HYGIENIC PRACTICES, PREVALENCE AND ANTIMICROBIAL SUSCEPTIBILITY PROFILE OF SALMONELLA ISOLATED FROM BEEF SUPPLY CHAIN IN ASSOSA TOWN, WESTERN ETHIOPIA

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ABSTRACT: Across-sectional study was conducted on Isolation, Identification and Antimicrobial susceptibility profile of *Salmonella* and its Public health significance in beef supply chain of Assosa town, western Ethiopia from October 2024 to April 2025 in beef**,** with the objectives to isolate and identify *salmonella* from beef supply chain, to assess the public health significance associated with risk factors and to estimate antimicrobial susceptibility patterns of salmonella isolates. A total of 384 samples were collected from beef slab house and butcher shop, and processed with standard Bacteriological methods. The study revealed that 68 (17.70%) of the collected swab samples with beef value chain was contaminated with salmonella. 17.68% of salmonella contaminates were recorded in abattoir with higher (31.6%) salmonella in abattoir workers hand swab followed by 21.62% in neck swab, 18.91% in abdominal swab, 15.09% in pooled material swab and 10.81% in hind limb swab, which was significant (P<0.05). Whereas, 30% salmonella contaminates were reported in pooled material swab, followed by 16.66% in butcher workers hand swab, and 6.66% butcher meat swab., which was non significant(p>0.05). In this study, sample source, hygienic practice, and washing carcass after and before skinning were potential risk factors. Majority (94.12%) of drug resistance prevalence was reported in Penicillin G, followed by (85.3%) amoxicillin, 82.35% tetracycline; 58% streptomycin, and 41.2% ciprofloxacin. Whereas higher (85.29%) of drug susceptibility was recorded in chloramphenicol, followed by gentamycin (76.47%), 67.64% kanamycin; 58.82% ciprofloxacin, and 41.2% streptomycin. The presence and consumption of beef meat may constitute a public health hazard and reduced meat quality due to salmonella contaminates. Thus health professionals should create awareness about meat handling practice, storage, sanitary practice, surface hygiene and slaughtering processes to abattoir workers and end users. And regular resistance follow-up, using antimicrobials sensitivity tests helps to select effective antibiotics and to reduce the problems of drug resistance developments towards commonly used antimicrobials so as to reduce the problem encountered.

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INTRODUCTION

1.1 Back ground

Globally, foodborne diseases have become a big concern. According to a World Health Organization (WHO) report from 2010, there were 600 million foodborne illnesses and 420,000 deaths as a result of consuming unsafe food (WHO, 2015). Every year, Salmonella causes approximately 93.8 million human gastroenteritis infections and 155, 000 deaths. According to Centers for Disease Control and Prevention (CDC) analysis, Salmonella bacteria cause about 1.35 million infections, 26,500 hospitalizations, and 420 deaths in the United States every year (Papp, 2024).

Non-typhoidal Salmonella (NTS) is one of the common foodborne pathogens that originate from cattle, sheep, and pigs. Salmonella enterica and Salmonella bongori are the predominant species of Salmonella isolated from food sources of meat. In most parts of the world, Salmonella enteritidis and Salmonella typhimurium transmitted from animals to humans (Ferrari *et al*., 2019). Humans can be infected with Salmonella from animal sources, environmental exposure, and ingestion of contaminated foodstuffs. Depending on the strain of the pathogen, the severity of the disease caused by Salmonella varies from asymptomatic carriage to severe life-threatening conditions. The diseases were gastrointestinal disorders and severe infections, such as bloodstream, and extra intestinal diseases like meningitis, septic arthritis, osteomyelitis, cholangitis, and pneumonia (Heredia *et al*., 2018).

Factors that led to the contamination of carcasses meat by Salmonella were poor hygiene practices, slaughtering processes, and food preparation of animal products (Muluneh and Kibret, 2015). Additionally, knives, cloths, carts, boxes, surfaces, and other equipment increase contamination by Salmonella. These microorganisms begin to grow and spoil the meat if the environment is favorable for their development. Asymptomatic food handlers or

personnel that have an active stage of the disease play a significant role in transmitting infection (Wales *et al*., 2011).

Nowadays, Drug-resistant pathogens are a global public health concern and Salmonella is one of the microorganisms in which some resistant serotypes have emerged, affecting the food chain (Bennani *et al*., 2020). In Ethiopia, the antibiotic resistance level of Salmonella from food animals emerged high (Darwish *et al*., 2013). The rise of multidrug-resistant (MDR) Salmonella strains against commonly prescribed antimicrobials poses public health concerns in both veterinary and human medicine sectors (Abdi *et al*., 2017). Widespread use of first line drugs has contributed to the proliferation of MDR isolates, exacerbating this imminent issue. Moreover, Ethiopia's prevalent consumption of raw meat fosters an environment conducive to community-wide infection development (Andargie *et al*., 2008).

1.2 Statement of the problem

Salmonella is one of the leading causes of foodborne illness worldwide, with 3.7 billion-dollar annual economic loss. It is the leading cause of acute gastroenteritis in several countries and continues to be a major public health concern globally, particularly in developing countries (Hoque *et al.,* 2019). Food safety is a matter of great concern and of public health importance in particular when the environment in which the food is handled is heavily contaminated (Soyiri *et al*., 2008). Most of fresh food especially that of animal origin like beef is highly vulnerable to microbial invasion and food poisoning since meat is an ideal medium for growth of a number of microorganisms due to its nutritive value (Soyiri *et al*., 2008).

The main constituents of meat are water and protein. In addition, fat, phosphorus, iron and vitamins are also found in meat. Tissues from healthy animals are normally sterile, but can be contaminated by microorganisms from the exterior of the animal and its intestinal tract during slaughter, dressing and cutting (Ukut *et al*., 2010). Contamination of meat can occur in multiple steps along the food production chain including production, processing, distribution, retail marketing and handling or preparation (Zhao *et al*., 2001). The abattoir environment and slaughtering processes play a vital role in the wholesomeness and meat safety. Unhygienic practices in abattoirs and post-process handling are associated with potential health risk to consumers due to presence of pathogens in meat and contaminated equipment's (Abdullah *et al*., 2006). Effluent from slaughterhouses are known to contribute in contamination of both surface and groundwater since during processing in abattoir blood, fat, manure, urine and meat tissues are discharged to the wastewater streams (Bello and Oyedemi, 2009).

