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*Research Article*

# Microbial quality of camel milk along the market value chain in Awsa zone of Afar region, northeast Ethiopia: One health approach

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**Abstract**

The intake of raw camel milk by the larger pastoral community in the Afar Region poses a major public health threat. This study aimed to identify and isolate bacterial pathogens, focusing on *Staphylococcus aureus* and *Escherichia coli*, from raw camel milk collected from udders and markets along the market chain in the study areas. A cross-sectional study design was conducted from November 2019 to July 2020. Two-hundred ten (210) raw camel milk samples were used for isolation of *S. aureus* and *E. coli* by standard microbiological methods. Moreover, structured questionnaires were prepared and administered to 105 pastoralists and market retailers to assess their awareness of milk hygiene and associated consequences. Data were analyzed using STATA 14 software. Out of 210 samples that w, 41 (39.1%) and 22 (20.9%) were identified as positive for *S. aureus and E. coli*, respectively. Both S. *aureus and E. coli* were detected in only 52 samples, whether single or in combination, resulting in an overall prevalence of 24.7% of positive samples. The calculated mean total bacterial count (TBC) was 5.37±0.08 log10 CFU/ml for udder milk samples, while it was 5.80 ± 0.14 log10 CFU/ml for market milk samples. The study revealed that nearly all respondents, 104 (99.05%), regularly consumed raw milk. Additionally, the majority of participants, 104 (96.19%), were unaware of the harmful bacteria that can be found in raw milk. The study identified both *S. aureus* and *E. coli* bacterial isolates from raw camel samples. Of the 60 raw milk samples having TBC tested, only 4 (6.67%) of them were found to be unsound for human consumption.

***Keywords***: Awsa, Camel, Market Chain, Raw Milk, Total Bacterial Count

## 1. INTRODUCTION

The world camel populations were approximately 38.5 million heads (FAO, 2020). More than

80% of domesticated camels inhabit Africa with 60% (11.8 million heads) in the eastern African countries like Sudan, Somalia, Ethiopia and Kenya (Faye, 2015). The camel population in Ethiopia is estimated at 8 million (CSA, 2020). Global camel milk production is estimated to 3.15 million tons in 2020. Of which Ethiopia produce 1,820,000 tons (CSA, 2020). Camel milk is a crucial food for pastoralists in the arid and semi-arid areas of the eastern lowlands of Ethiopia, where browsing and water are limited (Felleke, 2003). Despite food safety being among the major public health concerns, unsafe food has been a human health problem throughout history and today (Pal et al., 2014). Numerous epidemiological reports proved that non-heat treated milk and raw milk products represent one of the principal factors for diseases caused by foodborne pathogens in pastoral communities (De Buyser et al., 2001).

Despite raw camel milk has been consumed for decades by pastoralists for its nutritional and medicinal values. countries like Saudi Arabia, United Arab Emirates, Kazakhstan, Mauritania, and Algeria start to pasteurize camel milk and sell it in a market (Merzouk et al., 2013). The pastoralist society has long believed that raw camel milk is safe for human consumption due to its therapeutic properties compared to other animal species. Such strong antimicrobial activity of camel milk proved scientifically for its ability to inhibit Gram-positive and Gram-negative pathogens concerning food safety (Benkerroum et al., 2003).

Milk contamination occurs during milking from the udder, milking equipment, during transportation, storage equipment and the milking person. under these conditions, microorganisms get access to the milk and multiply (Adugna et al., 2013). Nevertheless, in pastoral communities, camel milk is collected and handled traditionally and is often transported under poor sanitary conditions (Benkerroum et al., 2003). *Staphylococcal* and *E. coli* are the most important contaminants of milk (Ashenafi, 1990).

Previously several studies were conducted on microbial quality of camel milk along the market chain in different areas (Abera et al., 2016; Kaindi et al., 2011). However, documented research works on the bacteriological quality of raw camel milk in the study areas are limited (Mohammed, 2016; Wasie et al., 2015) Thus, assessing the safety of camel milk along the milk market chain, from the primary production sites to open markets/retailers is of paramount importance to develop applicable intervention strategies directed at improving the quality and safety of milk.

