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Isolation of *Staphylococcus aureus* from camel (*Camelus dromedarius*) milk and its antimicrobial profile in Babile District, Eastern Hararghe, Ethiopia

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Abstract: A cross-sectional study was conducted from November 2021 to June 2022 in the Babile, Eastern Hararghe, Ethiopia, to isolate *Staphylococcus aureus* in Camel milk and determine its susceptibility to different market-available antimicrobials. From a total of 223 samples examined, 18.4% (41) were positive for *S. aureus*. There was a statistically significant difference (P = 0.001) in the isolation of *S. aureus* from milk udders at the producer and milk from containers at collectors and retailers. The isolates were highly susceptible to ciprofloxacin (100%) followed by gentamycin (92.7%), erythromycin (92.7%), kanamycin (90.2%), cefoxitin (68.3%), amikacin (65.9%). However, they were highly resistant to penicillin G (100%) followed by Ampicillin (85%), tetracycline (68.3%) Streptomycin (51.2%), and oxacillin (51.2%). An attempt was made to determine the milk handling practices and consumption behavior of actors in milk handling and value chain production by using a field survey that included milk producers, sellers, and consumers. It revealed poor milk handling practices, raw camel milk consumption, and inadequate knowledge of milk-borne diseases. In general, the study has revealed a high possibility of public health risk posed by *S. aureus* in the Eastern Hararghe Zone. Public awareness about good milk handling practices, pasteurization or boiling milk before consumption, rational use of drugs, and periodic assessment of the antimicrobial sensitivity of drugs before use are strongly recommended.

Keywords: Antimicrobial; Camel milk; Public health; *Staphylococcus aureus.*

1. Introduction

In terms of agricultural value-added and national gross domestic product (GDP), livestock production is a significant sub-sector in Ethiopia's economy. Ethiopia has a large livestock population in Africa, with 65 million cattle, 40 million sheep, 51 million goats, 8 million camels, and 49 million chickens in 2020 based on Central Statistical Agency (CSA) data (CSA, 2020). Camels (*Camelus dromedarius*) are indispensable in Ethiopia's national economy and pastoralist livelihood. Camel economic contributions to pastoral household income have recently increased when compared to other livestock in the country's pastoral plain (Kena, 2022). Camel milk is one of the key foods available in arid and sub-arid areas of Asian and African countries, including Ethiopia (FAO, 2010).

In Ethiopia, raw milk and other dairy products are frequently produced and consumed under unhygienic conditions (Ayele et al., 2017). Among the microorganisms most commonly implicated as causes of foodborne illnesses, *S. aureus* is a prominent cause of gastroenteritis caused by the intake of food contaminated with staphylococcal enterotoxins (Heidinger et al., 2009). *Staphylococcus aureus* was found in milk at various points along the milk handling chain in Ethiopia, which could be attributed to contamination from mastitis, cross-contamination of milk from infected farms, poor handling practices, and the use of unhygienic equipment (Ahmad et al., 2012; Ayele et al., 2017; Farzana et al., 2004). *S. aureus* is a prevalent food-borne bacterial pathogen that causes food poisoning in humans when ingested with contaminated food. In developing countries like Ethiopia, consumption of raw camel milk is common (Seifu, 2007), and an antimicrobial-resistant strain of *S. aureus* has been reported in the country (Befekadu et al., 2016).

Staphylococci are ubiquitous in the normal flora in the skin, mucous membranes of humans and warm-blooded animals, in the environment, and in water and have been frequently isolated from a wide range of foodstuffs such as dairy products and meat. *S. aureus* is a major cause of various community and hospital-acquired infections (Goering et al., 2012). It is an important foodborne pathogen that is usually associated with raw unpasteurized milk of dairy animals suffering from *Staphylococcal*-associated mastitis (Daka et al., 2012; Rahimi & Alian, 2013; Thaker et al., 2013). Some studies in Ethiopia on the prevalence of *S. aureus* from camel milk samples indicated 38.5% in Fedis, Eastern of Hararghe (Tasse et al., 2022) and 11.45% in Jigjiga District, Somali regional state (Serda et al., 2018). However, a prevalence of 38.5% was reported in Egypt (Elhosseny et al., 2018), and a 34.9% prevalence from raw camel milk in Kenya (Gitao et al., 2014) was also reported in Ethiopia.