For hygienic reasons abattoir use large amount of water in processing operations which in turn produce large amount of waste water. After animals are slaughtered and inspected in the abattoir, meat is transported by meat van to different retail meat outlets for selling to consumers. During selling in retail meat outlets further contamination can occur through contact with handling equipment's (tables, logs, hooks, balances and knives), insects, air, personnel and even consumers (Mtenga *et al*., 2000). Meat consumption is increasing worldwide due to rapid population growth and urbanization (Fayemi and Muchenje, 2012). This has resulted in increased concerns and challenges of meat safety and hygiene (Sofos and Geornaras, 2010). The best strategy for improving meat safety is through implementation of appropriate hygiene schemes as well as educating and monitoring meat handlers (Abd-Elaleem *et al*., 2014; Sofos, 2008). Therefore, meat safety regulations should be maintained from the slaughterhouse, processing, storage, distribution, retail outlets up until the products reach the consumers' table (Sofos and Geornaras, 2010).

Salmonella prevalence was conducted in various part of Ethiopia: different studies conducted in Ethiopia revealed fragmented substantial prevalence as well as antimicrobial susceptibility of *Salmonella* in veterinary and public health setups. According to some of study conducted in different part of Ethiopia the prevalence rate of *Salmonella* in raw milk were reported by Ferede (2014) in municipal abattoir, eastern Ethiopia; Abebe *et al* (2014) in selected Woredas of Tigray, Ethiopia; Wondimu *et al* (2017) at Wolaita Sodo municipal abattoir, Southern Ethiopia, and Akafete and Haileleul, (2011) in Ethiopia, showed overall salmonella prevalence of 17.7%, 16.4%, 12.5%, and 8.3% prevalence respectively. Beside this, Takele *et al*. (2018) and Dabassa and Bacha (2012) who reported 11.3% and 13.3% from beef carcasses in Jimma municipal abattoir, respectively, and Hiko *et al*. (2016) reported 11.8% from Addis Ababa Abattoirs Enterprise.

However, reports from coinciding study on meat and carasses, personnel and equipment used in the beef is limited especially in the current study area. The screening of meat and other beef products for pathogenic organisms was play a vital role in curtailing human infection. Investigation of the prevalence and antimicrobial resistance of *Salmonella* from cattle and in contact human in beef is of paramount importance to design methods to minimize

the possible transmission of *Salmonella* between humans and cattle. Moreover, it is also important in combating the emergence of antibiotic resistant strains of *Salmonella* (Zelalem *et al.*, 2011).

Using antimicrobial agents for cattle have been implicated as a source of human infection with antimicrobial resistant (AMR) *Salmonella* through direct contact with livestock and consumption of un cooked meat and contaminated materials (Alexander *et al.*, 2009). Antimicrobial resistant *Salmonella* are increasing due to the use of antimicrobial agents in food animals at sub therapeutic level or prophylactic doses for growth promotion and markedly increase the human health risks associated with consumption of contaminated meat products through mutation, acquisition of resistance encoding genes and irrational use of antimicrobials in food animals (Fufa *et al.*, 2017).

1.3. Objectives of the study

1.3.1. General Objective

- Assessment of hygienic practices, prevalence and antimicrobial susceptibility profile of salmonella isolated from beef supply chain in and around Assosa town, Benishangul Gumuz, western Ethiopia

1.3.2 Specific objective

- To isolate and identify salmonella species from beef supply chains in the study area,
- To estimate the prevalence of Salmonella along the beef supply chain,
- To determine the antimicrobial susceptibility profile salmonella,
- To identify associated risk factors

1. MATERIALS AND METHODS

1.1. Study Area

The study was conducted in Assosa town, BenishangulGumuz Regional State (BGRS), western Ethiopia. Currently, Assosa town has two administrative districts (district-1 and district-2). Each district as five "ketenas". According to Benishangul Gumuz Regional State Metrological Center report, (2020), the town is located at 10º 00'and 10º 03' north latitude and 34º 35' and 34º 39' east longitude. The total population of the town is 62,632 of which 32, 100 are males and 30,532 are females (CSA, 2020). The total area of the town is 2361.34 hectares with an altitudinal difference that ranges between 1461- 1641 meters above sea level (BGRSEIB, 2020). The mean annual temperature of Assosa town ranges from a minimum of 14-33^{0}C. However, there is a slight variation of temperature by month. February to May is the hottest months while November to December is the cold months. The average annual rain falls recorded during the last nine months were 1,119 mm (BGRSMSC, 2020). The rainy season starts in March and extends to November with the highest concentration in June, July, and August. The population size of different livestock species in Assosa town are cattle 569, goat 1545, sheep 739, poultry 17676 donkeys 122, and pig 8 total 20,659 livestock populations are found in the town (Assosa Town Administrative Office of Agriculture, 2020).

Figure 1: Administrative map of Assosa town (ATAO, 2021).

2.2 Study population

The study animals were apparently healthy indigenous zebu cattle (*Bos indicus*) kept by small holder farmers under production system coming to slaughter houses to supply meat for local consumption in Assosa town and its surroundings. Contact surfaces (knives, axes and cutting board) and hands of Individuals working in slaughter house and butcher shop were also included in the study.

3.3 Study Design

A cross-sectional study design was conducted from October 2024 to April 2025 at the Assosa town municipality abattoir and butcher shops, on hygienic practices, prevalence and Antimicrobial susceptibility profile of salmonella isolated from Beef supply chain in Assosa town, western Ethiopia.

1.2. Sample Size Determination

For cattle the sample size was determined using a single population proportion formula as follows: $n=z^2 p (1-p) / d2$
Where: N=the minimum required sample size; Z=Standard normal distribution value at 95% CI, which is 1.96; P=the prevalence of Salmonella isolates in slaughtered cattle carcasses (50%). No previous study done in the Assosa slaughtered house and butcher shop, So that, 50% expected prevalence was taken ; d=the margin of error taken as 5%.
Accordingly, the sample size was: **n = 3.8416×0.5×(1-0.5)/ 0.0025 = 384**. So 222 carcass swab at different body parts, 19 abattoir workers swab, 53 pooled material swabs were collected.
Additionally, pooled 90 butcher shop samples were collected; therefore the sample sources and types were listed as follows;

Table1. Abattoir and Butcher Sample Types and its sample size

Variables		**Sample size**		remark
I. **Abattoir samples**				
Carcass swab at different body parts	Hind/ medial limb	74		294
	abdomen/ lateral	74		
	Neck region	74		
Abattoir workers hand swab		19		
Material swab	Knife	18	53	
	Hook	18		
	Cutting board/ table	17		
Total abattoir swab		294		
II. Butcher shop samples				
Meat swab		30		90
pooled material swab		30		
Butcher workers swab (hand swab)		30		
Total butcher swab		90		