## 2. MATERIALS AND METHODS

### 2.1.Description of study the area

The Afar national region is one of the four major pastoral regions in Ethiopia, located in the northeastern part of the country and 588kms far from the capital city of Ethiopia. The annual temperature and rainfall in the region are 30-50°C and 200-600mm, respectively. And also, the altitude ranges from 100-1000 meters above sea level. The population of the region is estimated to be about 1.5 million of which 90% are pastoralists and 10% Agro-pastoral (CSA, 2020).The study was conducted in three districts of afar region such as Aysaita, Samara-Logia and, Dubti districts. These three districts of Awsa zone were selected based on their huge camel milk production and the only camel milk supplier for market in the region (Figure 1).

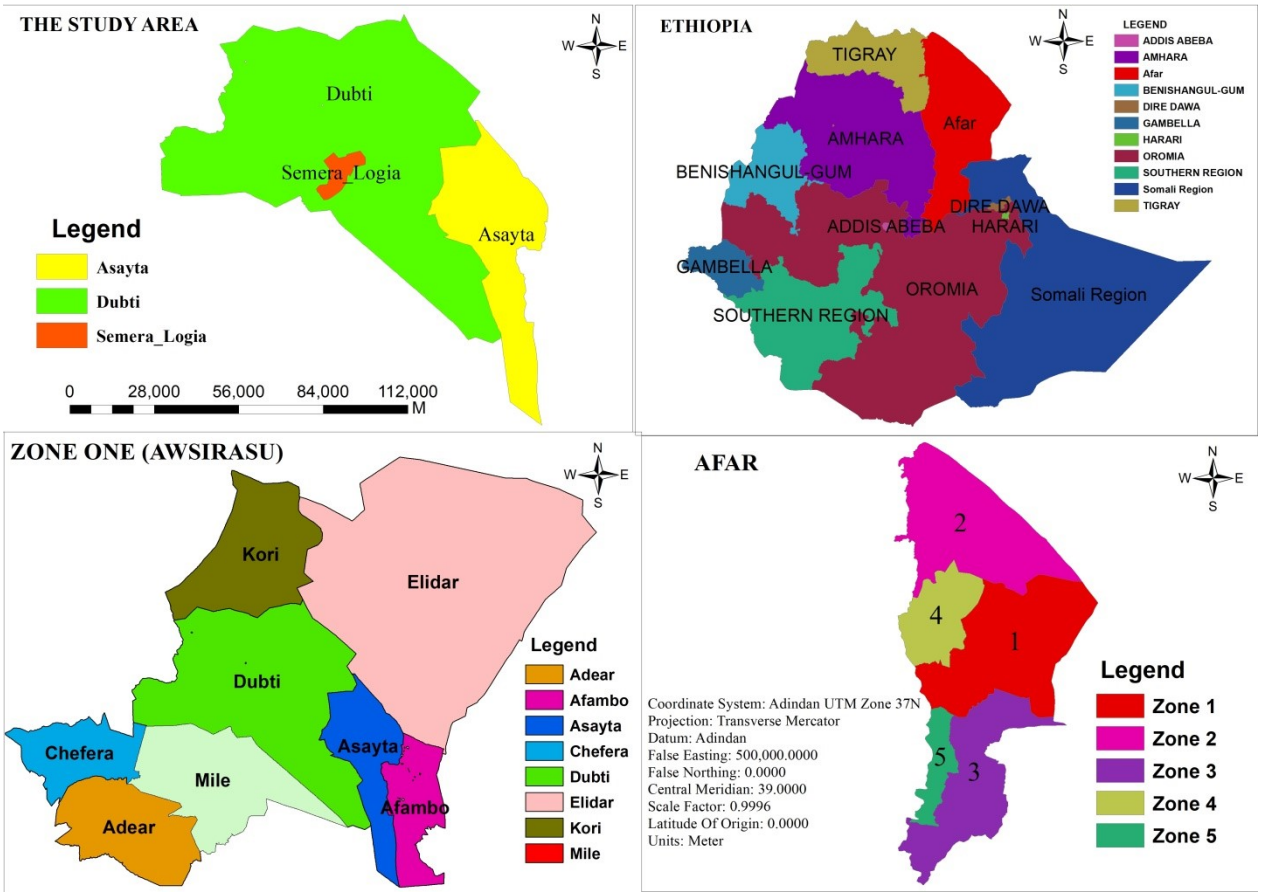



**Figure 1.** Map of the study area

### 2.2.Study design and period

A cross-sectional survey study design was carried out from November 2019 to July 2020.

