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Original Research

Microbial Quality of Horro Cattle Beef in Western Oromia, Ethiopia

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Abstract

This survey study aimed to assess the proficiency of 21 butcher shops in sanitary procedures on Horro cattle of Abattoirs in Shambu, Kombolcha, and Fincha towns. Results revealed that 38.1% of the population had received sanitation and food handling education, while 33.33% had received it in Kombolcha and 28.6% in Fincha. However, only 4.8% of butchers in Shambu, 14.3% in Kombolcha, and 19.1% in Fincha wore jewelry, and 33.3%, 28.6%, and 28.6% did not cover their hair. A microbial load analysis was conducted on sixty swab samples from three towns: 20 samples from each town. The samples were tested for E. coli, Staphylococcus aureus, and Salmonella. Results showed significant differences ($P<0.05$) in aerobic plate counts between samples taken on the same day and those taken on different days. The mean counts were 6.76105, 6.12 x105, and 4.91 x105 log10 cfu/cm^2. The study found that Escherichia coli and Staphylococci levels were above acceptable levels for beef in Shambu, Fincha, and Kombolcha, with mean levels of 1.98 x 10^3, 1.80 x 10^3, and 1.26 x 10^2 cfu/cm², respectively, in the cities of Shambu, Fincha, and Kombolcha. The study found that the microbial count for beef is generally above the acceptable level.

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INTRODUCTION

For many people, meat is the preferred source of animal protein since it is the most lucrative livestock product (Schurgers, 2000). It offers vital amino acids, which are crucial components of a diet that is varied and balanced in relation to humans (Rolfes et al., 2008; Tessema et al., 2014. An estimated 3.2 million tonnes of meat are produced annually in Ethiopia by ruminants, accounting for more than 72% of the country's total meat output. More than 50% of all meat produced in sub-Saharan Africa and more than 70% of all red meat produced are cattle products (Birhanu, 2019; FAOSTAT, 2013). Between 2004 and 2017, the nation's meat production trended upward, reaching 578,240 tonnes, 749,430 tonnes in 2010, and 597,765 tonnes in 2017. Huge heads of cattle contribute only about 0.2 percent of the world's total meat supply, indicating a lesser level of meat production.

While underdeveloped nations find it difficult to sustain a diet with only 25 kg of meat per capita yearly, developed nations consistently consume 77 kg of meat per capita annually (Birhanu, 2019). Additionally, FAOSTAT (2016) reports that Ethiopia consumes 8 kg of meat per person, less than both developed and developing nations (77 kg and 25 kg, respectively). According to Omer et al. (2013) and Yousuf et al. (2008), animal products like meat and fish are typically considered high-risk commodities and possible entry points for pathogenic microbes into the human food chain, potentially leading to the spread of disease. Because meat is perishable and has a short shelf life, handling it incorrectly might be harmful to your health (Rani et al., 2017). Nutrients including water, protein, fat, phosphate, iron, and vitamins are also present. Meat has a lot of water, which is ideal for microbial growth (Rao et al., 2009). Healthy animals usually have sterile meat. However, fresh meat's biological makeup and chemical makeup make it more likely to harbour a variety of dangerous microbes that can lead to meat decomposition, human infection, and financial loss (Fratamico et al., 2005).

