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The Prevalenceand Distribution of *Staphylococcus* in Abattoir and Dairy Farmsof Bishoftu Town, Ethiopia

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Abstract: The study was conducted to isolate, identify and investigate the prevalence of *Staphylococcus* from meat and raw dairy milk of Bishoftu Town, Ethiopia. A cross-sectional study was undertaken over 4 months period between February 2014 and April 2014 G.C on a total of 253 samples consisting of 87 samples of an abattoir and 166 samples of dairy farms collected from one Bishoftu municipal abattoir and selected 15 dairy farms in the study area were analyzed. The 103 *Staphylococci* isolated were finally identified by their biochemical characteristics for species assignment. They were divided into 4 groups: the first comprised the species *S. aureus* with a total of 45(17.8%) isolates, the second and third were represented respectively by the species *S. intermedius*, with 20 (7.9%) isolates and *S. hycius* with 16 (6.3%) isolates; the last contained 22 (8.7 %) isolates that were found to be CNS. The 21 isolates proved to be *Staphylococcus* from abattoir samples were tested for species assignment. They were grouped into *S. aureus* with 4 (4.6%) isolates, *S. intermedius* with 3 (3.5%) isolates and *S. hycius* with 1(1.2%) isolates and CNS with 13 (14.9 %) isolates which were predominated in abattoir and have statistically significant association with sample origin (Pv = 0.043) and sample type (Pv = 0.037). The total 82 isolates from the farm sample, predominantly contained staphylococcus aureus (23.5%) in which there is a statistically significant association with the sample source (PV = 0.000). This suggests the need to implement strict hygienic control measures along the food chain to improve the hygienic conditions during manufacturing, handling, storage and commercialization of milk in order to guarantee the quality of these highly popular products in Debre Zeit in order to decrease the risk of SFP.

Key words: Abattoit · Bishoftu · Dairy Farms · Identification · Prevalence · *Staphylococcus*

INTRODUCTION

Food must be visibly clean and free from noxious materials. It should be also nourishing and attractive as the aim of food hygiene should be the production and service of food, which is both safe and suitable for consumption [1, 2].

Contamination of food products with pathogenic organisms may influence considerably their harmlessness, endanger the health of consumers and decrease shelf quality resulting in food-borne infections, intoxications and economic losses from food spoilage [1]. Food-borne infections are caused by the ingestion of viable pathogenic microorganisms in food from infected animals or contaminated by infected persons during processing prior to their consumption. Food-borne poisoning is caused by the ingestion of toxins or other harmful substances that are produced by pathogenic microorganisms [3, 4].

Globally, millions of people suffer from communicable and non-communicable diseases caused by contaminated foods [5, 6]. There are three ways people have exposed to food borne diseases (FBD) due to pathogenic bacteria in foods of animal origin: meat (beef, mutton and pork), dairy (milk, cheese, yoghurt, ice cream) and eggs [2]. Foodborne diseases are universal public health problems and the implications are great including health and economic losses [1, 7]. Foodborne diseases or food poisonings are defined by the WHO as an illness or diseases of infectious or toxic nature caused by the consumption of foods or water contaminated with bacteria and/or their toxins, parasites, viruses, or chemicals [8, 9].

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A FBD outbreak is said to occur if similar illness, often gastrointestinal, in a minimum of 2 people and evidence of food as the source are confirmed [1, 10]. In many countries, national health care organizations defined FBD outbreaks as the occurrence of two or more cases of a similar illnesses resulting from the ingestion of a common food [1]. Staphylococcal food poisoning (SFP) is one of the most common FBD worldwide with high occurrence second to Salmonellosis [8, 11]. It is often associated with the ingestion of manually handled foods that contain one or more highly heat stable staphylococcal enterotoxins (SEs). Many foods will support growth of *Staphylococci* and toxin production. Milk and dairy products, especially handled foods, are common vehicles that are frequently implicated in SFP [4, 12, 13].

Livestock farming in general and milk production in particular still play an important socioeconomic role in developing countries. Dairy products, including milk, cheese, dry milk powder, cream, butter and yoghurt, are important and primary sources of nutrition in Ethiopia. Raw milk is widely manufactured and consumed by the people of Ethiopia [14]. Therefore, it is important that foods and raw ingredients, including milk, should be subject to microbiological controls. However, these products have not been subjected to hygiene or sanitary control, because they are made at home [15].