### 2.2.1. Source and study population

The source populations were lactating Camelus dromedaries from the Afar breed, specifically the Amibara and Mille breeds, with varying lactation stages and parity, raised within a pastoral transhumance production system and involved in informal raw milk marketing in the Awsa Zone of the Afar Region. Hence, the study population were lactating camels and the informally marketed raw milk from the selected districts for the research.

### 2.2.2. Sampling technique and Sample size determination

Samples from camel herding were selected using a two-stage sampling procedure. In the first stage, three districts (Asayita, Dubti, samara-logia) were purposively selected from Awsa zone, because they have high potential for camel milk production and wider camel milk marketing practices; in the second stage, the lists of camel milk producer households were taken from their respective administration, simple random sampling method was applied as a sampling strategy, the milk samples were taken randomly and directly from the udder and the local milk market center, and a total of 210 milk samples were collected for bacteriological analysis (105 samples from the milk market and 105 directly from the udder of camels), and 35 samples from the milk market chain and 35 samples from the udder milk were collected in each district (Figure 2).

Structured questionnaire to assess the milk hygiene practices were used to interview individual pastoralists who brought milk to the local milk market center. A total of 105 pastoralists who supplied camel milk for the local market were selected by simple random sampling and interviewed in the three study sites during the study period using the structured questionnaire adapted from previous studies and the questions in the questionnaire were closed ended. The questionnaire was prepared in English and translated to Afar-af and back to English by experts and checked for its consistency. Data collectors, supervisors and the Principal investigator discussed the data collection process before the actual data collection and the supervisors closely supervised the data collection process with the principal instigator. The structured questionnaire was pretested at Samara town on 5 participants which is 5% of the total sample size to assess its clarity.

### 2.2.3. Sample collection and transportation

From every collected milk sample, nearly 25ml of raw camel milk samples were collected aseptically into sterile Durham bottles (Abera, B.H., Assefa, E.K., Gebreslasse, 2008) Each container was labeled and kept in an icebox containing ice packs and transported immediately to Samara University, College of Veterinary Medicine, and Microbiology laboratory for

microbiological analysis. Upon arrival, the samples were kept in at 4°C refrigerators up to the time of processing. The analysis was carried out within 24-hour period after collection.