Meat can be contaminated by a wide range of microorganisms, however based on variables including pH, oxygen content, water availability, and storage temperature, certain species may become more prevalent (Ercolin et al., 2006; Weigand et al., 2007). The skin of animals during evisceration, pluck removal, trimming, contaminated work surfaces, equipment, and worker hands used in processing are all potential sources of bacterial contamination of meat and meat products, which is an inevitable by-product of meat processing (Gill et al., 2003; Govender et al., 2013; Jones et al., 2008; Lues et al., 2007). The many phases of preparation, shipping, and slaughter may also involve contamination (Ercolin et al., 2006; Tessema et al., 2014). Meat quality can also be impacted by improper handling of meat due to a lack of information about meat safety at slaughterhouses and butcher shops (Abd-Elaleem et al., 2014; Jianu & Golet, 2014; Tesfay, et al., 2014). Higher officials inspect Ethiopia's poorly controlled abattoirs (Gebeyehu, et al., 2013). The microbial load levels of beef sold at different retailers are not well-documented. Eating raw or undercooked beef is a popular habit that could lead to foodborne infections (Birhane, 2013; Tefera and Jermen, 2021). Certain meat handling and processing procedures used in several abattoirs in the towns of Shambu, Kombolcha, and Fincha may give various spoilage germs an easy opportunity to proliferate and lead to foodborne illnesses. Thus, it is necessary to evaluate the meat's microbial quality in order to develop sanitary procedures that may be utilised in slaughterhouses to lower the number of food-borne illnesses brought on by consuming damaged food. In order to assess the microbial quality of Horro cattle meat in Shambu, Kombolcha, and Fincha abattoirs of the western Ethiopian the current study was designed.

MATERIALS AND METHODS

The Study Area

The Horro Guduru Wollega zone in West Oromia was the study's location. There are about twelve districts in it. The Horro Guduru

Wollega zone was predicted to have a total population of 576,567 in 2007 based on statistics from the Central Statistical Agency (CSA), of which 511,504 were rural and 65,063 were urban. Its entire area is 7867.6 km^2. The administrative zone is roughly 47 km away from the Abay Choman District. It has a total size of 857.1 km^2, based on data and statistics from the Horro Guduru Wollega Zone. Its elevation varies from 1350 metres to 2444 metres above sea level. It experiences daily temperature variations of 20 to 32˚C and 1400 to 1500 mm of yearly rainfall on average. The settlement of Kombolcha is situated along the main route of the Gedo-Fincha sugar mill, some 275 kilometres west of Finfinnee. The region is situated between latitude 09029' north and longitude 37026' east. The mean altitude is roughly 2296 metres above sea level. Its lengthy wet season lasts from March to the middle of October (Olana, 2006). The monthly mean temperature ranges from 14.9 °C to 27.5 °C, while the yearly rainfall ranges from 1000 to 2400 mm, according to the Guduru District's 2010/11 annual report. About 314 kilometres separate the Shambu administrative town from Finfinnee. It has a 5.5 km^2 area covered. Fig. 1 depicts the study area's geographic position.