The unique characteristic of *S. aureus* in causing mastitis is that it is difficult to cure once it has developed. This is due to its wide range of virulence and pathogenicity factors, including quorum sensing, which allows it to escape immune defense mechanisms and then cause infections in the availability of immune cells (Dancer, 2008). Other bacterial/viral diseases include rapid antibiotic resistance development, enterotoxigenicity, and the synthesis of enzymes such as staphylokinase, lipase, and hemolysins (Feyissa et al., 2023; Stefani et al., 2012).

Camel milk is mostly consumed in its raw state in most Ethiopian camel-rearing areas, with no processing treatment (Sisay & Awoke, 2015). Despite the aforementioned prevailing situation and the presence of many public health problems resulting from the consumption of raw camel milk, there is few number of well-documented information on the occurrence of *S. aureus* in raw camel milk in Ethiopia. The current study area is a remote pastoral where veterinary services are inadequate and no previous study was conducted on camel mastitis. As a result, because *S. aureus* causes disease in animals and humans via infection or toxin production in food, assessing the bacteria's prevalence and antibiotic susceptibility in milk can play important roles in the application of treatment and control procedures against the pathogen (Feyissa et al., 2023). Therefore, the current research work is

focused on assessing the prevalence of *S. aureus*, determining its antimicrobial susceptibility, and assessing consumer hygienic practices in camels along the milk handling in the Babile district of Eastern Hararghe, Ethiopia.

2. Materials and Methods

2.1. Study area and animals

The study was conducted in the Babile district, Eastern Hararghe zone, of the Oromia regional state, Ethiopia. It is located about 557 kilometers east of Addis Ababa, the capital city of Ethiopia. It lies between 8^0, 9-9^0, 23'N altitude and 42^0, 15'-42^0, 53'E longitude and is characterized by a semi-arid and arid climate with an average annual rainfall of 410–800 mm and an annual temperature range of 24-28 ^{0}C. The vegetation of this study area was sparsely distributed and dominated by Cactus and Acacia species and bushy woodlands. The altitude ranges from 950 to 2000 m above sea level. The total human population of the Woreda is estimated to be 118,537, of which 59,298 were males and 59,139 were females (CSA, 2020). The total number of camels (*Camelus dromedarius*) in the Babile district was 18,317. The number of camels used for milking in the study area is 4700, and annual camel milk in this area is estimated to be 7614 tons (Babile Agricultural Office, 2019). All camels in the area are managed under an extensive management system.

2.2. Study design

A cross-sectional study was conducted from September 2021 to June 2022 to determine the prevalence, antimicrobial susceptibility, and public health importance of *Staphylococcus aureus* in raw camel milk in the Babile district. Data were collected in two ways: laboratory results and questionnaire interviews. A type of sample includes milk from camel udders at producers and bulk milk from containers at collectors and retailers. Semi-structured questions were used to gather information on the hygienic condition of milking and container used, types of containers used, time gap from producer to consumer, storage of milk, milk consumption habits, illnesses associated with milk consumption, and awareness of milk-borne diseases.

2.3. Sample size and sampling techniques

The sample sizes were determined using the formula given in Thrusfield (2005) for random sampling. A 95% confidence level and a 5% desired level of precision with the expected prevalence of *S. aureus* of 16.2% were reported in the Erer district, Eastern Hararge zone, Oromia regional state, Ethiopia (Adugna et al., 2013). Accordingly, 208 sample sizes were calculated using the stated formula. After the selection of 40 households, two-stage cluster sampling was used to sample individual lactating camels. In a given herd, camels were identified into two groups: lactating and non-lactating, as all lactating groups were included in the sample. 137 dairy camels were randomly selected from the study group of animals. About 12 milk collectors and 22 milk retailers were identified, from which 34 bulk milk samples from collectors and 52 bulk milk samples from retailers were selected randomly. So, a total of 223 milk samples from different sources were tested for the presence of *S. aureus*.

2.4. Questionnaire survey

A pre-structured questionnaire was used to assess the knowledge, attitudes, and practices of study participants, or the target population, which are camel milk producers at a farm, sellers, and consumers in the handling and consumption of milk in the study area. The questions were originally written in English and translated into "Afaan Oromo" when interviewed. The answers were then translated into English and entered into the original form. For this sample size, we calculated by using the formula given by Arsham (2005), which is = $0.25/SE^2$, where N = sample size and SE (standard error) = 5%. Therefore, by using the above formula, the sample size was calculated as 100 participants to be interviewed. Random sampling was used to select the respondents along the milk production chain.