1.3. Sampling methods

1.3.1. Biological sample

Cattle was selected using a systematic sampling method. On average 15 cattle was slaughtered daily. The sample was collected two days per week for 26 days within the study period. The number of samples that was collected each day is as follows; N=total sample size to be collected which is 384; D=total number of sample collection days, which is 26 and n=number of samples to be collected each day. n = N/D= (384/26) = 14.76.
15 cattle was selected each day using the identification numbers given to the animals. A total of 222 swab samples from hind limb, abdomen, and neck region of each cattle carcass were taken. Totally, from 74 cattle a total of 222 samples were collected at different anatomically part, from each cattle to appreciate Salmonella distribution and to increase the isolation rate of Salmonella. Additionally 19 abattoir workers' hand swab samples and 53 abattoir material swabs were collected. Besides this, 90 Butcher shop swab samples were collected at beef supply chain.

3.3.2. Questionaries' surveys

Semi- structured questionnaire was used to collect information from beef supply chain. The questionnaire was made with pre-coded response choices (closed-ended questions) with a few open-ended questions. Also, the questionnaire was used to collect information on possible sources contaminations in beef supply chain. Risk factors considered in the current study were demographic factors (age, breed, body conditions, drainage/waste disposal, carcass handling practices, hygienic practices (knife, hook and utensils, hall and floor), carcass washing practices after and before skinning, evisceration, stunning; and use of personnel protective equipment. The survey was included all volunteer abattoir workers who had daily contact with beef.

3.4 Sample Collection procedures, Transportation and Storage

Cattle carcass swab was collected according to the sample collection, isolation, and identification recommendations of the International Organization for Standardization (ISO, 2017). A total of 312 carcasses (one hundred-four from each cattle's hind limb, abdomen, and neck region) was collected from 104 selected cattle from Assosa town Municipal. About 100 square centimeters of surfaces around the hind limb (medial), abdomen (lateral), and neck region was swabbed by wiping with a sterile gauze swab soaked in nearly 10 milliliters of buffered peptone water (BPW) and rubbing over each sampling site horizontally and then vertically for 30 s. Abattoir workers hand swab samples were collected from abattoir personnel, which anticipated in slaughter operation such as skinning, stunning, evisceration, carcass and material handlers' and transporters'. Up on completion of the rubbing process, the swab was placed into the BPW used to wet the swab in a universal bottle. Then **a swab sample** was transported from the site of collection to the Assosa Regional veterinary, Microbiology Laboratory Department using transport medium 2 h of collection. The **swab samples** were analyzed immediately for the isolation of Salmonella (ISO, 2017).

1.4. Laboratory Technique

1.4.1. Isolations and Identification of Salmonella species

Each carcass sample was collected in four areas: the neck, brisket, flank, and rump. Bacteriological examination was done according to microbiology of food chain (ISO, 2018). Accordingly, it involves three stage processes: pre-enrichment, enrichment and plating out to isolate Salmonella spp. In primary enrichment step; loopful of swab samples were taken aseptically, homogenized into 9ml of buffered peptone water (HIMEDIA BM020, India) and incubated at 37°C for 24h. Then, 0.1ml aliquot was transferred and added to 10ml of Rappaport-Vassiliadis with soya (RVS). Finally, the tubes were vortexed and incubated at 41.5° for 24h. Lastly, the enriched milk sample was plated onto a XLD Agar (HIMEDIA M031, India). The secondary enrichment tubes were vortexed before plating on XLD agar. 10µl loopfull of bacterial culture was grown on XLD agar using streak method and incubated at 35°C for 24h. After the recommended incubation time; Typical Salmonella spp. colonies with characteristic growth morphologies of pink colonies with or without black centers considered as suspected salmonella colonies. Three to five typical colonies of Salmonella was picked and streaked onto Trypton soya agar and incubated at 37°C for 18–24h for the further biochemical identification.
Further biochemical tests were conducted to identify salmonella spp using ISO (2018). according, suspected colonies of salmonella were tested for indole, Methyl red, Voges-Proskaur and citrate utilization (IMViC), triple sugar iron (TSI), urease, and sugar fermentation tests (ISO, 2017).

1.4.2. Antimicrobial susceptibility testing

The Isolates of Salmonella was tested on Muller Hinton agar (HMEDIA), for antimicrobial drugs by disc diffusion technique (Wayne, 2017). Pure colonies was transferred to five mL normal saline tubes and compared to 0.5 McFarland turbidity standards. A sterile cotton swab was dipped into the adjusted suspension, and the excess was removed by gently rotating the swab against the tubes inside the wall. The swab was evenly inoculated across the entire surface of Muller Hinton agar and the plate was allowed to air dry for 15 min. The inoculated plate was incubated at 37o C for 16–18h after the antimicrobial discs was applied. All isolates of Salmonella was tested with a total of eight: Penicillin G-10, amoxicillin-10 µg, ciprofloxacin (CIP) 5µg, kanamycin 30µg, chloramphenicol (CHL) 30µg, gentamicin (GN)10 µg, tetracycline (TE) 30µg, streptomycin (S) 10µg) selected antibiotics discs (Oxide, UK). Finally, the inhibition zone diameters were measured to the nearest millimeter using a ruler. The result was interpreted as susceptible, intermediate or resistant based on the recommended CLSI results in interpretive standards (CLSI, 2019).

1.5. Data Analysis

Laboratory result was evaluated for their consistency with standard using working manuals. The coded data was entered into Microsoft excel 2007 and was be analyzed using STATA version 17. Descriptive statistics such as percentages and frequency distribution was used to describe the questionnaire survey and antimicrobial sensitivity test results. To identify potential risk factors of Salmonella isolates multivariable logistic regression analysis was used. The significance of the association between potential risk factors and the Salmonella isolates from cattle carcasses, the adjusted odds ratio at 95% confidence intervals (CI) with P- value of 0.05 was considered as statistical associated with salmonella contaminates.