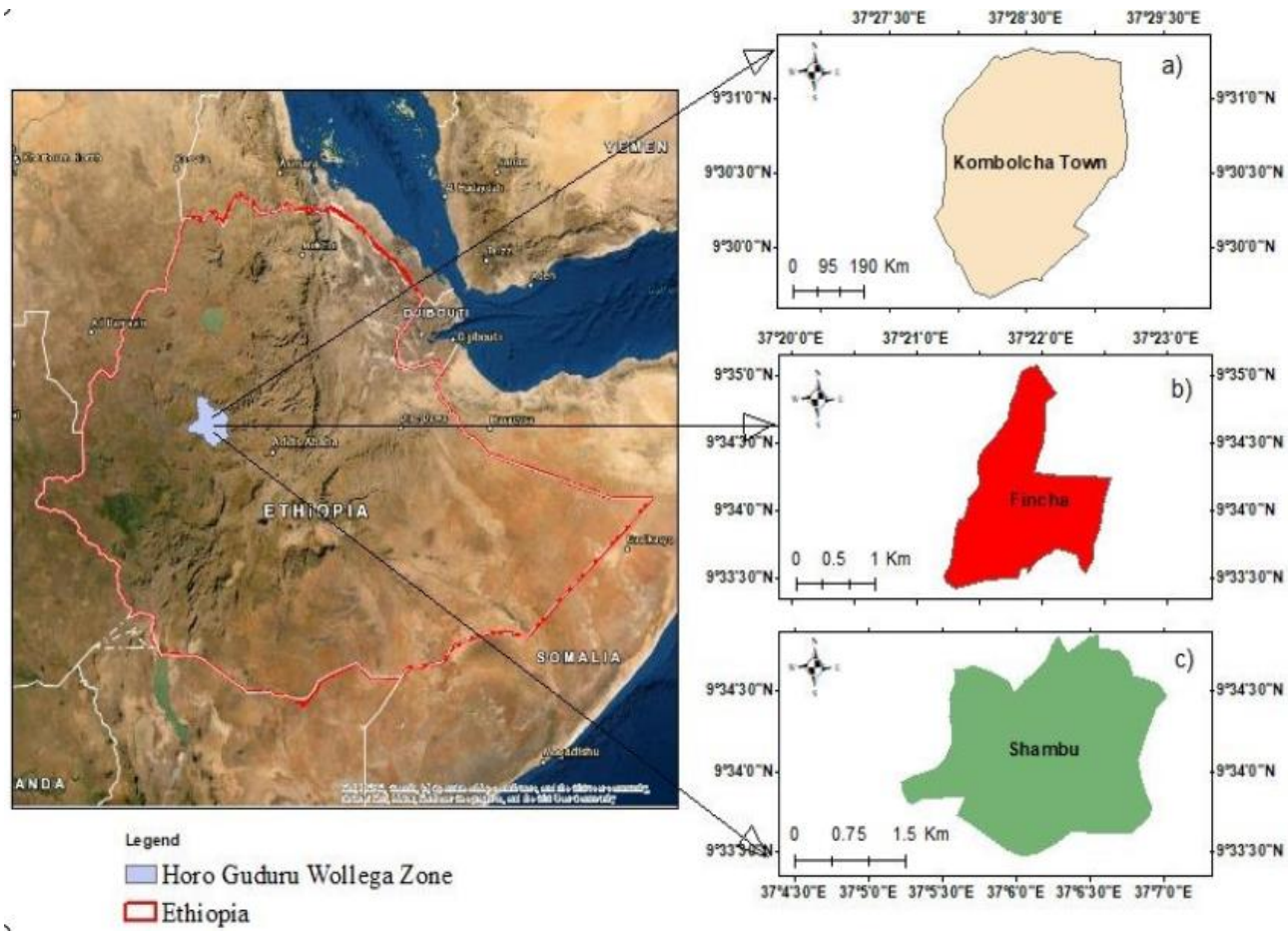

Figure 1. *Geographical location of the study area*

A questionnaire was created to gauge the butchers' employees' knowledge of proper hygienic practices when slaughtering animals. The questions covered in the questionnaire included hair covering, jewellery, money handling techniques, educational background,

experience, frequency of training, and availability of appropriate hygienic practice training. A pilot study was carried out beforehand to see how best to administer the questionnaire.

Sample Collection

Sixty aseptic samples were obtained from the Shambu, Fincha, and Kombolcha abattoirs using sterile, moistened cotton swabs over the course of four non-consecutive sampling days. A sterile frame measuring 10 cm by 10 cm was used to mark a 100 cm^2 area. The area was then rubbed for 30 seconds before being swabbed. Because they were unaware of swab sampling, the staff at the abattoir carried on with their regular duties (Adzitey et al., 2011). After that, the swabbed sample was put in a test tube with about 10 mL of buffered peptone water in it. After being tagged, the test tubes were brought in an icebox (4°C) to Wollega University's Microbiology Laboratory for prompt examination.

Sample Preparation

Using 1 millilitre of the sample and 9 millilitres of peptone water, serial dilutions were made (APHA, 1992). Using the spread plate method (Atlas, 1995), serial dilutions of a viable microorganism-containing sample were plated onto sterilised Petri dishes. The sample was then covered with a suitable growth medium suspension (plate count agar) and shaken well to distribute it evenly on the Petri dishes. The sample was then allowed to solidify. After that, petri dishes were cultured for 48 hours at 37°C (Ercolini et al., 2009). Nutrient agar and tryptic soy agar were used as general and enriched media, respectively, for the bacterial isolation process. As a differential media, MacConkey agar was employed. Staphylococcus species are isolated and identified using Baird-Parker agar. In order to isolate and identify Salmonella-Shigella agar and Escherichia coli, two methods were utilised (Sutton, 2011): colonies of bacteria grown on plate count agar were counted in a colony-counting chamber; colonies that were identified as discrete colonies were closely inspected under a compound microscope to ascertain the shape and colour of the bacteria.