2.5. Collection and transportation of samples

Approximately 10 ml of raw camel milk was taken using the method indicated by Quinn et al. (2011). Strict aseptic procedures were used for collecting milk samples to avoid contamination with microorganisms found on the skin of the udder and the samplers' hands. Before sampling, teat ends were washed and disinfected with 70% ethanol (Quinn et al., 2011). We used a sterile bottle with tightly fitting cups. After sampling, the bottles were labeled with a permanent marker. To avoid contamination while sampling from camels, the first few drops of milk were removed. After agitating the bulk tank milk, a sample was obtained with a sterilized dipper from milk containers at collectors and sellers. The collected samples were sent to Haramaya University's Veterinary Microbiology Laboratory in an ice box for culture and isolation of bacteria. For ethical reasons, the study was reviewed and approved by Haramaya University, Ethiopia, before actual work was started. Consent forms were obtained from all subjects included in this study.

2.6. Isolation and identification of bacteria

Bacterial cultures were carried out using standard microbiological procedures (Quinn et al., 2011). Loop a full milk sample streaked on blood agar base enriched with 5% sheep blood. The inoculated plates were incubated aerobically at 37 ^{0}C for 24 to 48 hours. The plates were next checked for the presence of Staphylococcus colonies. The physical characteristics of colonies were used to characterize them. As a result, colonies with morphological traits such as B-hemolysis within 24-48 hours under aerobic culture were suspected. Presumptive staphylococcal colonies were then sub-cultured on nutrient agar plates and incubated at 37 ^{0}C for 24-48 hours to obtain a pure culture (a clone of cells originating from a single cell). All suspected cultures of *Staphylococcus* species were subjected to Gram's stain and observed under a light microscope for Gram's reaction, size, shape, and cell arrangements. The

gram-stained smears from typical colonies that showed Gram-positive cocci occurring in bunched, grape-like irregular clusters were taken as presumptive *Staphylococcus* species. The final identification of *S. aureus* assignments was done based on biochemical tests such as the catalase test, oxidase test, Mannitol sugar fermentation, and Coagulase test as described by Quinn et al. (2011). Accordingly, pure cultures of the isolates were mixed with a drop of 3% H2O2, and subsequently, the formation of bubbles originating in the microbial colony was verified as catalase-positive. For the oxidase test, the disappearance of a dark purple color along the streak on the filter paper in a moistened Petri dish with a 1% aqueous solution of tetramethyl-p-phenylene diamine dihydrochloride was considered Staphylococcus oxidase-positive. The presence of growth and a change in PH in the medium of mannitol salt agar (from red to yellow) were regarded as presumptive identifications of *S. aureus* during the mannitol fermentation test. The coagulase test consists of inoculating a suspension of the bacterial strain in rabbit plasma in a test tube, which will be incubated in a bacteriological incubator at 37 ^{0}C for 24 hours. Over this period, it will be observed whether or not there is the formation of a clot in the plasma, in which case the presence of coagulation will indicate a positive result.

2.7. Antimicrobial Susceptibility

Antimicrobial susceptibility testing was performed by the Kirby-Bauer disk diffusion method using the National Committee for Clinical Laboratory Standards (Wayne, 2010) on all *S. aureus* isolates. Overnight fresh cultures prepared on Muller-Hinton agar for antibiotic sensitivity tests were used. The turbidity of the suspension was adjusted to the density of the 0.5 McFarland standard (0.5 ml of 1% w/v BaCl2 and 99.5 ml of 1% v/v H2SO4), which is approximately 3 x 10 8 CFU/ml, by adding a sterile saline solution or more colonies to standardize the size of the inoculum. The plate containing colonies with the typical appearance of *S. aureus* was used for counting bacteria. The colonies were then transformed into colony-forming units per milliliter (CFU/mL). The criteria used to select the antimicrobials were based on the availability of the drugs on the market. The following medications are available: erythromycin (15 µg), ampicillin (10 µg), Penicillin G (10 µg), streptomycin (10 µg), Tetracycline (30 µg), vancomycine (30 µg), Gentamycin (30 µg), Ciprofloxacin (5 µg), Sulfamethoxazole/Trimethoprim (25 µg), Kanamycine (30 µg), Cefoxitin (30 µg), amikacin (30 µg), chloramphenicol (30 µg), and Oxacillin (1 µg). S. aureus was used for susceptibility tests in this study. Then the standardized suspension was streaked into Muller-Hinton agar and allowed to dry. Next, the antibiotic discs were placed on the medium and incubated at 37°C for 24 hours. Finally, the widths of the inhibitory zones around the discs were measured to the nearest millimeter with a ruler, and the isolates were classified as susceptible (S), intermediate (I), or resistant (R) (CLSI, 2014).

