryptone water then the presence of indole is indicated by a red color the Kovacs reagent, forming a film over the aqueous phase of the medium. The presence of E. coli is confirmed by indole positive and metallic sheen on EMB agar [13].

2.4.5. Isolation and Identification of Salmonella

Twenty-five grams of every meat sample was blended and homogenized with225ml buffered peptone water and incubated for 24 hours at 37°C for pre-enrichment of Salmonella followed by enrichment on selective media. One ml and 0.1 ml of the pre-enriched sample was inoculated to 10 ml of the selenite-cystine (SC) broth, and 10 ml of Rappaport Visiladis broth (RVB), respectively. Samples on SC broth and RVB broth were incubated at 37°C and 42°C for 24h, respectively. Enriched Salmonella cultures were streaked onto Xylose Lysine Desoxycholate (XLD) agar and Brilliant green bile broth (BGB) and further incubated at 37°C for 12 hours. Typical colonies grown on XLD agar having a transparent zone of reddish color with or without a black center and colorless or white colonies on BGB due to the color change of the media were suspected for Salmonella [14].

Biochemical Test for Salmonella

After incubation on agar slant different biochemical tests on Triple Sugar Iron (TSI) slant, Voges-Proskauer (Vi) broth, Lysine Iron (LI) agar, Indole (I) broth, Methyl Red (M), Citrate (C) utilization were done and incubated for 18-24 hours at 37°C and checked for confirmation [15].

2.5. Assessments of Knowledge, Hygienic and Handling Practices of Workers at Different Retail Outlets and Slaughterhouse

The observation checklist as a form of semi-structured questionnaire and interview was used for assessing the hygienic practices of butchers and workers in a slaughterhouse and the sanitary conditions of the meat stored areas whether it is exposed to solid or liquid wastes, flies, insects, and animals. A total of 41 in which 35 and 16 respondents participated from retail outlets and slaughterhouse in Assosa town, respectively.

2.6. Data Analysis and Interpretation

One way ANOVA using SPSS software 20 was used for comparison of Bacterial counts in beef samples at various retail shops and abattoir (slaughterhouse). The significance of differences was held at $p<0.05$. Besides, descriptive statistics as a form of percentage and frequency were used.

3. Results and Discussion

3.1. Enumeration and Satisfactory Level of Aerobic Mesophilic Bacteria (AMB)

Plate count of aerobic mesophilic microorganisms found in meat is one among the microbiological indicators for food quality. The present study revealed that among the total meat sample analyzed in retail outlets; 26 (74.3%) were counted as contaminated AMB with minimum and maximum value of 2.75 and 7.52 log CFU/g, respectively (Table 1), whereas among analyzed samples at slaughterhouse; only 20 (57.1%) were contaminated and counted as AMB with minimum and maximum value of 2.49 and 5.16 log CFU/g, respectively. The mean and SD of viable bacteria (AMB) isolates from Abattoir and Butchers' shop was 4.03 log10cfu/g±0.90 and 5.04 log10cfu/g±1.41 respectively (Table 1). As the p-value showed that (Table 1) there have been significant differences in mean AMB counts between retail shops and abattoir, i.e., p=0.008.

Table 1. *Range and mean value of Aerobic mesophilic bacteria in terms of log10 CFU/gm of Raw meat at S. house and R. outlets in Assosa town, 2018.*

Raw meat site	No. of total samples (N)	No. of positive samples (n)	Positive samples (%)	log 10 CFU/gm		Mean	SD	P-value
				Minimum	Maximum			
S. house	35	20	57.1	2.49	5.16	4.03	0.90	
R. outlets	35	26	74.3	2.75	7.52	5.04	1.41	0.008
Total	70	46	65.7	2.49	7.52	4.60	1.31	