Detection of Bacterial Pathogens

Detection of Salmonella spp

An aliquot (0.1 ml) from the per enrichment was pipetted into 10 mL of tetrathionate broth (supplemented with iodine) in order to detect Salmonella. After streaking the isolate over Salmonella and Shigella agar plates, it was cultured for 24 hours at 37°C. Suspected colonies were recognised microscopically by Gramme staining (HPA, 2003; NMKL, 1991; Tefera & Jermen, 2021).

Detection of Escherichia coli

MacConkey agar was used in the isolation of E. Coli (Hi-Media, Mumbai, India). On

MacConkey agar plates, 0.1 mL of each sample was disseminated, and the plates were incubated for 24 hours at 37 °C. The process of confirming colonies involved streaking two to three colonies onto MacConkey agar, which was then followed by biochemical assays and Gramme staining (ISO 4832; NMKL, 1993; Tefera and Jermen, 2021).

Total Staphylococcus Spp. Count.

The pour plate method was used to count the species of Staphylococcus, and they were cultivated on mannitol salt agar (MSA). A 0.1 mL portion of the suitable dilution was inoculated into pre-dried MSA plates. Following a 24-hour incubation period at 37 °C, the inoculation plates were counted using a colony counter to determine the number of staphylococci, and the results were recorded (American Public Health Association, 2012; Tefera and Jermen, 2021).

Determination of Microbial Load

After calculating the number of colony-forming units (CFU) per millilitre of sample volume using the concentration's dilution factor, the number of different colonies on each plate was converted to log10 cfu/cm^2 values. The mean ± standard deviation (SD) was calculated for the viable counts in log10 cfu/cm^2 of the replicates (Swanson et al., 1992).

Characterization of Dominant Microorganisms

After counting, roughly five colonies were chosen at random from the plate count agar and injected into tubes holding roughly 5 millilitres of nutritional broth. Next, the cells were kept at 30°C for a whole night. The cultures were purified by repeated streak plating and morphological and biochemical assays were employed to characterise them (Bergey, 1994; Tefera & Jermen, 2021).

Morphological Characterization of Dominant Bacteria

Cell form and arrangement: A wet mount was made on a microscope slide and stained with methylene blue after an overnight pure broth culture. Using an oil immersion objective (x100) on a light microscope, the pigmented microbial cells were examined. Cell form (spherical, rod, spiral, etc.) and cell arrangement (single, pair, chain, clusters, and tetrads) were the morphological parameters taken into consideration during observation (Harley, 2002; Tefera & Jermen, 2021).

Utilising Gregerson's (1978) methodology, the Gramme reaction (KOH test) was carried out. A 24-hour-old pure culture colony from the plate count agar was agitated for about two minutes on a clean slide using two drops of 3 percent KOH. The gramme-negative mass was then allowed to rise by using an inoculating needle to follow the loop for at least 0.5 to 2 cm, while the grammeme-positive bacteria did not produce slime.

Biochemical Tests

Catalase Test: A 3% hydrogen peroxide solution was poured over the young colonies. Catalase is thought to be responsible for

bubble generation (Harley, 2002; Tefera & Jermen, 2021).

Biochemical Tests for Escherichia coli sp

Indole and MRVP tests were used to confirm the presence of E. coli spp. (NMKL, 1993; Harley, 2002; Tefera and Jermen, 2021).

Detection of Staphylococcus aureus

To identify S. aureus, a loopful of the homogenate sample was put onto mannitol salt agar. Next, S. aureus was discovered to be a golden-yellow, coagulase- and catalase-positive colony on MSA. As confirmatory tests, biochemical assays (coagulase and catalase) were carried out (APHA 2012; Tefera & Jermen, 2021).