2.8. Data management and analysis

All data obtained from field surveys and laboratory analyses were coded, entered into Microsoft Excel, and exported to SPSS version 20 for descriptive analysis. A frequency table was used to present the data. The Chi-Square tests were used to assess the relationship between the prevalence of *S. aureus* in milk samples and other factors. Finally, a P-value of 0.05 was used as the statistical significance value.

3. Results

3.1. Prevalence of Staphylococcus aureus

Source of milk	Sample size	Prevalence (%)	χ^2	p-value
Milk from udder at Producer	137	16(11.7)		
Bulk Milk from container at collection center	34	7(20.6)	13.3449	0.001
Bulk milk from container at retailer	52	18(34.6)		
Total	223	41(18.4)		

Table 1 – Prevalence of *Staphylococcus aureus* along the Source of milk in the study area

Among the 223 samples examined, 18.4% (41) were positive for *S. aureus*. From this, 11.7%, 20.6%, and 34.6% were milk from camel udders at the milk producer, milk from containers at collectors, and milk from containers at retailers, respectively (Table 1). The result showed that the milk with the highest isolation of S. aureus was milk from retailers, while less was milk from camel udders. The result showed a quite significant difference (P = 0.001) in prevalence among the three sources of the sample.

3.2. Antimicrobial susceptibility of *Staphylococcus aureus*

Antimicrobial	Unit	Antimicrobial susceptibility of *S. aureus* isolate (n=41)		
		R	I	S
Ampicillin	10 µg	35(85.4)	6(14.6)	0(0.0)
Ciprofloxacin	10 µg	0(0.0)	0(0.0)	41(100)
Erythromycin	15 µg	2(4.9)	1(2.4)	38(92.7)
Gentamycin	10 µg	0(0.0)	3(7.3)	38(92.7)
penicillin G	10 µg	41(100)	0(0.0)	0(0.0)
streptomycin (S)	10 µg	21(51.2)	13(31.7)	7(17.1)
Sulphamethoxazole trimethoprim	25 µg	2(4.9)	33(80.5)	6(14.6)
Tetracycline	30 µg	28(68.3)	12(29.3)	1(2.4)
Vancomycine	30 µg	19(46.3)	14(34.1)	8(19.5)
Chloramphenicol	30 µg	23(56.1)	10(24.4)	8(19.5)
Amikacine	30 µg	6(14.6)	8(19.5)	27(65.9)
Kanamycine	30 µg	0(0.0)	4(9.8)	37(90.2)
Oxacillin	1 µg	21(51.2)	9(22.0)	11(26.8)
Cefoxitin	30 µg	13(31.7)	0(0)	28(68.3)

R=Resistant, I=Intermediate, S=Susceptible

Table 2 – Antimicrobial susceptibility test against *Staphylococcus aureus* isolates

All 41 isolates of *S. aureus* were tested for antimicrobial susceptibility with 14 different antimicrobials. High susceptibility to Ciprofloxacin (100%), Gentamycin (92.7%), Erythromycin (92.7%), and Kanamycin (90.2%) was observed in the results of an antimicrobial susceptibility test against *S. aureus*, while resistance was noted against Penicillin G (100%), Ampicillin (85.4%), Tetracycline (65.9%), streptomycin (51.2%), and oxacillin (51.2%) (Table 2).

3.3. Results of the Questioner Survey

Factors	No. of respondents	Hygienic level of milk and container		
		Good N (%)	Medium N (%)	Poor N (%)
Respondent category:				
Producer	40	0	16(40.00)	24(60.00)
Seller	30	2(6.67)	12(40.00)	16(53..33)
Consumer	30	6(20.00)	15(50.00)	9(30.00)
Age of Respondent/year				
15-20	11	1(9.09)	3(27.27)	7(63.64)
21-30	60	7(11.67)	27(45.00)	26(43.33)
>30	29	0	13(44.83)	16(55,17)
Sex of Respondent				
Male	46	4(8.70)	21(45.65)	21(45.65)
Female	54	4(7.41)	22(40.74)	28(51.85)
Educational status				
Illiterate	33	2(6.06)	12(36.36)	19(57.58)
Elementary	60	6(10.00)	27(45.00)	27(45.00)
High school	7	4(57.14)	3(42.86)	

Table 3 – Implication of respondent-related factors on milk hygienic conditions.