S. house* Slaughterhouse, R. outlets*Retail outlets, %* Percentage, SD*Standard Deviation

On the other hand, microbiological quality of AMB counted at Abattoir and retail shops showed that 78% and 57.7% of the samples were satisfactory level, respectively (figure 1) due to microbiological quality ranged less than 1×10^{5}cfu log/g, which indicates good microbiological quality (Rahman, 2007). Similarly, 2 (10%) and 3 (11.5%) samples

taken from Abattoir and retail shops were counted as marginal acceptable, respectively, and the remaining 13% and 30.8% out of each of 35 raw meat samples at the abattoir and retail outlets were observed as rejected, respectively (figure1) during which their microbiological level ranged less than 1×10^6 and equal or greater than 1×10^6cfu log/g categorized as marginal acceptable and rejected, respectively [16].

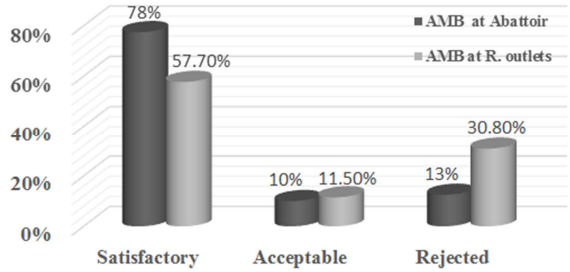

Figure 1. *The amount and percentage of satisfactory, marginal, and unsatisfactory level of Aerobic mesophilic bacteria (AMB) in Abattoir and retail outlets at Assosa town.*

A large number of aerobic bacteria counts make foods unsafe and that they indicate poor handling, storage, or inadequate general hygiene and overall it leads to unsatisfactory microbiological quality due to high aerobic colony counts (≥5 log CFU g-1) [17]. Although, AMB of any food articles is not a sure indicator of their safety for consumption, yet it's of supreme importance in judging the hygienic condition under which food has been produced, handled, and stored [18]. As the high incidences of bacterial contamination are mainly due to the unsanitary and largely unhygienic nature of the food [19]. High AMB may indicate that the length time-temperature control in storage and display facilities was inadequate to stop bacterial growth [20]. As compared to the present study of mean AMB value obtained in retail shops with results of other studies, this study was above that was reported by Cho et al. [21] with a mean of 4.71±1.53 logCFUg-1 for raw meats in Korea.

A similar study was conducted in Lagos [22], the entire aerobic bacteria count ranged from $3.3x10^3$to $5.9x10^6$ CFUg-1. On the opposite hand, the study conducted in Nigerian Butchers' shop reported by Ologhobo et al. [23], the highest Aerobic plate count was 6 log CFU/g. Moreover, wastewater and garbage discarded within the streets, and foods like meat aren't effectively shielded from dust and flies. It had been observed that raw meats were left uncovered and exposed to microbial contaminants during the whole selling period within the butchers' shop. These factors are likely to be linked to the high aerobic plate counts recorded in the present study.

3.2. Enumeration and Satisfactory Level of Staphylococcus Aureus

The present finding showed that 29 (82.8%) and 19 (54.3%) of raw meat samples were contaminated and counted to S. aurous at butchers shop and Abattoir with mean of 3.84 and 3.50 log10cfu/g, respectively (Table 2). However, the mean values of these samples were far greater than those reported for meat obtained at a retail shop, i.e., 2 log CFU/g [24]. Khalafalla et al. [25] also reported lower counts of staphylococci, i.e., 3 log CFU/g in in hamburger meat samples.

The minimum and maximum count of *S. aureus* at Retail outlet counts was 2.74log10cfu/g and 4.84 log10cfu/g,respectively, and similarly, the minimum and maximum count of S. aureus at Slaughterhouse counts was 2.71 log10cfu/g and 4.72 log10cfu/g, respectively (Table 2). While, as a table 2 showed, there are no statistical differences of mean microbial counts of raw meat at Slaughterhouse and Butchers' shop (p=0.170) since p value greater than 0.05.