Biochemical Tests for Salmonella spp

The lysine iron agar test (NMKL, 1991), the triple sugar iron agar test (NMKL, 1993; Bergey, 1994), ISO 6579, and the Simmons citrate agar test were used in the biochemical test for Salmonella spp.

Modelling, statistical analysis, and experimental design

The survey data was coded, entered, and analysed using SPSS version 25 (SPSS, 2009). The data's normality and equality variance were examined using the Shapiro-Wilk normality and Levene's tests, respectively, before additional statistical analysis for microbial load. The study's experimental design was entirely randomised. The R programme version 4.0.2 was employed to investigate the variations between batches and days of data (samples taken on the same day). The Duncan's multiple range test was used to calculate the mean separation. The model that was employed was this one: $Yijk = \mu + \alpha i + eijk$

Where; Y_{ij} = the response variable, μ = Overall mean common to all observations,

α_i = treatment effect, e_{ijk} = Random error

RESULTS AND DISCUSSION

Results

Observation of Butcher on hygienic practices

According to the study, all butchers were men, and in the municipalities of Shambu, Kombolcha, and Fincha, respectively, 2/8 (9.5%), 3/7 (14.3%), and 2/6 (9.5%) had certificates (Table 1). All butchers in the current study region (8/21 [38.1%), 7/21 [33.33%], and 6/21 [28.6%]) had received sanitation and food handling training in Shambu, Kombolcha, and Fincha towns, respectively, despite the frequency of instruction varying. In Shambu, Kombolcha, and Fincha, respectively, 4/8 (19%), 1/7 (4.8%), and 3/6 (14.3%) butchers wore jewellery, according to the findings of a hygiene survey. Additionally, 7/8 (33.3%), 6/7 (28.6%), and 6/6 (28.6%) of the butchers in our study did not cover their hair. Shambu town slaughtering locations (8/8; 38.1%) were found to be in bad condition, while Kombolcha 2 (9.5%) and Fincha 4 (19%] were deemed to have satisfactory hygienic conditions.

Table 1

Questionnaire survey on knowledge of butchers on hygienic practices

Questionnaire and Observation Types	Values	Towns		
		Shambu	Kombolcha	Fincha
		Frequency and. (%)	Frequency and. (%)	Frequency and (%)
Sex	Male	8(38.1)	7(33.33)	6(28.6)
Age	18-25	1(4.8)	2(9.5)	1(4.8)
	26-35	4(19)	3(14.3)	2(9.5)
	35-50	3(14.3)	2(9.5)	3(14.3)
Educational status	6-8	2(9.5)	1(4.8)	3(14.3)
	9-10	4(19)	2(9.5)	0
	11-12	0	1(4.8)	1(4.8)
	Certificate	2(9.5)	3(14.3)	2(9.5)
Training	Only once	4(19)	3(9.5)	2(14.3)
	Twice	4(19)	4(19)	4(19)
Hair cover	Covered	1(4.8)	1(4.8)	0
	Not covered	7(33.3)	6(28.6)	6(28.6)
hand wash	Once a day	6(28.6)	7(33.3)	2(9.5)
	Twice a day	2(9.5)	0	4(19)
Hand gloves	Not used	8(38.1)	7(33.33)	6(28.6)
Jewellery	Worn	4(19)	1(4.8)	3(14.3)
	Not worn	4(19)	6(28.6)	3(14.3)
shortening of nails	Shorten	5(23.8)	6(28.6)	3(14.3)
	Not shorten	3(14.3)	1(4.8)	3(14.3)
cleanness in abattoir	Clean	5(23.8)	6(28.6)	3(14.3)
clean over coat	Not clean	3(14.3)	1(4.8)	3(14.3)
general sanitation of slaughtering places and abattoirs	Good	0	2(9.5)	4(19)
	Poor	8(38.1)	5(23.8)	2(9.5)