In addition to the laboratory examination, issues of public health implications arising from *S. aureus* and possible sources of milk contamination were assessed using a structured questionnaire survey on 40 milk producers or farmers, 30 milk sellers, and 30 consumers.

In considering producers, sellers, and consumers, fewer good hygiene practices and most of those with poor practices were reported in this study (Table 3). The level of sample source brings differences in hygienic practices of milk handling; producers, sellers, and consumer groups have poor practices at about 60.0%, 53.3%, and 30.0%, respectively. All respondents have the habit of consuming raw milk without being subjected to any sort of processing treatment.

In considering age, sex, and educational level, less hygienic practices and most of them with poor practices were reported in this research work. Level of education brought about a difference in hygienic practices of milk handling in the illiterate group, which had poorly practiced practices at about 57.58% with only 6.06% of them under good categories. Also, the level of age brought about a difference in hygienic practices of milk handling in the 20-30-year-old group, which had poorly practiced at about 43.3%, with only 11.67% of them falling under the good category.

Milk handling practices	N. of respondents	No. of respondent with illness N(%)	χ^2	P-value
Types of containers used				
Plastic can	49	8(16.33)	3.0634	0.216
Aluminum can	14	2(14.29)		
Wood can	7	3(42.86)		
Hygienic condition of milk and container				
Good	2	0(0.0)		
Medium	28	2(7.14)	4.9831	0.083
Poor	40	11(27.50)		
Time from production to conception /Hours				
1-4 h	10	1(10)		
5-10 h	38	5(13.16)	4.1927	0.123
> 10 h	22	7(31.82)		
Storage form				
Room temperature	70	13(18.6)		
Refrigerator	0	0		

Table 4 – Milk handling practices and rate of illness after consumption of raw milk by respondents

Among the milk handlers, the majority (70%) of them used plastic containers, then metallic containers, and some of them used traditional milk containers (wood) (Table 4). Some illnesses were associated with milk kept in plastic containers (16.33%). The rate of illness increased with an increased period from milk production to consumption, with a non-significant difference.

4. Discussion

Raw camel milk consumption (i.e., drinking) is common in Ethiopia. However, it is not safe for consumer health because it can contribute to the transmission of many diseases (i.e., bacteria). *S. aureus* species are common food-borne bacterial pathogens that cause food poisoning in humans when consumed in conjunction with contaminated foods (Salandra et al., 2008). It could be polluted at the milking site, the camel itself, dirty milk containers, and milk handlers (Seifu, 2007).

The overall prevalence of *S. aureus* isolates from camel milk in the study area was found to be 18.4% (41/223), which varied between sources of the sample (i.e., milk from the udder at producers, milk from containers at collectors and retailers) and ranged from 11.7-34.6%. This finding is in agreement with Rahimi and Alian (2013), Serda et al. (2018), and Aydin et al. (2011) who reported 11% in Iran, 11.45% in Jijiga, Ethiopia, and 10.2% in Turkey, respectively. However, the results of the present study were lower than those of another study conducted in Pakistan by Aqib et al. (2017). However, the variation might be due to hygienic practices, long-distance transportation from production to marketing, and the bulking of milk from different herds.

In this study, 34.6% of the milk samples contaminated with *S. aureus* came from containers at the retailers, from containers at the collectors, and directly from udders at the producers. The results showed an increase in the prevalence of *S. aureus* from camel udders at milk producers and even at milk retailers in bulk containers. This result is in agreement with Regassa et al. (2013) and Serda et al. (2018), who reported an increase in the prevalence of *S. aureus* due to cross-contamination of milk while bulking, unclean utensils, and poor handling during transportation from milk producers to retailers.

The susceptibility of *S. aureus* to antimicrobial agents has varied worldwide, but *S. aureus* isolates were usually susceptible to kanamycin, ciprofloxacin, vancomycin, and gentamicin (Daka et al., 2012; Mekuria et al., 2013; Thaker et al., 2013). *S. aureus*

isolates in the present study also showed high susceptibility to ciprofloxacin, gentamycin, erythromycin, kanamycin, cefoxitin, and amikacin.

The antimicrobial susceptibility result in the present study is comparable to Alamin et al. (2013) who reported ciprofloxacin (77.8%) and gentamycin (88.8%) and also slightly similar to Befekadu et al. (2016) who reported ciprofloxacin (75%), cefoxitin (100%), erythromycin (50%) and kanamycin (50%). In contrast to the present study, the sensitivity of *S. aureus* to some antibiotics is much different. For instance, Befekadu et al. (2016) reported that the susceptibility rate of *S. aureus* isolates to erythromycin was 21.6%, and Kh AL-Tofaily (2011) who cited a sensitivity percentage of 16.6% to erythromycin. However, *S. aureus* isolated in the present study was found to be highly susceptible to these antibiotics. This might be due to the limited use of these antimicrobials for the treatment of diseases in dairy camels, including mastitis in the study area.