Meat is also a major constituent of the human diet in Ethiopia. It is an essential food item and one of the main sources of protein, fats, minerals and vitamins. Most meat have high water content corresponding to the water activity approximately 0.99 which is suitable for microbial growth [16]. Meat is subjected to changes by its own enzyme, by microbial action and its fat may be oxidized chemically microorganisms grow on meat causing visual, textural and organoleptic change when they release metabolites [17].

Meat is a good material for bacterial growth; its quality depends on the initial bacterial contamination. This contamination causes meat deterioration, lowers quality and sometimes illness may be caused by bacterial pathogens or their toxins through meat and meat products.

Generally, animal proteins such as meats, meat products, fish and fishery products are generally regarded as high risk commodity in respect of pathogen contents, natural toxins and other possible contaminants and adulterants [18]. In fact, tissue from healthy animal are sterile however, it has been pointed that during slaughter, dressing and cutting, microorganisms came chiefly from the exterior of the animal and its intestinal tract but that more added from knives, cloths, air, carts and equipment in general. External contamination of meat is a constant possibility from the moment of bleeding unit consumption [19]. Among the factors that affect microbial growth in meat are intrinsic properties (physical and chemical properties of meat) and extrinsic (environmental factors) [20], however the factors having the greatest influence on the growth of microorganisms in meat and meat products are the storage temperatures, moisture and oxygen availability [21]. The possible sources of these bacteria are likely to come from the skin of the animal from which the meat was obtained. Other potential sources of microbial contaminations are the equipment used for each the operation that is performed until the final product is eaten, the clothing and hands of personnel and the physical facilities themselves are all implicated [20].

The safety of milk with respect to FBD is of great concern around the world. This is especially true in developing countries like Ethiopia, where the production of milk and various dairy products often takes place under unsanitary conditions and the consumption of raw milk which are typically manufactured in small dairy farms under unsatisfactory hygienic conditions [22]. In spite of the aforementioned prevailing situation and the presence of a number of public health problems due to FBDs resulting from the consumption of different food items in Ethiopia, there is paucity of well-documented information on the occurrence of *Staphylococcus* in milk and meat. Therefore, this study was designed:

- To isolate *Staphylococcus* species and determine its prevalence and distribution in abattoir and dairy farms;

MATERIALS AND METHODS

Study Area: The study was conducted in Bishoftu, from February 2014 to April 2014. Bishoftu is located in Oromia National Regional State about 45 km South-east of Addis Ababa, just on the escarpment of the Great Rift Valley and the geography of the area is marked by creator lakes. It is found at 9°N latitude and 40°E longitude and at an altitude of 1850 meters above sea level in the central high lands of Ethiopia. It has a human population of about 95, 000. It experiences a bimodal pattern of rainfall with the main rainy season extending from June to September (of which 84% of rain is expected) and a short rainy season from

March to May with an average annual rainfall of 800 mm. The mean annual minimum and maximum temperatures are 12.3°C and 27.7°C, respectively, with an overall average of 18.7°C. The highest temperatures are recorded in May and the mean relative humidity is 61.3%. Bishoftu is the center of Ada'aLiben District and it has a total land area of about 1610.56Km and is divided in to three agro-ecological zones namely midland (94%), highland (3%) and lowland (3%) [23].

Types and Origin of Samples: The present study was conducted in both milk and swabs. Swab samples were collected from selected abattoir and dairy farms. Samples, which are repeatedly collected from the same abattoir, include swabs from personnel's hands, carcass, knives and slaughter lines. Swab samples from personnel's hands, knives and slaughter lines of the abattoir were collected before the slaughtering had been started at the time of visiting by using sterile swab soaked in peptone water and in each case the samples of swab were pooled except the carcass swabs which were collected individually from the randomly selected carcass. The milk samples collected once per visit from a selected dairy farm of selected 15 farms include: raw bovine udder milk; raw bovine pooled udder bulk tanks milk of a selected dairy farm and buckets swabs, tank(s) swab(s) and personnel's hands swabs which had swabbed before milking was started in the selected dairy farms in the study area, Bishoftu town.

Study Design and Study Populations: A cross-sectional study was conducted for the research from February 2014 to April 2014.

The study animals were Holstein Fresians, Holstein Fresian cross bred and Borena breeds of lactating cows in selected dairy farms and beef cattle from different production systems, breeds, age groups and sex are used. Personnel of different age and sex groups working in the selected dairy farms and abattoir was also studied.