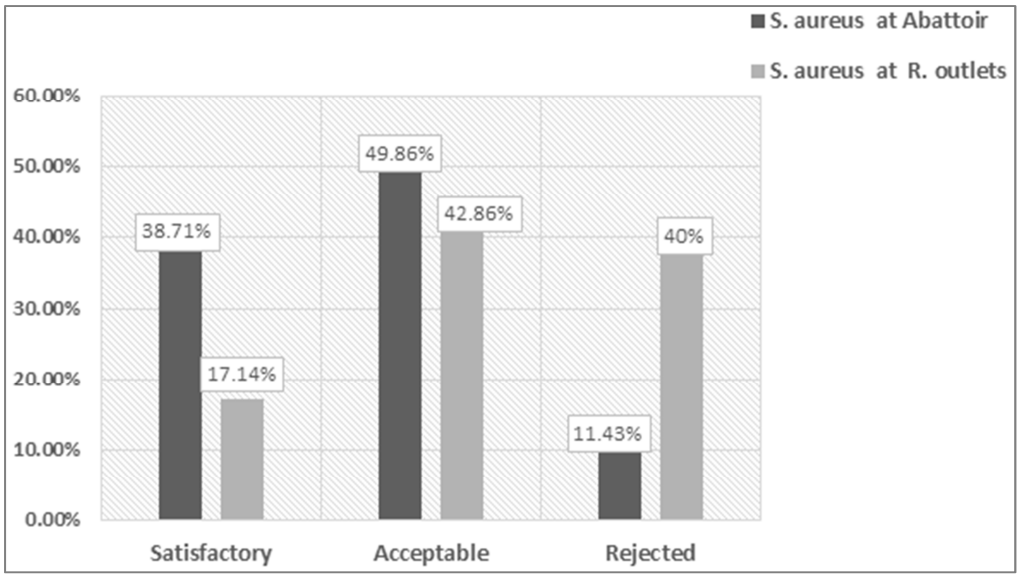

Figure 2. *The number and percentage of good, acceptable, and unsatisfactory levels of S. aureus at Abattoir and Retail outlets at Assosa town, 2018 (n=70).*

Table 2. *Mean and range value of Staphylococcus aureus in terms of log10 CFU/g of raw meat at S. house and R. outlets in Assosa town, 2018.*

Raw meat site	No. of total samples	No. of positive samples	% of pof positive samples	Log CFU/gm		Mean± SD	P-value
				Minimum	Maximum		
S. house	35	19	54.3	2.71	4.72	3.50 ± 0.54	
R. outlets	35	29	82.8	2.74	4.84	3.84 ± 0.61	0.170
Total	70	48	68.5	2.71	4.84	3.70 ± 0.60	

S. house* Slaughterhouse, R. outlets* Retail outlets, %* a percentage, SD*Standard Deviation

As it is shown (figure 2), 4 (11.43%) and 14 (40%) of the raw meat samples from Abattoir and Butchers shop, respectively were unsatisfactory (rejected) levels since results were out of acceptable microbiological limits (ranged $\geq 10^4$cfu/g) and those are potentially hazardous for consumers. The microbiological quality ranged $\geq 10^4$CFU/g due to inadequate temperature control and poor hygienic practices. The amount during this range may cause foodborne illness and immediate remedial actions should be initiated. 18 (49.86%) and 15 (42.86%) samples at the abattoir and retail outlets, respectively, were reported as marginal level (figure 2), in which their microbiological quality ranged from 10^2-10^3cfu/g results are borderline limits but may indicate possible hygiene problems within the preparation of the food. However, 13 (38.71%) and 6 (17.14%) of raw meat at Abattoir and retail outlets respectively were with satisfactory level (figure 2) which range less than 1×10^2cfu/g.

As compared to the result of the present study to the previous one, unsatisfactory levels of S. aureus in retail shops (40%) were higher rate during this study. For instance, during a study, from 200 samples of street vended ready-to-eat meats sold in Cameroon, 20 (10%) were contaminated with S. aureus [26]. Similarly, other studies conducted in Taiwan, S. aureus was detected with unsatisfactory levels of 17% of the entire sample [27].