2. RESULTS

3.1. Prevalence of Salmonella

Bacteriologically, of the (N=384) samples tested, 68 (17.70%) were initially suspected to be presumptive colonies of Salmonella on Xylose-lysine-deoxycholate agar (XLD). 68 (17.70%) of the salmonella isolates were able to produce pink colony with black center on Xylose-lysine-deoxycholate agar (XLD) agar, and gram-negative medium sized rod-shaped, on gram's staining. Biochemical tests revealed that 64 of the samples were found to be positive for Salmonella. These isolates tested positive for catalase, citrate and Methyl Red tests. However, isolates were negative for Urease test, Indole test and V-P tests. On triple sugar iron agar, Salmonella colonies produced hydrogen sulfide, as indicated by the black discoloration of the agar, the formation of bubbles in the agar due to gas, and the red color change in the slant ($R/Y/H_2S^+$) were considered to be *Salmonella* positive. The isolates were further subjected to sugar tests and able to ferment, Xylose, glucose, maltose, sucrose, and lactose, completely. Acid production was indicated by the color change from reddish to yellow and the gas production was noted by the appearance of gas bubbles in the test tubes (Table 2).

Table 2. Results of various biochemical tests performed on Salmonella isolates

Xylose	catalase	oxidase	Indole	MR	VP	Citrate	O-F	TSI	XLD	urease
+	+	-	-	+	-	+	+	$R/y/H2S^+$	+	-

Key. (MR) =methyl red, Vp= voges –proskauer, O-F= oxidation-Fermentation, (+)=positive reaction, (_) negative reaction.

In the present study, 294 abattoir and 90 butcher shop samples were collected and processed by standard bacteriological methods. The overall salmonella isolated was 68(17.70%) which was significantly higher frequency of salmonella isolates ($p<0.05$). were detected both from slaughter house and butcher shops.

In Assosa slaughter house, higher salmonella prevalence (31.6%) was recorded in abattoir workers hand swab, followed by 21.62% (neck swab), 18.91% abdominal (lateral swab); pooled material swab (15.09%); and 10.81% in hind limb, which was significantly associated ($P<0.05$) (Table 3).

Accordingly, hind limb/medial carcass were 4.25 times more likely harbor salmonella contaminates with, which was significantly associated ($P<0.05$). Abdominal (lateral) part of the beef carcass was 1.16 times contaminates' by

salmonella infection. Again, neck region was 15 times more likely exposed to salmonella contaminates and abattoir workers hand swab was 4.25 times contaminated with salmonella infection during handling the meat samples as (Table 4).

In the present study, higher salmonella prevalence (17.78%) were reported in butcher shop as compared to slaughter house in the Assosa district, which was non -significant(P>0.05) (Table 3).

Table 3. Prevalence of salmonella by sample source

Factors	N=384	Positive(%)	OR	CHI2	P-value
Abattoir	294	52(17.6)	3.14	293.00	0.0001
Butchers shop	90	16(17.78)	0.23	1.58	0.20
Total	384	68(17.70)	1.02	0.00	0.95

Table 4. Prevalence of salmonella at Assosa Slaughter house

No.	**Sample type**	**N=331**	**Positive (%)**	**OR**	**CHI2**	**P –value**
1	Hind limb(medial) swab	74	8(10.81)	4.25	20.91	0.000*
2	Abdomen(lateral) swab	74	14 (18.91)	1.16	51.46	0.000*
3	Neck swab	74	16(21.62)	15	39.50	0.000*
4	Hand swab	19	6(31.6)	4.25	9.23	0.024*
5	Pooled material swab	53	8(15.09)	0.6	0.23	0.62
Total		294	52(17.68)			

Table5. Prevalence of Salmonella at Assosa Butcher shop

No.	**Sample type**	**N=90**	**Positive (%)**	**OR**	**CHI2**	**P -value**
1	Meat swab	30	2(6.66)	1.29	1.26	0.25*
2	Material swab	30	9(30)	1.5	0.96	0.32*
3	Abattoir worker swab	30	5(16.66)	6.39	1.52	0.21
Total		90	16(17.77)			

In butcher shop, higher salmonella contaminates (30%) were investigated in pooled materials followed abattoir workers hand swab (16.66%), and 6.66% in meat swabs (Table 5).

3.2 Salmonella Associated Risk factors

Majority of salmonella infection (20.58%) was recorded in 4-8 years age, followed by 15.94% in greater than 9 years age and 7.66% in 4 years age, which was statistically non-significant (P>0.05). Higher (23.28%) salmonella contaminates were isolated in poor body conditions followed by 19.48% in good body conditions, which was statistically non-significant (p>0.05). 20% of the salmonella infection was isolated in cross breed while 18.2% of contaminates were isolated in local zebu breeds (P>0.05).

Drainage of the slaughter house, hygiene practice, meat storage were non-significantly associated with salmonella contaminants in this study (P>.05). Accordingly, in this study, poor drainage system of the slaughter house was 1.72 times more likely contaminated as compared to good drainage system with (OR= 1.72; CHI2=0.02; P>0.05). The poor hygiene practice of the slab was 1.06 times more likely contaminated with respect to good hygiene practice with (OR=1.06; CHI2=18.69; P>0.05). Besides this, 19.09% of salmonella contaminants were identified in improper meat handling practices, whereas 18.30% were recorded in good handling practices which was non- significantly associated (P>0.05). Again, poor surface hygiene in slaughter house was 1.06 times harbor contaminates as compared to good surface hygiene, with insignificant association with salmonella infection (P>0.05)(Table 6).

In multivariate analysis of the study subjects, carcasses not washed during slaughtering was 0.83 times more likely to have increased the risk of Salmonella isolates compared to carcass washed during slaughtering (OR=0.83; CHI2=0.00; P>0.05). Besides, slaughtered personnel who have not washed their hands after separating intestinal content were 1.02 times increased Salmonella isolates compared to those who washed their hands after separating intestinal content (OR=1.02; CHI2=0.02).

In this study, 15.68 % of the salmonella contaminates were recorded in non-wash knife before slaughter as compared to wash knife before slaughter with 1.20 times more contaminates the carcass during slaughtering operations (OR=1.2; CHI2=5.06; P=0.07). 19.61% salmonella contaminates were recorded in non-hand washing before slaughtering with 0.83 times more likely harbor the salmonella infections (OR=0.83; CHI2=0.75). With respect to the types of hand washing practice in the abattoir, 18.72% of the salmonella contaminates were isolated in hand washing practices applied before slaughtering with water only with 0.85 times more likely contaminates the slaughtering house and carcass (OR=0.85; CHI2=0.60); as compared to hand washing practice applied with soap and water before slaughtering operation with (18.2%) contaminates. Again, higher contaminates (23.2%) were isolated in non-washing carcass after skinning with 0.67 times harbor the contaminates as compared with washing carcass after skinning with 17.34% contaminates the carcass (OR=0.67; CHI2=17.72/ P=0.001)(Table 6).