Sample Collection and Transportation: A total of 253 samples were taken from selected dairy farms and abattoir. From the total of 253 samples, 166 were collected from selected dairy farms of which 106 udder milk, 15 pooled bucket swabs, 15 pooled farm personnel hand swabs, 15 tank milk and 15 tank swabs while 87 were collected from the selected abattoir of which 11abattoir personnel hand swabs, 11 knives swabs, 54 meat swabs and 11 slaughter line swabs. These samples were collected from various age groups, sex and breeds of cattle and various age groups and sex of selected abattoir and dairy farmworkers. The sample collected includes milk and swabs; and each one was discussed below. All samples were unmistakably labeled using the date of collection, sources, name of the farm and sample type.

Table 1: Type and number of samples collected and analyzed during the present study period

Samplesource	Types samples	Number of samples(n)
	Pooled hand swabs of farm personnel	15
	Tank swabs	15
Farm	Pooled bucket swabs	15
	Tank milk	15
	Udder milk	106
	Sub- total from selected dairy farm	166
Abattoir	Pooled swabs from abattoir	11
	Pooled slaughter line swabs	11
	Pooled knives swabs	11
	Meat swabs	54
	Sub-total from selected abattoir	87
	Whole total	253

Table 1 summarized the number of samples collected and type of samples from both abattoir and dairy farms.

Milk Sample Collection and Transportation: The study involved randomly selected lactating cows in the district. Udders and teats were cleaned using luke warm water and dried before sample collection. The teats were disinfected with 70% alcohol before sampling. About 2 ml of milk were collected and unmistakably labeled using the date of collection, sources (dairy farm) and sample type. All samples were aseptically collected and put into a sterile screw capped bottles and kept in an icebox containing ice packs and taken immediately to the laboratory of Microbiology at the CVMA, Addis Ababa University, Bishoftu.

Swab Sample Collection and Transportation: Swab samples were collected using sterile cotton swabs from selected dairy farms and abattoir. Each sterile cotton swab was dipped into 5ml sterile peptone water prior to collection. Then, samples for culture were obtained swabbing and pooling swabs from each of the personnel hands, knives, slaughter lines before and meat swabs after working had started by new pre-moistened cotton-tipped swabs. Hand swabs were collected from volunteer abattoir and dairy farmworkers. All samples were collected aseptically and unmistakably labeled using the date of collection, sources (dairy farms/abattoir), name of the farm and sample type Then, subsequently, it was put into a

single screw-capped tube containing peptone water. The samples for culture were placed in racks for easy handling and held in an icebox, properly packed and kept cold. Finally, it was transported to Microbiology laboratory of CVMA, Addis Ababa University to be processed immediately after arrival [24].

Study Methodology

Bacterial Culture: The International Organization for Standardization, ISO [25]6888-3: 2003 was employed for the isolation and identification of *Staphylococcus* species from swabs and raw bovine milk samples (Annex-9). The bacteriological media used for the study were prepared following the instructions of the manufacturers (Annex-1). In order to get discrete separate colonies, the surface of the agar media used in the study was made dry by keeping the medium in the incubator for overnight. A loop full from each sample was streaked onto blood agar plate enriched with 7% heparinized sheep blood. Blood agar plates were incubated aerobically at 37°C for 24hours. The plates were examined for the presence of *Staphylococcus* colonies. Isolates supposed to belong to *Staphylococcus* species on the basis of their morphological aspects (creamy, grayish, white or yellow colonies) and hemolytic pattern on the surface of BAP were collected. Presumed staphylococcal colonies were then sub-cultured on nutrient agar plates (NAP) and incubated at 37°C for 24 hours to get a pure culture (clone of cells derived from a single cell). The pure isolates from NAP were preserved and maintained for biochemical differentiation tests and characterizing the isolates. Pure cultures of a single colony type from the NAP were inoculated into nutrient slants and incubated at 37°C for 24-48 hours under aerobic culture conditions. The pure isolates in the nutrient slant were preserved and maintained at 4°C for further need.

Isolation and Identification of Staphylococcus Species: Final identification of *Staphylococci* organisms and species assignment were done based on Gram staining, Catalase test, sugar fermentation and coagulase test and the results were recorded.