The high count of staphylococci particularity in retail shops within the present study indicates that S. aureus are common bacteria found in unprocessed meat which handled by bare hands and contamination with S. aurous could be resulted from the origin of the meat or poor hygiene conditions such as hands or skins of handlers (human being) and hand touch. Due to faulty handling activities, they are typical contaminants with hands, discharge from humans and clothing, equipment, and temperature-time abuse before consumption that could cause further proliferation of the pathogen and the production of toxins by entero-toxigenic [28].

3.3. Enumeration of Total Coliforms

30 (87.7%) and 24 (68.6%) of the meat samples taken from shops and slaughterhouse were heavily contaminated with coliforms and the remaining 5 (14.3%) and 11 (31.4%) samples from shops and slaughterhouse, respectively were found negative for coliforms (figure 3). The above results reflect that meat samples were highly contaminated with coliforms suggests mostly fecal contamination and points to potentially sever hazard [29] indicates that raw meat sold in the town is unhygienic. The presence of coliforms of presumably human origin points to the risk of exposure to entero-pathogens as *Salmonella, Shigella,* and *entero pathogenic* [30]. However the presence of coliforms in the food doesn't necessarily indicate fecal contamination rather their presence at high levels implies a warning of unhygienic food handling may occur or processing was not effective [31].

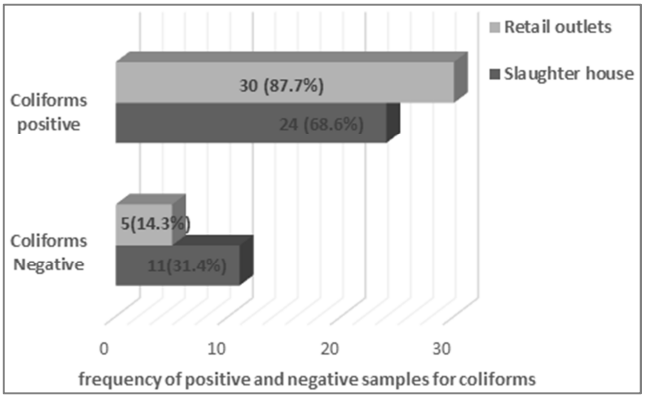

Figure 3. *The number and percentage of positive samples for total coliforms isolated from Abattoir and Retail outlets at Assosa town.*

3.4. Isolation and Identification of E. coli and Salmonella Species

Among the total of 70 samples, 35 each of retails and Abattoir, 17 (48.6%), and 13 (37.1%) were respectively contaminated with E. coli (Figure 4). E. coli in raw meat can significantly contribute that poor food handling practices and, its detection indicates recent fecal contamination through poor hygienic practices of meat vendors and also indicates the likelihood of contaminating enteric pathogens [32-34].

Besides, E. coli is a known causative agent of diarrhea and other food-borne related illnesses through the consumption of contaminated foodstuffs. Pathogenic members of the coliform group and other entero-bacteriacae families are represented by genera like salmonella and Shigella and are found within the intestines of humans and animals [35]. On the other hand, when the current study was compared with other studies, nearly the incidence of E. coli was found at retail shops, for instance, according to the study conducted by Kumar [36] reported that 16 (29.09%) out of 55 samples were contaminated with E. coli. Similarly, the present result was above those obtained in Korean from street vended raw meats, whereby 9 (45%) of street vended raw meat had been contaminated with E. coli [21]. A study in Mexico conducted by Diaz et al. [37] showed that E. coli has been detected in 37 (86%) from street vended meat, and this was so higher E. coli contamination level than the present study at both

abattoir and Butcher shops.

Overall, E. coli is one of the bacteria that exist within the normal micro flora of the intestinal tract of humans and animals. As observed during sample collection, the handling of meat with bare hands, non-usage of aprons, and absence of hair covering and handling of money while serving may additionally contribute to poor hygienic conditions. Such conditions could pose a favorable environment for E. coli and other pathogens contamination [38, 39].