Table 6: **Multivariate binary logistic regression of attribute risk factors with salmonella**

Risk factors	**Categories**	**n=252**	**No (%) positives**	OR	**CHI2**	**P-value**
Age(years)	4 (year)	13	1(7.69%)	0.96	1.78	0.41
	4-8 years	170	35(20.58%)			
	> 9 years	69	11 (15.94%)			
Breed	Cross	65	13(20%)	0.95	0.22	0.63
	Zebu	187	34(18.2%)			
BCS	Good	154	30(19.48%)	0.97	0.72	0.69
	Poor	73	17(23.28%)			
Drainage	*Yes*	*153*	*26(16.99)*	1.72	0.02	0.87
	No	*99*	*21(18.2)*			
Hygiene practice	*Yes*	*177*	*34(21.2)*	1.06	18.69	0.000*
	No	*75*	*13(17.33)*			
Handling practice (carcass)	*good*	*142*	*26(18.30*	0.90	0.02	0.87
	poor	*110*	*21(19.09)*			
proper storage	*Yes*	*146*	*27(18.49)*	0.78	0.00	0.94
	No	*106*	*20(18.86)*			
wash knife before slaughtering	*Yes*	*150*	*30(20)*	1.20	5.06	0.07
	No	*102*	*16(15.68)*			
Hand washing before slaughtering	*yes*	*43*	*6 (13.95)*	0.83	0.75	0.38
	no	*209*	*41(19.61)*			
	with water	*219*	*41(18.72)*	0.85	0.60	0.94

Type of handwashing practice applied before slaughtering	*with soap and water*	*33*	*6(18.2)*			
wash carcass after skinning	*yes*	*196*	*34(17.34)*	0.67	17.72	0.0001*
	no	*56*	*13(23.2)*			
Hand washing after separating intestinal content	*yes*	*198*	*34(17.2)*	1.02	0.02	0.89
	no	*54*	*13(24.07)*			
Washing carcass during slaughtering	*yes*	*162*	*30(18.51)*	0.83	0.00	0.94
	no	*90*	*17(18.88)*			
Sanitized slaughtering floor	*yes*	*60*	*11(18.33)*	1.06	0.00	0.94
	no	*192*	*36(18.75)*			

3.3 Antimicrobial Susceptibility Test

Out of 64 *salmonella*, 34 isolates were subjected to antimicrobial susceptibility tests. In this study, majority of salmonella isolates were resistance to penicillin (94.12%) followed by amoxicillin (85.29%); tetracycline (82.35%); and streptomycin (58%) and ciprofloxacin (41.2%) were drugs to which a large proportion of *salmonella* isolates' resistance. All 34 testes species of salmonella isolates were highly susceptible to chloramphenicol (85.29%), followed by Gentamycin (76.47%); kanamycin (67.64%); ciprofloxacin(58.82%) and streptomycin (41.2%).

Table 7: Resistance and susceptible of *Salmonella* Isolates to different antimicrobials (n = 34).

Antimicrobial agents	**Disc content (µg)**	**No. of Isolates**	**Resistance**	**Intermediate**	**Susceptible**
			No (%)	No (%)	No (%)
Streptomycin	S10	34	20(58)	0(0)	14(41.2)
Gentamycin	CN10	34	5(14.70)	3(8.82)	26(76.47)
Tetracycline	TTE 30	34	28(82.35)	0(0)	6(17.64)
kanamycin	K 30	34	9(26.47)	2(5.88)	23(67.64)
Penicillin G	P-10	34	32(94.12)	0(0)	2(5.88)
Amoxicillin	AMX	34	29(85.29%)	2(5.88%)	3(8.82%)
Chloramphenicol	C-30	34	2(5.88)	3(8.82)	29(85.29)
Ciprofloxacin	CIP5	34	14(41.2)	0(0)	20(58.82)

Key: %=percent, S=susceptible; I=intermediate; R=resistance

3.4 Questionnaire Survey Result

3.4.1. Socio-demographic data of abattoir personnel

In the present survey, thirty abattoir personnels (30) that had direct contact with the slaughtering were included. In the present questionnaire survey, 83.33% of the dominant abattoir workers were males. Majority of abattoir workers (63.33%) were 31-50 years age; followed by 20% in 18-31 years age range and 16.66% greater than 50 years age. 33.33%, 30%, 23.33%, and 13.33% of the duty at the slaughter houses were cleaners, de-hiding, stunning, and slaughterers respectively(Table 8). With respect education level, majority of abattoir workers were iliterate (36.66%) and primary level (43.33%) followed by (13.33%) secondary and (6.66%) college level.

Table 8. Socio -demographic respondents of slaughterhouses (n=30)

Variables	Categories	Freq.	percentage%
Sex	female	5	16.66
	male	25	83.33
age (year)	18-31	6	20
	31-50	19	63.33
	>50 years	5	16.66
level of education	illiterate	11	36.66
	primary	13	43.33
	secondary	4	13.33
	college	2	6.66
Duty at the slaughter houses	Slaughterers	4	13.33
	Stunning	7	23.33
	De-hiding	9	30
	Cleaners	10	33.33

With regards to hygienic handling practices at slaughter houses, majority 25(83.3%) of the methods of carcass dressing was horizontal/on floor and 5(16.6%) were vertical/hanging of carcass dressing methods. The respondent shown that, carcass washing by waters after evisceration was 11(36.6%), while 19(63.4%) were didn‘t wash after evisceration.

Concerning the knowledge of slaughterhouse workers, major possible source of carcass contaminations were Feces during evisceration 3(10%), hides during de-hiding 7(23.3%), handlers hand 5(16.66%), knife 6(20%), floor 5(16.6%) and hanging hook 4(13.33%). Accessibility water at slaughterhouse for hand washing through sink of their hands in waters were 8(26.6%), while didn‘t sink of their hands in waters 22(73.3%). The source of waters used in the slaughterhouse 20(66.6%) were used city tap waters, 5(16.7%) borehole waters and 3(10%) collected rain waters and 6.66% were used river only.