Gram's Staining: All suspected cultures of Staphylococcus species were subjected to Gram's stain and observed under a light microscope for Gram's reaction, size and shape and cell arrangements by following Gram's staining procedures. The Gram-stained smears from typical colonies that showed Gram-positive cocci occurring in bunched, grapelike irregular clusters were taken as presumptive Staphylococcus species.

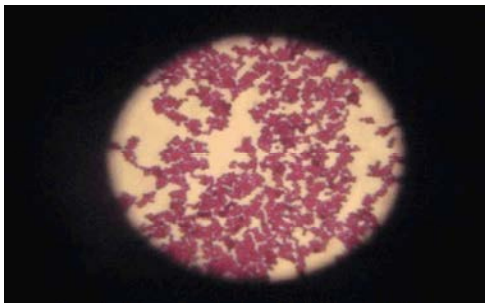

Fig. 1: Gram staining characteristics of *Staphylococci*

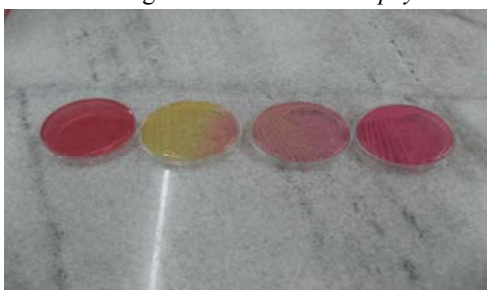

Fig. 2: Original mannitol salt agar, *S. aureus*, *S. intermedius* and *S. hicus* and CNS (left to right)

Catalase Test: The pure culture of the isolates was picked using a sterile loop from the agar slant and mixed with a drop of 3% H_2O_2 on a clean glass slide. Since the organisms were positive, bubbles of oxygen were liberated within a few seconds and the Catalase negative isolates didn't produce bubbles. The Catalase positive cocci were considered to be *Staphylococci*.

Mannitol Salt Agar: The colonies that were identified by Gram-staining reaction and Catalase test as *Staphylococci* were streaked on MSA plates and incubated at 37°C and examined after 24-48 hours for growth and changed in the color of the medium. The presence of growth and change of pH in the media (red to yellow color) were regarded as confirmative identification of *Staphylococci*. Phenol red pH indicator detected the acidic metabolic product of mannitol. Fermentation of mannitol by *S. aureus* causes yellow discoloration of the medium. Colonies that develop weak or delay yellow color after 24 hours of incubation were taken as S. intermedius and colonies that fail to produce any change on the medium were considered as *S. hicus* and CNS (Figure-2).

Coagulase Test: The tube coagulase test was performed in sterile tubes by adding 0.5 ml of selected isolates of Staphylococcus grown on Tryptone soya Broth (TSB) at 37°C for 24 hours to 0.5 ml of citrated rabbit plasma. After mixing by gentle rotation, the tubes were incubated

at 37°C along with a negative control tube containing a mixture of 0.5 ml of sterile TSB and 0.5 ml of rabbit plasma. Clotting was evaluated at 30 minutes intervals for the first 4 hours of the test and then after 24 hours incubation. The reaction was considered positive, if any degree of clotting from a loose clot to a solid clot that is immovable when the tube is inverted (tilted) is visible within the tube and no degree of clotting was taken as negative.

Purple Agar Base: Purple agar base (PAB) with the addition of 1 percent maltose was used to differentiate the pathogenic *Staphylococci*, particularly the coagulase-positive isolates. The suspected culture was inoculated on PAB media plate with1% of maltose and incubated at 37°C for 24-48 hours. The identification was based on the fact that *S. aureus* rapidly ferment maltose and the acid metabolic products cause the pH indicator (bromocresol purple) to change the medium and colonies to yellow. *S. intermedius* gives a weak or delay reaction and *S. hicus* does not ferment maltose but attacks the peptone in the medium producing an alkaline reaction (a deeper purple) around the colonies.

Polymxine B: It was used to differentiate *S. aureus* and *S. hicus* from *S. intermedius* based on the fact that both *S. aureus* and *S. hicus* are very resistant to Polymxine B but S. intermedius is susceptible to Polymxine B [26].

Data Management and Analysis: The collected data were entered into Microsoft Excel sheet and exported to SPSS version 20.0 computer software then the data were analyzed. Accordingly, descriptive statistics such as percentages and frequency distribution were used to describe/present bacterial isolation and antimicrobial susceptibility which was expressed as percent of resistant, intermediate and susceptible. In addition, the proportion of bacteria resistant to at least one of the fifteen antibiotics and resistant two or more were calculated. The data were also calculated by using the Pearson chi-square (X^2) test at a significance level of 5% and 95% CI to determine the differences of prevalence of *Staphylococcus, Staphylococcus* species and CPS between sample types and origin. The difference was statistically significant if the p- value was less than 0.05 to determine the statistical association between the variables.