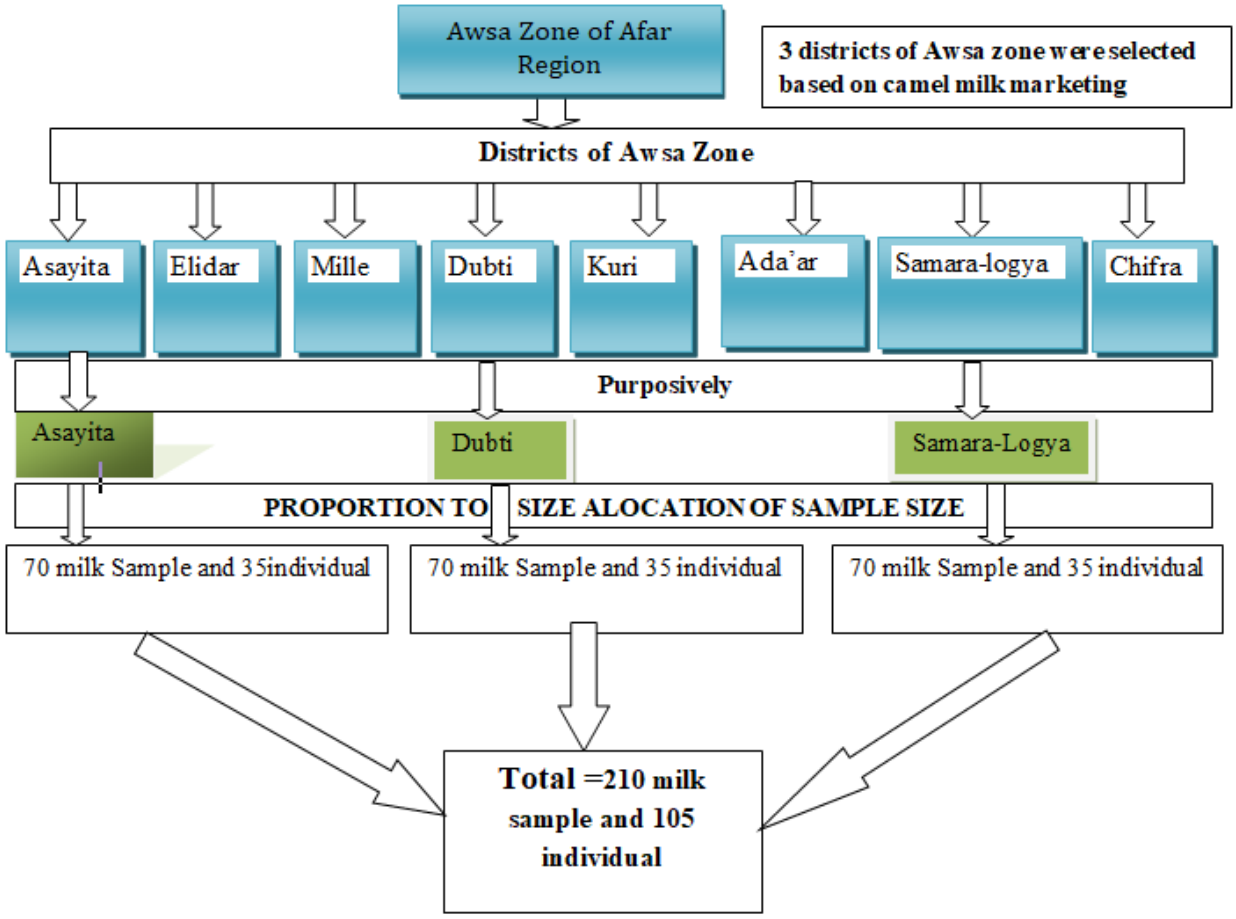



**Figure 2.** Schematic presentation of selected three districts and respondents

### 2.2.4. Analysis of milk bacteriological quality (load)

The raw milk samples were assessed for bacteriological quality by using standard plate count technique (Kebede, 2005). For total bacterial count (TBC), a total of 60 milk samples was taken, 20 samples from each study site (Asayita, Dubti and Samara-Logya). The total number of colonies on plates 25 to 250 per plates was selected and colonies were counted (Welearegay et al., 2012).The result was compared with Indian bacteriological standards of raw milk stated as very good (< $2x10^5$cfu/ml), good (2-$10x10^5$cfu/ml), fair (10-$50x10^5$cfu/ml), poor (> $50x10^5$cfu/ml) and very poor (not specified) (Sherikar et al., 2004).

### 2.2.5. Bacterial isolation and identification method

From a total 210 milk samples, 105 from the udder and 105 from the market were taken for bacterial isolation and identification (Kebede, 2005). Bacteriological media for the study were prepared

according to manufacturer's instructions. Isolation and identification of bacteria were carried out based on colony morphology, microscopic techniques, and biochemical tests. Moreover, highly selective media including Mannitol Salt Agar, MacConkey agar, Eosin Methylene Blue (EMB) agar, and Triple Sugar Iron agar were also utilized.

### 2.3. Data management and analysis

Data were entered in Epi-info version 7. Data analysis was carried out using STATA software ver 14.0. Before conducting analysis, the Log10 transformation of the bacterial count was computed. Descriptive statistics like percentages were used to assess hygienic practices and to express the proportion of bacterial isolation and milk quality grade based on Indian standards. Linear regression analysis was also performed to analyze the effects of hygienic practices on a bacteriological count of the milk. Using linear regression analysis, the mean [±SE] log10cfu/ml values between the two collecting locations were used to examine the differences in bacterial load between market milk and raw milk taken directly from teats. TBC mean ± standard error was computed for each specific sample source [expressed in log 10cfu/ml] as shown in (Table 4). For $P < 0.05$ the results were considered significant.