The received the training on hygienic handling of meat at slaughterhouse were 17(56.6%), while didn‘t received the training were 13(43.4%), the respondent medicals checkup done were 20 once per years 15(50%), by every six months 9(30%) and every three months 6(20%). The hygienic handling working equipment at slaughterhouse, the washing a knife by hot waters at each activity the respondents were 7(23.3%), while didn‘t washed by hot waters were 23(76.7%). Use of the personnel protective materials working in slaughterhouse were 6(20%),while didn‘t used were 24(80%) (Table 9)

Table 9. Hygienic handling practices at slaughter houses

Factors	Categories	Freq.	percentage%
Method of carcass dressing	Vertical (hanging)	5	16.66
	Horizontal (on floor)	25	83.33
Presence of sink for washing hands in the slaughterhouse	yes	8	26.66
	no	22	73.33
Carcass washing after evisceration	yes	11	36.66
	no	19	63.33
Use of the protective materials (apron, coverall,..)	yes	6	20
	no	24	80
Do you wash your hands in between activities	yes	12	40
	no	18	60
Do you sink the knife in hot water after each activity	yes	7	23.33
	no	23	76.66
What do you think is the major possible sources for carcass contamination	Feces during evisceration	3	10
	hides during de -hiding	7	23.33
	handlers hand	5	16.66
	knife	6	20
	floor	5	16.66
	hanging hook	4	13.33
What is the source of water used in the slaughterhouse?	Municipal tap water	20	66.66
	Borehole	5	16.66
	Collected rain water	3	10
	River	2	6.66
Have you ever received any training on hygienic handling of meat	Yes	10	33.33
	No	20	66.66
How frequent you go for medical checkup	Every three months	6	20
	Every six months	9	30
	Once per year	15	50
Apron (protective clothes)	Used	13	43.33
	Not used	17	56.66
Placement in the abattoir	Slaughtering	10	33.33
	Loading	5	16.66
	Washing stomach	7	23.33
	Washing the intestine	8	26.66

3. DISCUSSION

4.1 Prevalence of salmonella

In present study overall prevalence of Salmonellae was 68 (17.70%), which was isolated at Assosa slab house and Butcher shops by standard bacteriologically and Biochemical test methods. Besides this, 17.68% of salmonella contaminates were reported in slab house and 17.77% in butcher shops. This findings were agreed with findings of Elias (2024) in slaughter house and retailer shops of Harar city, eastern Ethiopia, who reported 24% and 15% salmonella prevalence respectively and the overall prevalence of Salmonella along the source of contamination was 76(21.1%).

In this result 17.68% of salmonella contaminates were reported in slab house which was compared with previous studies conducted by Ferede (2014) municipal abattoir, eastern Ethiopia, 17.7% salmonella prevalence. The previous study reported by Abebe *et al* (2014) in selected Woredas of Tigray, Ethiopia, Wondimu *et al* (2017) at Wolaita Sodo municipal abattoir, Southern Ethiopia, and Akafete and Haileleul, (2011) in Ethiopia, showed lower overall prevalence than the present finding with 16.4%, 12.5%, and 8.3% prevalence respectively.

The present findings, corroborates with the findings of Takele *et al*. (2018) and Dabassa and Bacha (2012) who reported 11.3% and 13.3% from beef carcasses in Jimma municipal abattoir, respectively, and Hiko *et al*. (2016) who reported 11.8% from Addis Ababa Abattoirs Enterprise whereas this prevalence is lower than other reports from Tigray region (16.4%), (2014) Dire Dawa abattoir (17.7%), (2014) and Senegal (42.8%).

Counter to this, the current finding is higher than the report of El-Gamal and EL-Bahi,(2016) Renatus *et al*. (2016) Thongsay *et al*. (2013) Kalambhe *et al*. (2016) Bahnass *et al*. (2015) Sefinew and Bayleyegn,(2012) and Gizachew and Mulugeta (2015) from Egypt (0.0%), Namibia (0.50%), Thailand (4.5%), Central India (6%), Saudi Arabia (8.5%), and Bahir Dar (4.8, 7.6%), respectively. This might be due to variation in the nature of samples, sampling strategy, and procedures origin of animals, contamination from intestinal tract breakage and fecal leakage during evisceration, and from lairage due to lack of care in the study setting.

In this present study, the higher salmonella contaminates (31.6%) were isolated in abattoir workers of hand swab, with 4.25 times more contaminates the handling carcasses and slaughtering houses. The contaminated carcasses from the slaughterhouse could result to infection of in-contact persons (Cummings, K.J. *et al*., 2013). Furthermore, beef originating from the slaughterhouse, if not handled hygienically, could result in the contamination of cooking utensils and ready-to-eat food and in-contact surfaces in homes and food vendor kitchens that source meat from the place. Unhygienic handling of food by vendors which is a major public health concern (Collard, P. and Sen, R.2015) is common in Nigeria (Ogah, J.O. *et al*., 2015). Handling food without maintaining hygiene has been incriminated as a major source of contamination of food and water in Nigeria (Akinyemi, K.O. *et al*., 2010). It is possible that contaminated meat contributes significantly to the endemicity of salmonellosis and the increased reports of Salmonella induced septicemia in Nigeria (Ogunleye, V.O., et al., 2005; Adedare, T.A *et al.*, 2008; Eze, E.A. *et al*., 2011). The observed contamination of the meat with Salmonella in KSH could possibly have originated from the processors since slaughterhouse personnel are reported to shed Salmonella (Anyanwu, M.U. *et al*., 2019, Kariuki, S. *et al*.,2002

With regards to salmonella distribution to different body parties, significant salmonella contaminates were reported in neck meat swab (21.623%); 18.91% in abdominal/lateral/ swab; 10.81% salmonella contaminates in hind limb (medial) meat swab, which was significantly associated($p<0.05$). This findings were higher as compared to the findings of Alemayhu T *et al*.,(2024), revealed, 9.6% of salmonella in abdomen, 6.7% in neck, 7.7% in hind limb, and overall all 8% salmonella prevalence in cattle slaughtered in Dessie municipality abattoir, northern Ethiopia.

Comparably, Tekleberhan w *et al*., (2018) from abattoir of mekelle city, Ethiopia indicated that, the mean salmonella count of neck, abdomen and hind found were 2.40, 2.37 and 2.33 ; with overall mean of log cfu/100cm2 2.37 respectively. The occurrence of salmonella in the neck was found to be higher compared to other parts of the carcass.

4.2 Salmonella infection Associated Risk factors

With regards to salmonella associated risk factors, 17.68% of the abattoir and 17.77 % of butcher shop samples were contaminated with salmonella. In these findings, the prevalence of salmonella infection was significantly influenced by age categories. Significant *salmonella* infection associated with age categories which was higher in (20.58%) in 4-8 years age followed by (15.94%) of greater than 9 years age and in 4 years (7.69%) which was non- significant ($P>0.05$). This finding was higher as compared to the findings of Isayas A *et al*., (2023) in selected District of Wolaita zone, South Ethiopia, who reported, 6.5% salmonella infection in 3-6 years age, 7.5% in 7-9 years and 44.4% in greater 9 years age of Cattle, which was significant ($P<0.05$). This finding was supported by (Biffa *et al*., 2005), who discovered a strong association between age and the prevalence of bacteria.