RESULTS

Prevalence and Distribution of *Staphylococcus* in Meat and Milk: Out of 253 samples of swabs and milk originating from randomly selected an abattoir and 15 dairy farms, 103 (40.7%) were proved positive for *Staphylococci* as shown in the table-2. Out of 40.7% positive isolates of *staphylococcus* species, 21(24.1%) were isolated from samples collected from the abattoir of which 45.5% abattoir personnel hand swab, 0.0% knives swab, 45.5% slaughter line swab and 20.4% were isolated from meat swabs while from the total of 40.7% *Staphylococcus* isolates of present study, 82(49.4%) of *Staphylococcus* species isolated from samples collected from dairy farms of which 26.7% bucket swab, 46.7% personnel hand swab of farm, 53.3% tank swab, 80% tank milk and 48.1% udder milk (Table 2).

Prevalence and Distribution of *Staphylococcus* Species in Meat and Milk: The 103 *Staphylococci* isolates were finally identified by their biochemical characteristics for species assignment. They were divided into 4 groups: the first comprised the species *S.aureus*with a total of 45(45/253) isolates; the second and third were represented respectively by the species *S. intermedius* with 20(20/253) isolates and *S. hicus* with 16 (16/253) isolates; the last contained 22 (22/253) isolates that were found to be CNS. The identification results showed a dominance of staphylococcus aureus isolated (17.8%) from the total of 103(103/253) isolated staphylococcus species. Out of 40.7% staphylococcus isolated, 49.4% were isolated from samples collected from dairy farm and 24.1% from samples collected from abattoir (Table 3). In the present study higher prevalence of CNS (14.9%) was recorded in samples collected from abattoir than in that of farm which was 5.4% (Table 3).

The positive isolates of *staphylococcus* from different types of samples were analyzed by using Pearson chi-square (Table 3). In the present study as shown in the table 3, the associations statistically significant for *staphylococcus*hicus and coagulase negative *Staphylococcus* whose prevalence were 16(16/253) and 22(22/253) respectively. Out of 6.3% prevalence of *Staphylococcus* hicus isolated, 1.2% from abattoir and 9.0% from farm. Out of 22(22/253) of coagulase negative *Staphylococcus* isolated, 14.9% were isolated from abattoir and 5.4% from samples collected from dairy farms. The results showed that coagulase negative *Staphylococcus* were predominantly isolated from samples collected from abattoir and whose proportion was higher in abattoir than in the dairy farm. The Pearson chi-square analyses the association between type of sample and proportion of the isolates (Table 3).

The proportion of *staphylococcus* isolated from abattoir (24.1%) and farm 87(49.4%) from the total of 40.7% isolated were tested by using Pearson chi-square (Table 4). In the present study, there were statistically

Table 2: Prevalence of *Staphylococcus* isolated from swab and milk samples

Sample source	Sample type	Frequency	Proportion of positive isolates (n %)
Abattoir	Personnel hand swab	11	5(45.5)
	Knives swab	11	0(0.0)
	Slaughter line swab	11	5(45.5)
	Meat swab	54	11(20.4)
	Sub-total	87	21(24.1)
Farm	Bucket swab	15	4(26.7)
	Personnel hand swab	15	7(46.7)
	Tanks swab	15	8(53.3)
	Tank milk	15	12(80)
	Udder milk	106	51(48.1)
	Sub-total	166	82(49.4)
	Total	253	103(40.7)