## 3. RESULTS

### 3.1.Total bacterial count (TBC)

The overall average total bacterial count (TBC) was 5.37±0.08 log10 CFU/ml and 5.80 ± 0.14 log10 CFU/ml for milk samples collected from the udder and market chains, respectively. Accordingly, the count increased by 0.43 log10 CFU/ml from udder to market chains. TBC was highest in Logia followed by Dubti and Asayita with results of 6.0 ± 0.25, 5.8 ± 0.28 and 5.6 ± 0.22, respectively (Tables 1-3). According to the results presented in Table 4 there is no statistical difference between the three study sites ($P > 0.05$)

**Table 1.** Total bacterial count from raw milk collected directly udder and market (Asayita)

| SN | Sample Source | Bacterial load count CFU/ml with log10 CFU $mL^{-1}$ | SN | Sample Source | Bacterial load count CFU/ml |
|---|---|---|---|---|---|
| 1 | | 4.9x104 (4.69log10) | 11 | | $4.3x10^5$(5.63log10) |
| 2 | | $7.9x10^4$ (4.89log10) | 12 | | $4.8x10^4$(4.68log10) |
| 3 | | $8.1x10^4$ (4.91log10) | 13 | | $3.7x10^5$(5.56log10) |
| 4 | | $8.5x10^4$(4.92log10) | 14 | | $3.3x10^6$(6.52log10) |
| 5 | Udder | $8.8x10^5$(5.94log10) | 15 | Market | $5.1x10^5$(5.71log10) |
| 6 | | $3.7x10^5$(5.56log10) | 16 | | $5.8x10^5$(5.76log10) |
| 7 | | $3.9x10^5$(5.59log10) | 17 | | $1.17x10^5$(5.18log10) |
| 8 | | $4.2x10^4$ (4.62log10) | 18 | | $9.3x10^4$(4.97log10) |
| 9 | | $4.3x10^4$(4.63log10) | 19 | | $7.2x10^4$(4.86log10) |
| 10 | | $6.9x10^4$(4.83log10) | 20 | | $6.6x10^4$(4.82log10) |

**Table 2:** Total bacterial count from raw milk collected directly udder and market (Dubti site)

| SN | Sample type | Bacterial load count CFU/ml with log10 CFU $mL^{-1}$ | s. no | Sample source | Bacterial load count CFU/ml |
|---|---|---|---|---|---|
| **1** | | $9.2x10^4$ (4.96 log10) | 11 | | $1.07x10^5$ (5.19log10) |
| 2 | | $9.9x10^4$ (4.99 log10) | 12 | | $1.16x10^5$ (5.14log10) |
| 3 | | $1.05x10^5$ (5.02 log10) | 13 | | $7.1x10^6$ (6.85log10) |
| 4 | | $4.4x10^5$ (5.64 log10) | 14 | | $3.9x10^6$ (6.59log10) |
| 5 | Udder | $4.7x10^5$ (5.67 log10) | 15 | Market | $3.2x10^6$ (6.5log10) |
| 6 | | $2.02x10^5$ (5.3 log10) | 16 | | $4.1x10^6$ (6.61log10) |
| 7 | | $2.4x10^5$ (5.38 log10) | 17 | | $9.9x10^5$ (5.99log10) |
| 8 | | $2.19x10^5$ (5.34 log10) | 18 | | $2x10^5$ (5.3log10) |
| 9 | | $4.2x10^5$ (5.62 log10) | 19 | | $1.09x10^5$ (5.04log10) |
| 10 | | $5.1x10^5$ (5.7 log10) | 20 | | $1.04x10^5$ (5.02log10) |