Significant (20%) salmonella infection was recorded in cross breeds followed by 18.2% in local zebu breeds ($p>0.05$). Comparable findings were reported by with Bitew *et al*. (2010) who reported in Bahir Dar, between Cross and Fogera breed, Lakew *et al*. (2009) in cross and local Arsi breed.

This study revealed that beef house with poor drainage was 1.72 times more likely to be harbor salmonella contaminates than well drainage housing systems. The association can be attributed to poor sanitation practices, handling practices and washing practices in slaughter house that promote the survival and transmission of contaminates (Bizunesh *et al*., 2022**).**
Occurrence of salmonella infection was significantly associated with hygienic practice ($p<0.05$). Abattoir with poor hygiene standard are 1.06 times more likely harbor the infection as compared to good hygiene practices.
19.09% of salmonella contaminates were isolated in poor handling practices while18.30% contaminates were isolated in good handling practices of the slaughter house with 0.90 times more contaminates the slaughter house and handling carcasses with(OR=0.90; CHI2=0.02; P>0.05). This findings were comparable with the previous findings of (Mulugeta and Wassie, 2013; Lakew *et al*., 2009; Sori *et al*., 2005). This might be due to absence of abattoir hygiene, handling of meat with common abattoir workers' and using of common abattoir protective cloths, which could be vectors of spread especially for zoonotic diseases (Radostitis *et al*., 2007). Comparably, Alemayhu T *et al*.,(2024) in Dessie municipality abattoir, northern Ethiopia, revealed that, 29.4% of abattoir workers did not washing of knife before slaughtering while 47% washing their knife; 23% of them, was not hand washing before slaughtering and 8.8% of abattoir workers washing their hands; 26.3% of the workers sanitized slaughter floor, while 7.1% did not; and also 37.5% of the abattoir workers, were hand washing after separating intestinal content and 5.7% did not(P>0.05).

4.3 Response to Different Categorical Variables

The reflection of this study establishes that the carcasses go downhill on dirty floor, the wall, floor and equipment used be not clean. The workers have no strict place to put equipments and their clothes were blood tinged and in adding together, user-friendliness water at slaughterhouse for hand washing through go down of their hands in waters be 8(26.6%), while didn't sink of their hands in waters 22(73.4%). They run to finish the work fairly than following hygienic slaughtering process.
The presented unhygienic practices and services in slaughter houses could aggravate the contami nation of carcasses and edible organs. Fecal detaching of salmonella from cattle may be intermittent and difficult to detect due to healthy carriers sporadically excrete only a few Salmonellae, unless they undertake some kind of stress, for example during transport or holding in the lairage prior to slaughter. However, the organism appears to be fairly spread throughout bovine population (Lawan *et al*., 2011). The study also suggested that overall faulty evisceration, falling carcass on dirty slaughter house floor, unhygienic equipments and personnel, improper transportation of carcass, unhygienic preparation at meat retail might be considered as a common source of Salmonella along the supply chain.
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In the current study more than 43.3% of slaughter house workers have only a primary school education. Similarly more than 43.3% of slaughter house workers did not have job related training as regards to food hygiene but acquired their respective skills from observations. The results are in agreement with reports of Mekonnin *et al*. (2013) and Endale and Hailay (2013) who reported a primary school education and lack of job relating trainings in more than half of the slaughter house workers and butchers in Mekelle city, Ethiopia. Therefore, these workers could cross contaminate and not handle meat hygienically due to lack of knowledge regarding hygiene, sanitation, risk of contamination and personal hygiene.
The level of education and training of food handlers about the critical idea and necessities of personal hygiene and its environment acting an important part in protection the safety of food to consumers. During the study it was exposed that, the abattoir had low level of education and this could make difficult in suitability of modern slaughtering practices as well as adherence to strict hygienic and standard slaughtering practices that contribute to microbial contamination. The present study found that out of 30 abattoir workers interviewed, 36.66% were illiterate, and all (43.3%) had no any training regarding meat hygiene. Large sized carcasses were in direct contact with the dirty floor that may contribute to contamination of meat from the contact part as the floor was in poor hygienic condition.

These findings are similar to those reported by Adzitey *et al*. (2011) that 45% of abattoir workers dressed carcasses on bare floor in the abattoir, 16% dressed carcasses on unclean slaughter slabs and 19% on both the slaughter slabs and bare floor in which the slaughter floor and slabs were smeared with blood, rumen contents and other wastes from previous dressed animals which increased the risk of contamination of subsequent carcasses.
In the study done by Haileselassie *et al*. (2012), 53.8% of the respondents reported that sanitary measures in the abattoir were not observed making the quality of meat produced in the study area questionable, a finding which was similar to what was observed in the present study whereby majority of respondents reported that the abattoir was in poor hygienic condition which made poor quality of meat produced.

Routine medical examination is important since it helps to control and prevent zoonotic diseases such as Tuberculosis. The result revealed that all workers in retail meat outlets had no a routine medical examination. Nervy *et al*. (2011) reported that careless sneezing and coughing among butchers may lead to contamination of beef. In order to protect the health of consumers and for aesthetic reasons, meat handlers should stop habit of careless sneezing and coughing when handling it. The overalls should be light in color so that contamination can be easily identified and the overalls cleaned easily. Most of the respondents agree in this study that even though the new applicants were asked for health certification, no periodic health status check up was carried out in the abattoir. Out of those workers who reported illness (74.2%), 34.8% did not report through legal way (approved by medical examination).