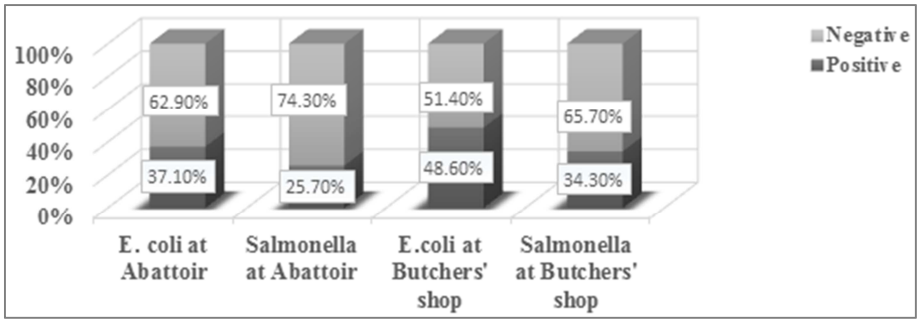

Figure 4. *Percentage of E. coli and Salmonella in raw meat at Slaughterhouse and retail shops.*

Similarly, as shown in figure 4, the percentage of positive samples isolated from Abattoir and retail outlets of Salmonella was 9 (25.7%) and 12 (34.3%), respectively. In line with the Center for Disease Control and Prevention (CDC), Salmonella is one of the foremost common causes of food-borne illnesses and certain strains are of serious importance due to the emerging resistance to common antibiotics [40]. The presence of Salmonella in ready to eat meat represents an important hazard for consumers because those pathogens are often liable for gastroenteritis, food poisoning, typhoid, and paratyphoid [41].

It had been found that the prevalence of salmonella spp. contamination at an abattoir in the present study was 9 (25.7%) out of 35 raw meat samples. However, the presence of even small numbers of salmonella in carcass meat may cause heavy contamination of meat. When the current study was compared with other studies, it had a higher prevalence of salmonella, as an example, as compared to previous findings conducted in Jimma town, 2 (1.2%) samples were contaminated with salmonella and 5 (8.3%) quite far as compared by Tasew et al. [42]. Whereas Salmonella isolation from raw meat at retail was 20% in the study conducted in Gaborone, Botswana [43], 9% in raw meat obtained from butchers shop in Awassa [44], and 42% in Addis Ababa [45]. A study was conducted in Taiwan, 41% of the raw meats were contaminated with salmonella species [46] which so exceeds the results of the present study. On the opposite hand, Mohammed et al. [47] highlighted that Salmonella poses threat to humans, and public practitioners should consider potential means of Salmonella transmission in meat during slaughtering and preparation is more common [48].

3.5. Assessments of Butchers' Knowledge to Foodborne Diseases in Assosa Town

In the present study the educational status of the respondents of meat vendors; 10 (28.6%), 12 (34.3%), 5 (14.3%), and 8 (22.86%) were illiterate, elementary, high school level, and college respectively (Table 4), which showed that the majority vendors are relatively educated. On the other hand, regarding knowledge about the foodborne disease; 21 (60%) respondents had considered knowledgeable about the foodborne disease and the remaining 14 (40%) were not, this may enhance the risk factor to contaminate the street vended meat in the present study which is contradicted to the findings of Ehiri et al. [49] stated in their study that the majority of the vendors 56 (70%) respondents who had taken in part of food hygiene education in Scotland and knew about the foodborne disease.