Table 3: Prevalence of *staphylococcus* species isolated from milk and swabs

		Number (n %)			
Sample source	Sample type	*S. aureus*	*S. intermedius*	*S. hicus*	CNS
Abattoir	AHS	1(9.1)	1(9.1)	0(0.0)	3(27.3)
	KS	0(0.0)	0(0.0)	0(0.0)	0(0.0)
	SLS	0(0.0)	1(9.1)	0(0.0)	4(36.4)
	MS	3(5.6)	1(1.9)	1(1.9)	6(11.1)
	Sub-total	4(4.6)	3(3.5)	1(1.2)	13(14.9)
Farm	BS	3(20.0)	1(6.7)	0(0.0)	0(0.0)
	FHS	4(26.7)	2(13.3)	0(0.0)	1(6.7)
	TM	4(26.7)	1(6.7)	5(33.3)	2(13.3)
	TS	5(33.3)	2(13.3)	1(6.7)	0(0.0)
	UM	25(23.6)	11(10.4)	9(8.5)	6(5.7)
	Sub-total	41(24.7)	17(10.2)	15(9.0)	9(5.4)
	Whole total	45(17.8)	20(7.9)	16(6.3)	22(8.7)
	X^2=31.450	X^2=15.476	X^2=5.872	X^2=25.390	X^2=16.363
	Pv=0.000	Pv=0.051	Pv=0.662	Pv=0.001	Pv=0.037
	df =8	df =8	df =8	df =8	df =8
Association	Significant	Insignificant	Insignificant	Significant	Significant

AHS=hand swab from abattoir, KS=knives swab, SLS=slaughter line swab, MS=meat swab, BS=bucket swab, FHS=hand swabs from farm, TM=tanks milk, TS=tanks swab, UM= udder milk, PV= p-value, df =degree of freedom

Table 4: Pearson chi-square analyses the association between sample source and the prevalence of *staphylococcus* from swabs and milk samples

S. species	S.S (A, F, or B)	Chi-square	P-value	Association
S. aureus	B	14.448	0.000	Significant
S. intermedius	B	3.618	0.057	Insignificant
S. hicus	B	5.993	0.014	Significant
CNS	B	4.090	0.043	Significant

S.S = source of sample, A = abattoir, F = farm, B = both abattoir and farm, CNS = coagulase negative *staphylococcus*, S. = *Staphylococcus*

significant association between the *staphylococcus* species isolate and the sources from which the samples were derived except *staphylococcus* intermedius whose association with sample sources was statistically insignificant.

DISCUSSION

In the present study, in total of 253 samples consisting of 106 udder milk, 15 pooled farm personnel hand swabs, 15 bucket swabs, 15 tank swabs and 15 tank milk and 11 pooled abattoir personnel hand swabs, 11 knives swabs, 11 slaughter line swabs and 54 meat swabs were investigated. The identification results proved the presence of the pathogen in swabs and raw milk samples examined in the study area. The overall prevalence of *Staphylococcus* was 40.7% (103/253). This result was in-line with the results of Mekonnen [27] who found 127(31.8%) *Staphylococci* isolated from 400 samples of cottage cheese and raw bovine bulk milk, Makale [28] reported 250 *Staphylococci* isolated from hands and nasal swabs of 25 food handlers working in 5 different

restaurants and Salandra, *et al.* [29] reported as 55.9% of *Staphylococci* isolated from dairy products. The hypothesized reason in the difference of reported results could be differences in study area, origin and type of samples and in study design and sample size.

From the total prevalence (40.7%), 49.4% (82/166) *Staphylococcus* species were isolated from farms and 24.1% (21/87) isolated from samples derived from abattoir. A high prevalence of *Staphylococcus* was recorded in samples originated from farm than abattoir. Factors that could be hypothesized to be causes of contamination of milk in this study include insufficient pre-milking udder preparation, insufficient cleaning of milkers' hands, milking buckets and storage containers (tanks). Comparing the proportion of *Staphylococcus* in abattoir personnel hand swabs, slaughter line swabs, knives swabs and meat swabs of abattoir, the high prevalence of *Staphylococcus* was seen in both abattoir personnel hand swabs and slaughter line swabs. This could be attributed to the effects of meat contamination at different points of slaughtering process from lack of hand washing and poor hygienic handling of slaughter lines.

Comparing the prevalence of *Staphylococcus* in the raw milk samples in the present study the high prevalence of *Staphylococcus* was seen in tanks milk than udder milk and again comparing the swab samples from farm, highest prevalence was recorded in tank swabs (53.3%) followed by personnel hand swabs (46.7%). This could be attributed to the cumulative effects of udder milk contamination at different points. Additionally, handling of milk in different plastic containers and the use of sieves may cause contamination of milk Soomro, *et al*. [30]. Also, the number of personnel working at farm might have contributed to milk contamination.