Microbial Load of Beef

Three abattoirs in the Horro Guduru Wollega zone provided sixty swab samples: twenty came from Shambu, twenty from Fincha, and twenty from Kombolcha. Using common plate-counting methods, the bacterial load of the swab samples was investigated. According to Eby (2010), the current study found that colony counts between 30 and 300 CFU were statistically reliable for microbial load, while counts less than 30 and above 300 were not taken into consideration because it was statistically unreliable to count colonies less than 25/30 and too large and laborious to count colonies exceeding 250/300. Aerobic plate counts (APC), E. coli, and staphylococci counts were all significantly (P≤0.05) different between daily swab samples and those from the same day. The Shambu, Fincha, and Kombolcha abattoirs had overall mean APCs of 5.49, 5.43, and 5.32 log10 cfu/cm^2, respectively. Samples taken from Shambu town had the greatest APC burdens, measuring 6.36 log10 cfu/cm^2. The Shambu, Fincha, and Kombolcha abattoirs have overall mean E. Col values of 3.02, 2.97, and 2.83 log10 cfu/cm^2, respectively (Table 2). In the abattoir towns of Shambu, Fincha, and Kombolcha, the overall averages of Staphylococcus aureus were 6.20, 6.13, and 5.98 log10 cfu/cm^2, respectively. There was no trace of salmonella in any sample.

Table 2

Effect of Days and Batches on Microbial Load of Beef in Shambu, Fincha and Kombolcha Town (Ls Means)

Variables	Shambu			Kombolcha			Fincha		
Days	***	*	***	***	*	***	***	*	***
	APC (cfu in log10)	ECC (cfu in log10)	StC (cfu in log10)	APC (cfu in log10)	ECC (cfu in log10)	StC (cfu in log10)	APC (cfu in log10)	ECC (cfu in log10)	StC (cfu in log10)
Day 1	5.37^{b}	3.43^{a}	6.67^{a}	5.16^{b}	3.12^{a}	6.42^{a}	5.30^{b}	3.38^{a}	6.61^{a}
Day2	5.89^{a}	3.12^{a}	6.21^{a}	5.64^{a}	2.98^{a}	6.03^{a}	5.82^{a}	3.07^{a}	6.18^{a}
Day3	4.80^{c}	2.53^{b}	5.16^{b}	4.67^{c}	2.33^{b}	5.00^{b}	4.74^{c}	2.49^{b}	5.13^{b}
Day 4	5.92^{a}	3.01^{ab}	6.62^{a}	5.81^{a}	2.89^{a}	6.48^{a}	5.85^{a}	2.95^{ab}	6.59^{a}
Batches	***	*	*	***	*	*	***	*	*
S1	5.64^{ab}	3.47^{a}	6.57^{a}	5.29^{b}	3.33^{a}	6.48^{a}	5.58^{ab}	3.44^{a}	6.55^{a}
S2	5.59^{ab}	3.12^{a}	6.13^{ab}	5.52^{ab}	2.91^{a}	5.97^{a}	5.54^{ab}	3.09^{a}	6.10^{ab}
S3	4.95^{c}	3.11^{a}	6.43^{a}	4.70^{c}	2.88^{a}	6.25^{a}	4.85^{c}	3.07^{a}	6.40^{a}
S4	6.05^{a}	2.43^{b}	5.42^{b}	5.95^{a}	2.84^{a}	5.08^{b}	6.03^{a}	2.32^{b}	5.35^{b}
S5	5.24^{bc}	2.97^{ab}	6.26^{a}	5.14^{bc}	2.19^{b}	6.14^{a}	5.14^{bc}	2.94^{a}	6.24^{a}
CV	5.97	12.03	7.75	6.38	14.28	8.73	6.58	12.45	7.97
Overall mean	5.49	3.02	6.20	5.32	2.83	5.98	5.43	2.97	6.13

*Ns = Non significant at P ≥0.05, * = P < 0.05, cfu = colony forming unit, log10 = common logarithm, APC = aerobic plate count, ECC = Escherichia coli, StC = Staphylococci count. Means with the same letter in the same column are not significantly different at P ≥ 0.05.*