Unaware of personnel hygiene among food handlers is one of the foremost commonly reported practices contributing to foodborne illnesses [50]. Training may be a crucial prerequisite to the successful implementation of a food safety management system and food safety [51]. However, in the current study 21 (60%) respondents were not taken any training but the remaining 14 (40%) of them could take the training. Additionally, 18 (51.4%) respondents agreed that vendors should be prevented from vending if they were sick by diarrhea and the remaining 17 (48.6%) did not agree (Table 4). Meat is taken into account to be spoiled when it is unsuitable for human consumption and based on the present study 26 (74.3%) respondents had known a slice of given meat could be contaminated with vectors or flies, for instance, the vendors in the study site, they specified some reasons during which such contamination are often caused by a wide variety of factors such as improper handling and practices, exposure to open-air or by flies and cockroaches which carry the foremost common pathogenic microorganisms (4).

On the other hand, 9 out of 35 were non-knowledgeable with an idea of how meat might be contaminated, and unfortunately, 21 (60%) respondents disagreed about the idea that infected carrier butcher causes foodborne illness (table 3). The majority of the respondents; 29 (82.9%) knew foodborne diseases were preventable and that they gave the subsequent reasons; most meat-borne outbreaks are most serious difficult but it is easy to cease the spread of many types of infection through hand washing. This is often because the hands of food handlers can be a vector to spread

harmful microorganisms via cross-contamination (table 4).

To sum up this study, street vended meat in the study site were displayed and sold openly at very dirty surrounding on the roadside. This can easily be contaminated by dust, insects like cockroaches and flies, and handlers might transmit and enhance the extent of foodborne pathogens and those 26 (74.3%) respondents (butchers) did agree with this statement, and the remaining 9 (25.7%) of them could not. Additionally, 11 (31.4%) respondents had good knowledge about healthy food handlers might carry foodborne pathogens and unfortunately, 24 (68.6%) did not know (table 4).

An observational study was also used in the assessment of food safety practices by street vendors during their trade and the environment or vending site assessment. In which the observation stated that the raw meats had been displayed uncovered for above six hours for sale at ambient temperature on a table which might be used again and the majority of vendors were located very close to the main road. In which 29 (82.9%) meat retail outlets were exposed to dust and harbor vectors such as flies and again the majority of food vendors in the street had direct physical contaminants with the raw meat. On the other hand, vendors could handle money while serving meat to consumers, and this practice results in contamination of raw meat from dirty money through cross-contamination. Similarly, a study conducted by Hedberg et al. [52] found that 35% of vendors due to the bare hand contact with meat as a contributing factor with handling money. The sanitary condition of the vending environments also was poor as observed in the current study site (Table 5). All food handlers have a basic task to take care of a high degree of private cleanliness and observe hygienic and safe food handling practices. Keeping hands clean, shortening fingernails, wearing clean working garments, and hair cover (hairnet and cap) are a number of the precautions that a food handler must maintain [53]. In the present study, none of the vendors in retail shops had access to wear hand gloves and only 8 (22.9%) wore hairnets (Table 5). When this study was compared with other studies conducted by Çakiroglu and Ucar [54] reported that 82.9% of the staff wore caps, masks, and gloves during food production. Because hair is understood to harbor *S. aureus, it's* essential to prevent loose hair and dandruff from falling onto the food and food preparation areas by having a head or hand cover. Furthermore as shown (Table 5), 20 (57.1%) of street meat vendors achieved their activities under inadequate lighting, clean floor and wall. In most cases, 33 (94.3%) meat carcass was exposed to room temperature because there was no refrigeration/cooling facility to store and keep it. As a result, due to lack of refrigeration, the marketing process was opened and therefore the meat could be contaminated through different pathogens.

An assessment of the cleaning status of meat surface, equipment, or tables revealed that 27 (77.1%) of them being considered 'poor' or unprotected well and only the remaining 8 (22.9%) as good or protected well (Table 5). To sum up, food handlers should have a basic task to take care of a high degree of private and environmental cleanliness of the retail establishments, however, regarding this, only 11 (31.4%) of retail shops seems like clean, and an observation showed that, the majority, 24 (68.6%) of the hygienic status of retail (butcher) shops seemed like unclean and unsatisfactory (Table 5).