In the present study, the overall prevalence of *S. aureus* was found to be 45(17.8%). This finding is in accordance with the findings observed in Egypt (17.2%) by Seedy, *et al.* [31], 7% by Mekonnen [28] from cheese and raw bovine bulk milk and 19.5% by Jakee, *et al.* [32] who isolated *S. aureus* strains from human and animal sources. Pereira, *et al*. [33] examined 55 healthy food handlers in a large industrial kitchen in Belo Horizonte (Brazil) and found that 32 (58.2%) were carriers of *S. aureus* and 17 (30.9%) carried enterotoxigenic strains in their nasal cavity, throat and under fingernails.

In current study, out of total prevalence of *Staphylococcus aureus* 45(17.8%), 41(24.7%) was isolated from farm which was higher than that of abattoir 4(4.6%). The hypothesized reasons could be due to the large number (n=166) and small number (n=87) of sample sizes used in the present study respectively and the difference in sample origin (source) because it has statistically significant association with the source of sample (PV= 0.000). This indicated that the milk contamination was higher by *staphylococcus aureus* in the selected farms than the contamination level of meat by *Staphylococcus aureus* in the selected an abattoir.

Out of the samples containing *Staphylococci*, *S. aureus* was detected in 23.6% (25/106) of the udder milk and 26.7% (4/15) tanks milk samples. The findings of the present study revealed a lower prevalence rate than 75% in 220 bovine bulk milk reported in Jorgensen, *et al*. [34], 68% (15/22) in Loir, *et al*. [1], 61.3% (49/80) in Hein, *et al.* [35], 40% (32/81) in Bendahou, *et al*. [36]. This different prevalence of *S. aureus* in these reports could be explained either by the different microbiological techniques used in these studies, differences in the origin of the samples or by geographical differences.

In current study, 7.9% *Staphylococcus intermedius* was detected in swab and milk samples. This is compared with result reported by Mekonnen [27] who isolated 7% from cottage cheese and raw bovine bulk milk. The present study result of 6.3% *staphylococcus hicus* was also compared with 5% isolated by Mekonnen [27] from cheese and raw bovine bulk milk. These two species of staphylococcus were isolated at higher rates than the previously reported results. The hypothesized reason could be the difference in sample type and source.

In the present study from the total positive isolates of *Staphylococcus* species (103), 22(22/253) was CNS. This result was in agreement with the result in a study conducted by Udo, *et al.* [37] the researchers found that 81.61% CNS from hands of food handlers, investigation of Tsegmed [38] who reported CNS in 54% of raw milk of cattle in Mongolia, Lamprell *et al*. [39] of 29% in 1036 samples and Mekonnen [27] of 12.8% in 400 cheese and milk sample.

The results showed in the present study that CNS species more frequently occurred in the samples originated from abattoir (14.9%) than that of farm (5.4%). The higher prevalence of CNS in the abattoir sample than farm sample could be due to lower hygienic measures in the slaughtering process of meat than that of milking processes .The hypothesized reasons could also be the differences in sample types and source since it has statistical association with both types (Pv=0.037) and

sources (Pv=0.034) of samples. Because CNS is a part of the normal teat skin flora and mucosa of humans and animals, some species are also found free-living in the environment Lourdes, *et al*. [40]. Therefore, they are common cause of contamination of milk and meat. As indicated in the present study, there was higher contamination of meat than milk by CNS.

CONCLUSION AND RECOMMENDATIONS

Staphylococcus organisms are widely spread in many foods and low contamination levels that favor growth and multiplication could induce staphylococcal food poisoning. The results obtained from this survey showed that meat and milk from Debre Zeit, Ethiopia were contaminated by *Staphylococcus* species. The presence of pathogenic *Staphylococcus* poses a health hazard and rise concerns about the safety of these food products. In addition, there is a need to implement strict hygienic measures in the manufacturing, handling, storage and selling of meat and milk in order to guarantee the quality of these highly popular products in Debre Zeit so as to minimize or eliminate the risk of *staphylococcal* food poisoning. The results warrant further investigations to elucidate the public health significance and the enterotoxigenecity of the isolates in meat and milk in the area.

Thus based on the findings of the present study and the above conclusions the following recommendations are forwarded:

- Sanitation and the application of good handling practices must be adopted in the production, storage and commercialization of raw meat to increase the shelf life and to make it safer for human consumption.
- Raw milk intended for human consumption must be subjected to pasteurization or heat treatment at least equivalent to pasteurization temperature.
- Awareness should be created among the public for the implementation of better control and subsequent reduction of Staphylococcalfood poisoning.

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