**Table 3.** Total bacterial count from raw milk collected directly udder and market (Samara-Logia site)

| SN | Sample Source | Bacterial load count CFU/ml with log10 CFU $mL^{-1}$ | SN | Sample Source | Bacterial load count CFU/ml |
|---|---|---|---|---|---|
| 1 | | $4x10^4$ (4.6 log10) | 11 | | $2.5x10^6$ (6.39 log10) |
| 2 | | $4.5x10^4$ (4.65 log10) | 12 | | $1.5x10^6$ (6.18 log10) |
| 3 | | $2x10^5$ (5.3 log10) | 13 | | $6.5x10^5$ (5.81 log10) |
| 4 | | $1.5x10^5$ (5.17 log10) | 14 | | $1.65x10^5$ (5.21 log10) |
| 5 | Udder | $5.3x10^4$ (4.72 log10) | 15 | Market | $7.1x10^6$ (6.85 log10) |
| 6 | | $4x10^5$ (5.6 log10) | 16 | | $5.1x10^6$ (6.71 log10) |
| 7 | | $2.01x10^5$ (5.3 log10) | 17 | | $1.76x10^5$ (5.24 log10) |
| 8 | | $7.5x10^5$ (5.87 log10) | 18 | | $8.1x10^5$ (5.91 log10) |
| 9 | | $6.5x10^5$ (5.81 log10) | 19 | | $5.5x10^6$ (6.74 log10) |
| 10 | | $7x10^5$ (5.84 log10) | 20 | | $2.2x10^5$ (5.35 log10) |

**Table 4.** Mean (± SE) total bacterial counts (log10CFU $mL^{-1}$) variation among samples collected site and source

| Study sites | Sample source | No of sample | min | max | TBC (Mean ± SE) | 95% CI | P-value |
|---|---|---|---|---|---|---|---|
| Asayita | Market | 10 | 5 | 7 | 5.6 ±0.22 | 5.2-6.09 | |
| Dubti | Market | 10 | 5 | 7 | 5.8 ± 0.28 | 5.27-6.38 | 0.556 |
| Samara-Logia | Market | 10 | 5 | 7 | 6.0± 0.25 | 5.5-6.5 | |
| Asayita | Udder | 10 | 5 | 6 | 5.3 ±0.15 | 5-5.61 | |
| Dubti | Udder | 10 | 5 | 6 | 5.4 ± 0.15 | 5.13-5.71 | |
| Samara-Logia | Udder | 10 | 5 | 6 | 5.4 ± 0.16 | 5.13-5.75 | |

## 3.2.Bacteriological Milk Quality Grade

The result was compared with Indian bacteriological standards of raw milk stated as very good (<$2x10^5$cfu/ml), good (2-$10x10^5$cfu/ml), fair (10-$50x10^5$cfu/ml), poor (>$50x10^5$cfu/ml). Those samples taken from camel udder were found to have a total bacterial count (TBC) below the minimum standard limit set (<5.0x10 or <$50x10^5$/cfu/ml milk). This was bacteriologically sound for human consumption. Four of the 60 samples taken from the market chain were found to be

contaminated unacceptably for human consumption (to have a TBC >50x$10^5$/cfu/ml milk) (Table 5).

**Table 5.** Bacteriological milk quality grade

| | Milk Quality Grade | | | |
|---|---|---|---|---|
| **Sample source** | **Very good (<2 x$10^5$)** | **Good (2-10 x$10^5$** | **Fair (10-50 x$10^5$** | **Poor (>50x$10^5$** |
| Udder (30) | 14 (46.6%) | 16 (53.3%) | | |
| Market (30) | 11 (36.7%) | 9 (30%) | 6 (20%) | 4 (13.3%) |

### 3.3.Bacterial species isolated

The overall prevalence of *S. aureus and E. coli* from different milk sources is presented in Table 6. Of all, 105 (60%) market milk samples and 105 (17.14%) udder milk samples yield at least one bacterial species. Of these, 13 (12.4%) from udder milk samples while 41 (39.1%) from market milk sources were culturally positive for S. aureus and 5 (4.8%) udder milk and 22 (20.9%) marketed milk samples for *E. coli* (Table 6). According to the result presented in Table 6 there is no statistical difference between the udder and market milk source (P>0.05).