3.6. Assessment of the Hygienic Practice and Knowledge of Workers in Slaughterhouse and the Surrounding Environment of the Slaughterhouse in Assosa Town

The results of slaughterhouse workers Knowledge, handling practices; and environment observations in Assosa town are summarized in Table 6 and Table 7, respectively.

4. Conclusion and Recommendations

In the present study, the majority of the meat samples were within acceptable and some were satisfactory quality range but still, it indicates that high microbial contamination of the raw meat especially those that were sold by butchers. The percentage of the rejected level of raw meat samples was higher at Butchers shop for both AMB (30.8%) and S. aureus (40%) than Slaughterhouse AMB (13%) and S. aureus (11.43%). Similarly, a high count of E. coli, mean AMB, and total coliforms were obtained from the Butchers shop. The prevalence of salmonella was relatively less recorded at Slaughterhouse (25.7%) than Butchers' house (34.3%).

Still, the result showed that there is a need for hygiene to keep the safety of meat and following up the health of the animal to reduce contamination of meat and its products by pathogens. Most of the butchers and slaughtermen lack adequate training on food hygiene and safety as well as the slaughterhouse in the town are not well comforted and well established. Therefore adequate training should be given to butchers and slaughter workers and more emphasis on the re-establishment of the slaughterhouse by the Assosa town administration office and other concerned bodies.

Table 3. *Morphological and biochemical characteristics of bacteria isolated from raw meat at S. house & R. outlets.*

Isolated microorganisms			
Parameters	***Salmonella***	***S. aureus***	***E. coli***
Growth in Mannitol salt agar	N/A	Bright yellow (orange)	N/A
Growth in MacConkey agar	-	N/A	Red/pink
Grams reaction	-	+	-
Cellular morphology	Rod (Flagellated)	Cocci	Straight Rod
Coagulase test	-	+	-
Growth on TSI (Triple sugar iron agar)	Butt – Black	N/A Butt –Yellow	Slant – Red,

Isolated microorganisms			
Parameters	***Salmonella***	***S. aureus***	***E. coli***
Growth on Lysine iron agar (LIA)	Butt – Yellow	N/A	Butt & Slant – Red
Sugar fermentation	-	+	+
H_2S production	+	N/A	-
Gas formation	+	N/A	- (+)
IMViC test			
Indole test	-	-	+
Methyl red	+	N/A	+
Voges-proskauer	-	N/A	-
Citrate test	+	-	-

+* Positive (grown), -* Negative (not grown), N/A* Not applicable

Table 4. *Assessments of butchers' knowledge in relation to food borne diseases in Assosa town, 2018 (n=35).*

Parameters	**Frequency n=35**	**Percent**
Educational status Illiterate	10	28.6
Elementary	12	34.3
High school	5	14.3
College/University	8	22.9
Do you know about food borne disease?		
Yes	21	60
No	14	40
Have you taken any training on food hygiene and safety?		
Yes	14	40
No	21	60
Do you work when you have diarrhea?		
Yes	18	51.4
No	17	48.6
Do you know reason for food contamination?		
Yes	26	74.3
If yes, please specify…		
No	9	25.7
Do you know that food borne diseases are preventable?		
Yes (If yes, how…)	29	82.9
No	6	17.1
Do you agree that raw meat can be contaminated through cross contamination with handlers?		
Strongly agree	9	25.7
Agree	12	34.3
No opinion	2	5.7
Strongly disagree	12	34.3
Food borne pathogens can be seen by naked eyes?		
Yes	17	48.6
No	18	51.4
Are insects such as cockroaches and flies might transmit foodborne pathogens?		
Yes	26	74.3
No	9	25.7
Apparently healthy food handlers might carry food borne pathogens?		
Yes	11	31.4
No	24	68.6

Table 5. *Assessments of meat vendors' handling practices and surrounding environments of Retail outlets, Assosa town, 2018 (n=35).*