Implication of micro-organisms

Table 3 displays the average counts of microorganisms in Shambu, Fincha, and Kombolcha. The cities of Shambu, Fincha, and Kombolcha had mean aerobic plate (AP) counts of 6.76 x 105, 6.12 x 105, and 4.91 x 105 log10 cfu/cm^2, in that order. The cities of Shambu, Fincha, and Kombolcha had mean E. Coli values of 1.98 x 103, 1.80 x 103, and 1.26 x 103 log10 cfu/cm^2, in that order. The cities of Shambu, Fincha, and Kombolcha had mean staphylococci counts of 5.33 x 106, 5.02 x 106, and 4.11 x 106 log10 cfu/cm^2, in that order.

Table 3

Mean microbial load of beef in the colony-forming unit and at the common log

Study town	Variables	No of samples	Mean count cfu/ cm^2	Log Mean	SD
Shambu	Aerobic Plate Counts	20	$6.76x10^5$	5.49	0.66
	E.coli		$1.98 x10^3$	3.02	0.55
	Staphylococcus aureus		$5.33 x10^6$	6.16	0.83
Fincha	Aerobic Plate Counts	20	$6.12 x10^5$	5.43	0.68
	E.coli		$1.80 x10^3$	2.97	0.57
	Staphylococcus aureus		$5.02 x10^6$	6.13	0.84
Kombolcha	Aerobic Plate Counts	20	$4.91 x10^5$	5.32	0.68
	E.coli		$1.26 x10^3$	2.83	0.58
	Staphylococcus aureus		$4.11 x10^6$	5.98	0.88

The indicator micro-organisms

Table 4 displays the correlation matrix among the microorganisms. APC and ECC did not significantly correlate ($P \geq 0.68$). A noteworthy association was seen between StC and ECC ($P \geq 0.0001$).

Table 4

Correlation matrix between the common micro-organisms in beef

Variables	APC	ECC	StC
APC	1	0.09^{ns}	0.21^{ns}
ECC		1	0.75**
StC			1

APC, aerobic plate count; ECC, Escherichia coli; StC, Staphylococci count.

*ns = non-significant correlation, **= highly significant difference at p< 0.001.*

Discussion

Observation of Butcher on hygienic practices

Despite receiving instruction in food handling and personal cleanliness, all butchers in this study were found to have inadequately applied it (Table 1). The present study's findings are in line with those of Zerabruk et al. (2019) and Mirembe et al. (2015), who examined the microbial safety and quality of minced meat and meat contact surfaces in specific butcher shops in Addis Ababa, Ethiopia, as well as the sanitation and hygiene status of butcheries in the Kampala district of Uganda. Even though most of the butchers in the current study did not clip their nails, many of them wore jewellery and went about their work without concealing their hair or donning hand gloves. This outcome is consistent with the findings of Zerabruk et al. (2019), who found that the majority of meat handlers did not wear hair covers, their hands' nails were dirty, and less than half of them wore clean working coats.