**Table 6:** Frequency distribution of the *E. coli* and *S. aureus* in raw camel milk

| **Study site** | **Sample source** | **Sample tested** | *S. aureus* **(%)** | *E. coli* **(%)** | $X^2$ | **p-value** |
|---|---|---|---|---|---|---|
| Asayita | Udder | 35 | 3 (8.6) | 1(2.9) | 1.75 | 0.78 |
| Dubti | Udder | 35 | 4 (11.4) | 2 (5.7) | | |
| Samara-Logia | Udder | 35 | 6 (17.1) | 2 (5.7) | | |
| Asayita | Market | 35 | 11 (31.4) | 5 (14.3) | | |
| Dubti | Market | 35 | 13 (37.1) | 7 (20) | 7.5 | 0.11 |
| Samara-Logia | Market | 35 | 17 (48.6) | 10 (28.6) | | |
| Total | | **210** | **41 (39.1)** | **22 (20.9)** | | |

### 3.4. Survey findings

A total of 105 randomly selected milk supplying pastoralists within the local market chain were interviewed using a structured questionnaire. Nearly all 104 (99.05%) of the respondents were having a habit of consuming raw camel milk. The majority of participants, 104(96.190%) had no awareness of pathogenic bacteria present in milk and believed that milk is free of bacterial pathogens. The study had also indicated that 57 (54.29%) use only tap water for cleaning milk utensils. The survey has also revealed that 55 (52.38%) and of respondents clean their milking utensils with water and smoke, and 28 (26.67%) of respondents clean the utensils with water and soap (Table 7).

**Table 7:** Milk owner awareness about milk hygiene and handling practice in the production system

| Variable | Category | Frequency (%) |
|---|---|---|
| Consumption of raw camel milk | Yes | 104 (99.05) |
| | No | 1 (0.95) |
| Pathogenic bacterial presence in the raw milk | No | 104 (99.05) |
| | Yes | 4(3.81) |
| Practice of discarding of 1st milk drop | Yes | 33(31.43) |
| | No | 72(68.57) |
| Hand washing practice before and after milking | Yes | 98(93.33) |
| | No | 7(6.7) |
| Awareness of udder washing before milking | Yes | 32(30.48) |
| | No | 73(69.52) |
| Milk equipment hygiene | Do not clean | 0 (0) |
| | Cleaning only with water | 22(20.95) |
| | Cleaning with water and soap | 28(26.67) |
| | Cleaning with water and smoke | 55(52.38) |
| Storage equipment hygiene | Do not clean | 9(8.57) |
| | Cleaning only with water | 43(40.95) |
| | Cleaning with water and soap | 39(37.14) |
| | Cleaning with water and smoke | 6(5.71) |
| | Cleaning with water and ash | 8(7.62) |
| Share milking equipment | Yes | 21(20.00) |
| | No | 84(80.00) |

## 4. DISCUSSION

Camel milk is a vital food for the pastoral society of the Eastern lowlands of Ethiopia. However, raw camel milk has been identified as a vehicle of several microorganisms pathogenic for man, and their source may lie either within or outside the udder. Pathogenic bacteria may be present in raw milk as a direct consequence of udder disease (Donkor et al., 2010). In the current study, 210 raw milk samples were processed following standard microbiological methods among those 41 (39.1%) and 22 (20.9%) were culturally positive for *S. aureus* and *E. coli*, respectively. Despite of, 210 milk samples culturally studied, only 52 (24.76%) samples were found to have contaminated in either single or mixed form providing an overall prevalence of 24.7% positivity. The present finding was in agreement with the findings of (Worku et al., 2012) who reported pathogenic organisms commonly producing mastitis including, *Staphylococcus aureus* and *Escherichia coli*.

Total bacterial count (TBC) is an indication of the sanitary conditions under which the milk is produced (Ahmed et al., 2010). Total Bacterial Count (TBC) was carried out for 60 raw camel milk samples using the Indian Standards. Since there has not been a TBC set standard for Ethiopian one