The antimicrobial resistance of *S. aureus* in the present study was exhibited to penicillin G, ampicillin, streptomycin, tetracycline, oxacillin, and chloramphenicol. Intermediate resistances to vancomycin and Sulphamethoxazole/trimethoprim were presented. In this study, some antimicrobial resistance was comparable with Sori et al. (2011), who reported penicillin G (87 %); Balemi et al. (2021), who reported penicillin G (100%), and Rathore and Kataria (2012), who reported resistance to ampicillin (100%). In contrast to the present study, the percentage of resistance is not comparable with Rahimi and Alian (2013) who reported 17.4% of resistance to penicillin G in Iran and disagreed with Befekadu et al. (2016), who reported 50% susceptible to tetracycline. The increased resistance in the present study might be due to repeated therapeutic and indiscriminate use of these drugs in this study area. *S. aureus* isolates in the present study were resistant to vancomycin and chloramphenicol. Our data disagreed with Befekadu et al. (2016), who reported susceptibility to chloramphenicol (75%), sulphamethoxazole/trimethoprim (75%), and vancomycin (100%). The probable explanation for the high antibiotic resistance of *S. aureus* to these drugs is a lack of stringent regulation and monitoring in the dispensing and use of antimicrobials in the country, which might also contribute to the occurrence of high antimicrobial resistance to these drugs.

In this study, poor hygienic conditions of milk were observed among milk producers and milk sellers. The hygienic condition and handling practices of milk might have serious implications for public health. Maintaining the hygienic conditions of the camel udder, container, and personnel is important for good-quality milk. Odongo et al. (2016), reported that poor hygienic conditions of milk and containers were higher among herdsmen and farmers than retailers. However, a high prevalence of *S. aureus* occurs at the seller's site. This might be due to contamination during the mixing of milk from different producers or collectors, delayed transport, or prolonged exposure to high environmental temperatures. Poor hygienic conditions of milk related to educational status were: illiterate, elementary class, and high school education, which is in agreement with the report of Serda et al. (2018) from Jigjiga, Somali regional state of Ethiopia.

Illnesses associated with raw milk consumption were higher when using plastic cans than wood cans, and aluminum cans. The highest percentage of illnesses was observed among users of milk in traditional milk containers (wood cans) and milk in plastic containers. This data is similar to Rahimi and Alian (2013), who agree that handling milk in plastic containers may cause contamination of milk due to scratching easily and providing hiding places for bacteria, even during cleaning, as well as poor conductor heat leading to bacterial contamination of the milk.

Of 20.4% of the illnesses associated with the consumption of poor-hygienic raw camel milk, 7% were associated with the consumption of medium-hygienic raw milk, with no presence of illness at good hygiene. Odongo et al. (2016) reported that poor hygiene is one of the major ways of introducing pathogens to milk. Seifu (2007), Serda et al. (2018), and Farah et al. (2007) reported that the majority of consumers were ill due to the long period that milk stayed at home before consumption out of a refrigerator, favoring the microorganisms. Odongo et al. (2016) and Younan and Abdurahman (2004) reported that high room temperatures imply that microorganisms can multiply in raw milk during storage and transportation. Therefore, the consumption of raw camel milk without any processing should be a major concern from a public health point of view.

5. Conclusion

The high prevalence of *S. aureus* at milk retailers might indicate cross-contamination of milk due to pooling, delayed transport, and unhygienic milk handling practices. The antimicrobial susceptibility tests carried out in this study revealed a high susceptibility of *S. aureus* toward ciprofloxacin, gentamycin, erythromycin, kanamycin, and cefoxitin, whereas a high resistance of *S. aureus* to Penicillin G, ampicillin, and Tetracycline was recorded. In general, the study has revealed a high prevalence of *S. aureus*, resistance to commonly used antibiotics, and the possibility of a public health risk from poor handling practices. Therefore, good hygienic practices should be maintained for the udder, containers, and handling during milking and handling to minimize the prevalence of *S. aureus*; rational use of drugs should be considered in the case where treatment is considered, and awareness should be created among the community for the implementation of better control and subsequent reduction of public health effects.

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