Microbial Load of Beef

The three abattoirs in the study area provided swab samples for the microbial load investigation, and the overall results showed inadequate cleanliness (Table 2). The notable discrepancy seen across sampling days and batches on the same day could perhaps result from the lack of consistent and routine hygiene practices within the abattoir and among the handlers. The results of Gebeyehu, et al. (2013) and Koffi-Nevry et al. (2011), who discovered notable variations in the mean microbial load of fresh carcasses between sampling days and samples from the same batches, are in line with this outcome. This may also be related to the lack of regular and vigilant veterinary monitoring and well-maintained abattoirs, especially in Shambu Town. Another reason for the use of damp, slick floors—slaughtering places—could be inadequate hygiene. The findings of Timm et al. (2013), Zerabruk et al. (2019), and Grönvall (2013) are all in line with this outcome. The APC results (5.49, 5.43, and 5.32 log10 cfu/cm^2) from the Kombolcha, Shambu, and Fincha abattoirs, respectively, are lower than those of Ahmad et al. (2013) and Ayalew et al. (2015), who reported a mean value of 6.08±0.126 log10 cfu/cm^2. These results are comparable with those of Ishmael et al. (2018), who reported the value of APC before carcass washing within the range of 2.5 to 5.8 mean log10 cfu/cm^2. According to Cohen et al. (2006), the highest staphylococci levels (6.20, 6.13, and 5.98 log10 cfu/cm^2) seen in Shambu, Fincha, and Kombolcha, respectively, may be related to handlers' poor personal hygiene and cross-contamination from skin and utensils. Elevated numbers of Staphylococcus aureus could potentially signify elevated levels of contamination resulting from the neglect of hand hygiene practices by abattoir staff. This result is lower than that of Ahmad et al. (2013), who reported a value of 2.76 log10 cfu/cm^2. It is comparable with the findings of Ayalew et al. (2015), who indicated a mean count of staphylococcus aureus in the range of 5.82±0.11 log10 cfu/cm^2 to 6.39±0.07 log10 cfu/cm^2 for abattoir and knife samples, respectively. The mean value of E. coli detected (3.02, 2.97, and 2.83 log CFU/cm^2) in Shambu, Fincha, and

Kombolcha, respectively, is found to be lower when compared with Ayalew et al. (2015), who reported 6.03±0.03 log10 cfu/cm^2 counts from butchers' hands, and higher than the result (2.81 log10 cfu/cm^2) reported by Ahmad et al. (2013).

Implications of microorganisms

An indicator of meat's microbial quality is the aerobic plate count (APC) (Table 3). A high concentration of germs (APC >107 CFU/cm^2) suggests that the meat spoiled rapidly. The APC of 60% of the tested samples cannot be greater than 106 CFU/g or cm^2, per the raw meat grading and marketing regulations (1991) (Mukhopadhyay et al., 2009). Salmonella, E. Coli, and coagulase-positive S. aureus are the main bacterial pathogens that cause food-borne illnesses in cattle and pork products (Shaltout et al., 2020). The towns of Shambu and Fincha had the highest mean value of APCs, which suggested that the poor quality of the areas used for slaughter, for transportation, and for storage could encourage the proliferation of microorganisms. The meat in the current investigation was highly contaminated, as evidenced by the mean APC exceeding 106 log10 cfu/cm^2. The APC results obtained from this investigation align with the conclusions provided by Bhandare et al. (2007) and Alvarez-Hassan et al. (2010).

The indicator microorganisms

The correlation between APC and ECC (P > 0.68) indicated in Table 4 is not in line with the findings of Kornacki (2011), who reported a significant correlation between APC and ECC in bovine carcasses. A significant correlation between ECC and StC (P ≥ 0.0001) may indicate the presence of associated microbes.

CONCLUSIONS

A high load of microbes is present in the following fundamental issues: poorly constructed abattoirs, especially in Shambu town; use of wet and slippery floors (slaughtering places); poor implementation practices regarding the hygienic status of butcheries; and a lack of close and regular supervision by veterinarians. The municipalities of Shambu and Fincha had the highest mean value of APCs, which suggested that the quality of the slaughterhouses there was subpar. Elevated S. aureus counts also suggest elevated levels of contamination as a result of abattoir employees' disregard for adequate hand hygiene practices. Because the abattoir and handlers do not maintain regular and uniform sanitary conditions, the amount of microorganisms changes between sampling days even batches of the same day. The presence of related microorganisms was probably indicated by a positive association between ECC and StC. Overall, the current investigation found a high microbial count that was higher than the recommended level of microbial beef content.

RECOMMENDATION

According to our research, appropriate intervention is required to preserve the quality of beef.

i. Assisting butchers with appropriate training to enhance their

understanding of personal and environmental hygiene.

ii. Ensuring routine oversight of municipal authorities and veterinarians.

iii. Ensuring the establishment of an abattoir, namely in Shambu town.

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DECLARATION

There is no conflict of interest among the authors.

DATA AVAILABILITY

All data underlying the study results are available from the corresponding author upon reasonable request

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