The wearing of jewelry, watches, and other detachable items should be discouraged. In addition to their clothes, the workers by themselves can be a probable source of contamination due to illness. The current study showed that there was no clear division of slaughtering process: stunning, bleeding, skinning, evisceration, hanging, and cutting/deboning. Furthermore, there was no preventive mechanism installed for insects and rodents in municipal abattoir which is similar with report in (M. Hailesilase, 2013). The hygienic condition of the abattoir workers has potential to contribute for contamination in meat processing. The author (L.Adetunde 2011) reports unclean slaughter men‘s hands, clothing, and equipment used in carcass dressing process accounted for the microbial contamination.
In our observation, the abattoir was extremely poor in sanitation due to the absence of water and blood drainage, and the accumulation of waste materials which were disposed of near to the slaughtering house. Therefore, the difference in the frequency of Salmonella isolation rate in the present study from different authors work could be attributed to variation in sampling strategy, detection procedures, target populations, topographical origins of the animals, numbers of animals sampled, study design, season, hygienic status of the abattoir and retailer shops, and antimicrobial treatment warranted during the process.
Salmonella infection was more prevalent in untrained abattoir workers (66.66%) compared to the trained ones (33.33%). This study revealed that job related training was significantly associated with Salmonella carriage ($p<0.05$).Untrained personnel working in the abattoir were 4.25times more likely to contaminate the carcasses with Salmonella than trained personnel. Ali et al. (2010) reported that abattoir men lack knowledge of disinfecting and sanitizing, they clean their shops once in 24 hours with detergent and water which is not enough to maintain the hygienic environments in the butcher. Regular cleaning and disinfecting the beef retail outlets is important since it helps to reduce microbial contamination.
In the present survey, the major possible sources for carcass contamination in slaughter house was (23.33%) in hides during de hiding; 20% knife; 16.66% floor; 16.66% handlers hand; 13.33% hanging hoof; and 10% feces and during evisceration. The contamination may also have originated from the live animals which are known to harbor and shed different bacterial organisms which serve as sources of primary contamination of the carcass at slaughter (Bouvet, J. etal.,2003) , and Salmonella are usually found in the intestines (Shiaka, G.P. et al., 2015). The concrete slaughter floor and wooden display tables had rough surfaces made so to prevent accidental falls and by cutting knives respectively and this may have resulted in difficulty in proper cleaning and retaining of large quantities of the organism after the daily activities. The WBUs in which the beef were washed also contained large quantities of the organisms that might have been washed off from the heavily contaminated beef. The knife, boot, file, and wheelbarrow retained relatively less quantities of the organism after contact with beef carcasses and this could be attributed to the fact that they are made of metal and plastic whose surfaces are relatively smooth.

4.4 Antimicrobial Sensitivity test result

Antimicrobial resistance is a growing worldwide issue in human and veterinary health, affecting both developed and developing countries. The growing use

of antimicrobial drugs in food animal production and humans was a significant contributor to the establishment of bacterial resistance (Gebremedhin *et al*., 2021).

The present study showed that the resistance of *salmonella* to Penicillin G (94.12%), amoxicillin (85.29%), Tetracycline (82.35%), and (58%) streptomycin and (41.2%) ciprofloxacin observed in abattoir samples. Comparably, salmonella isolates resistance result was reported by UJU Catherine *et al*., (2020) in kwata slaughter house, Awka Anambra state, Nigeria, which revealed 88.1% Amoxicillin, 100% ampicillin, 59.7% chloramphenicol, and 46 % streptomycin.

In the present findings, 85.29% chloramphenicol, followed by 76.47%% of Gentamycin, 67.64% kanamycin, 58.82% ciprofloxacin, and 41.2% streptomycin, was sensitive to Salmonella infection. This finding was in line with the findings of Igbinosa *et al*., (2021) in Benin city, Nigeria, reporting salmonella isolates were 100% sensitive to Gentamycin and Ofloxacin.

Comparable with the present findings, Frehiwot M *et al*., (2023) in Adami Tulu Jida, komobolcha District, reported that, 100% resistance was observed for ampicillin, cephalothin and rifampin and on the other hand 100% susceptibility was observed for chloramphenicol, ciprofloxacin, gentamicin, nalidixic acid, kanamycin and tetracycline.

Comparably, legesse G *et al*., (2015), of the total 53 Salmonella isolates subjected for antimicrobial susceptibility test, 47 (88.7 %), 35 (62.3%), 19 (35.8%), 17(32.1 %) and 16(30.2 %) exhibited resistance to Ampicillin, Amoxicillin, Nitrofuranthoin and Tetracycline respectively. The high resistance observed to antimicrobials including Ampicillin, Amoxicillin, Nitrofuranthoin, Tetracycline, and Trimethoprime-Sulfamethaxazole in this study could be due to uncontrolled availability of the antimicrobial agents in drug vendors, which leads to misuse. Thus, this might exert greater selection pressure for the resistant strains thereby making them resistant to antimicrobials. The presence of antimicrobial resistance have the potential to adversely affect human health by causing illness that is more difficult to treat because of the resistance profile of the microorganism.

4. CONCLUSION AND RECOMMENDATIONS

The findings of our present study clearly indicated that Food safety and quality of slaughter house in Assosa were unsatisfactory. Higher (17.70 %) *salmonella* contaminates were detected in abattoir and Butcher samples (P<0.05); with 17.7% and 1.68% salmonella contaminates in butcher shop and abattoir respectively. Additionally, 6.66% salmonella contaminates were reported in retail shop meat swabs while 21.62% neck swab; 18.91% abdominal swab; and 10.81% hind limb swab of salmonella contaminates were detected in different anatomical body parts(P<0.05) of abattoir samples. In the present findings, Sample source, hygienic practice, and washing carcass after and before skinning were potential risk factors. This indicates that *salmonella* is one of the major problems in beef industry that contaminated and reduced the quality of meat at each critical control points. Besides this, all salmonella isolates exhibited pink colony with black center onto XLD, and gram-negative rod shape, and catalase, Methyl red and citrate positive whereas, Indole, Voges- proskauer and oxidase negative. Moreover, 94.12% of penicillin G, followed by 85.29% amoxicillin, 82.35% tetracycline, 58%, streptomycin; and 41.2% ciprofloxacin were resistance whereas 85.29% of chloramphenicol; 76.47% Gentamycin, 67.64% kanamycin, 58.82% ciprofloxacin; and 41.2% streptomycin, were sensitive to salmonella isolates. Therefore, the results of the present study provided that salmonella quality and safety of beef meat was unsatisfactory. These findings stress the need for an integrated control of salmonella from farm production on to consumption of food of animal origin.

In light of the above conclusive remarks, the following recommendations are forwarded:

- Frequent hand washing, proper wearing of personnel protective materials, and proper allocation of abattoirs are applicable at all critical control points.
- Training was found to be a factor linked with good meat handling practices.
- Hiring employees with basic food safety training should be practiced.
- The study also emphasizes regulatory authorities to regulate and coordinate the meat-handling industries.
- The degree of the risk of consumption of beef meat contaminated with Salmonella should be assessed.

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