Characteristics	**Frequency**	**Percent**
Cleaning status of meat contact surface, equipment or tables		
Protected well	8	22.9
Unprotected	27	77.1
Food handlers (butchers) in retail shops wear gowns appropriately?		
Yes	10	28.6
No	25	71.4
Food handlers (butchers) in retail shops wear hairnets?		
Yes	8	22.9
No	27	77.1
Fingernails of the meat handlers?		
Clean & trimmed	9	25.7
Not trimmed & unclean	27	74.3
The carcass is stored and kept properly in the refrigerator?		
Yes	2	5.7

Characteristics	Frequency	Percent
No	33	94.3
If any contact of the carcass with the bare hands of the butcher's?		
Yes	35	100
No	-	-
Is their proper solid /liquid/ waste storage receptacle near the vending site?		
Not available	30	85.7
Available (proper)	3	8.6
Available but improperly	2	5.7
Is the vending area with a cleaned floor, wall and adequate lighting?		
Yes	15	42.9
No	20	57.1
Is the carcass in retail shops (outlets) easily exposed to harbor vectors such as flies?		
Yes	29	82.9
No	6	17.1
Is there any discharging from vender nose, eye, ear or cough during visit		
Observed	3	8.6
No observed	32	91.4
Vendors handling money while vending the raw meat?		
Yes	29	82.9
No	6	17.1
What look like the general hygiene situation of retail shop		
Clean (Satisfactory)	11	31.4
Not clean (Un satisfactory)	24	68.6

Table 6. *Slaughter's workers Knowledge and handling practices in Assosa town, 2018.*

Characteristics	Frequency n=16	Percent
Educational status		
Illiterate	1	6.25
Elementary	10	62.5
High school	5	31.25
Preparatory	-	-
College	-	-
Do you know about food borne disease?		
Yes	11	68.75
No	5	31.25
Have you taken any training on food hygiene and safety?		
Yes	2	12.5
No	14	87.5
Do you work when you have diarrhea?		
Yes	1	6.25
No	15	93.75
Are you examined your health status recently?		
Yes	7	43.75
No	9	56.25
Do you know reason for food contamination?		
Yes	9	56.25
No	7	43.75
Do you believe that food borne disease caused by consumption of meat (raw meat)		
Yes	13	81.25
No	3	18.75
Do you believe that food borne diseases are preventable?		
Yes	13	81.25
No	3	18.75
Do you agree that raw meat can be contaminated through cross contamination with food handlers?		
Strongly agree	8	50
Agree	3	18.75
Strongly disagree	3	18.75
No opinion	2	12.5
Are insects such as cockroaches and flies might transmit food borne pathogens?		
Yes	13	81.25
No	1	6.25
I don't know	2	12.5
Are you carried out your work with hand glove appropriately during slaughtering?		
Yes	3	18.78
No	13	81.25
Do you wear gown and a hairnet during slaughtering?		

Characteristics	Frequency n=16	Percent
Yes	12	75
No	4	25
Water source used to wash the carcass in slaughterhouse		
Communal distribution		
Tap water	X	
Tanker		

Table 7. *Slaughter house environment observations in Assosa town, 2018.*

Characteristics	Frequency n=16	Percent
Is the meat (carcass) covered and kept properly and safe during transportation?		
Yes	11	68.75
No	5	31.25
Does the slaughterhouse make it comfortable to carry activities with a cleaned floor, wall or light?		
Agree	12	75
Disagree	4	25
Do you believe that there is an appropriate drainage system for collection of liquid waste?		
Agree	12	75
Disagree	4	25
Do you agree that refuse receptacles far from the slaughterhouse?		
Agree	8	50
Disagree	8	50
Is the carcass in Slaughterhouse easily exposed to harbor vectors such as flies & insects?		
Agree	3	18.75
Disagree Is there any difficulty to achieve slaughtering in the working area?	13	81.25
Yes	14	87.5
No	2	12.5
Ways of transportation of the carcass from slaughterhouse to the retail outlets	Car	100

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