humped camels, we were compelled to use the Indian Reference Standard (Sherikar et al., 2004). According to the standard, 4 of the 60 samples were found to be contaminated unacceptably high providing an overall prevalence of 6.67%. The majority of microbiologically unacceptable or poor graded milk samples were collected from Logia-Samara market chain (Mohammed, 2016) and Dubti (Wasie et al., 2015). This could be due to a lack of access to information, absence of veterinary facility, long distance transportation, camel breed difference, and availability of water. Moreover, those samples taken from camel teats/udder were found to have a total bacterial count (TBC) below the minimum standard limit set ($<5.0x10^6$)/CFU/ml milk and bacteriologically sound for human consumption (Sherikar et al., 2004). Milk collected directly from udder was found to have relatively better bacteriological quality than the milk collected from the market. This might be due to the traditional methods of distribution and transportation of milk including; use of easily contaminated and hard to clean container, long transit time to markets with frequent opening of containers for retail or milk transfer. The present study agrees with (Maluwa, 2009) who reported the mean *total bacterial count (*TBC) ranged from $10^2$-$10^4$ CFU/ml milk from camel teats/udder in Kenya. And also supported by studies conducted in United Arab Emirates (2.83 log CFU/ml (Younan et al., 2004). This was bacteriologically sound for human consumption; this was due to below the standard limit *set ($<5.0x10^6$)/CFU/ml)*. This finding is in contrary to the findings of study done in Morocco (6.85 log CFU/ml) (Benkerroum et al., 2003).

The minimum bacterial load detected in those samples might be attributed to an extended exposure of samples (no cooling system) to higher environmental temperature may result in rising the ambient temperature of the milk thereby increasing the multiplication of bacteria contained therein. This relationship between temperature rise and bacterial multiplication was also reported by different scholars (Grodzki et al., 2015). Moreover, the higher TBC observed in Logia samples could also be due to lack of cooling system at the market site, equipment sanity and milker's hand. Milk samples from buckets/vessels had significantly higher mean TBC ($P<0.05$) that could be associated with unhygienic milker's hand, water used, utensils and the environment.

Mean TBC was carried out for 10 samples for each 6 specific sample sources. The mean TBC was then compared among each other. The mean TBC ranged 6.0±0.25-5.3 ±0.15. The highest mean TBC (6.0±0.25) was observed in Logia-market where milk samples were transported over a longer distance and sold on retail basis. The lowest mean TBC (5.3 ±0.15) was observed from samples of Asayita-udder source where the samples were freshly drawn from camel udders and noticeable that the smallest variation (±0.15) was also observed among these samples. However, the highest mean

TBC variation (± 0.28) was seen to have originated from Dubti-market. The higher TBC variation among Dubti-marker samples might be attributed to camels' nutrition, milking procedure, milking equipment's, milker's hand sanitation, relative humidity and transportation differences (Bava et al., 2011; Pantoja et al., 2009).

Of 210 samples assessed, the highest level of contamination was recorded (30%) from the milk samples collected from markets compared to milk samples from under (8.5%) which could be attributed to exposure of milk to the environment and unhygienic milking and handling. The risk of contamination of milk with pathogens is attributed to the practice of poor hygiene and handling practice of camel milk during milking and after milking. This is similar to the finding reported by (Benkerroum et al., 2004).

Similarly, within conventional practices, the hygiene status of the farmers, the quality of water utilized for sanitation purposes which does not adequately safeguard the caw's udder, the condition of the milking environment, and tools employed in the milking process may constitute the principal sources of initial milk contamination (Welearegay et al., 2012). The present investigation has disclosed that almost all participants (99.05%) exhibited a proclivity for consuming unprocessed camel milk. This phenomenon may be attributable to insufficient public awareness, prevailing cultural beliefs, and suboptimal attitude (Welearegay et al., 2012).

## 5. CONCLUSION

According to this study, 41 *Staphylococcus aureus* and 22 *E. coli* isolates were identified from 210 raw camel milk samples using standard microbiological methods and 158 samples were negative from any of the two target bacteria and only 52 of milk samples were found to have the two pathogenic bacteria with an overall prevalence of 24.7%. Total bacterial count (TBC) was computed for 60 raw milk samples ranging from $4.8x10^4$to $7.1x10^6$/ CFU/ml. Of those 60 samples tested for bacterial quality, 4 (6.67%) of them were found to have poor quality based on standards and unfit for human consumption and the majority (75%) of those poor milk samples were collected from Logia retail markets. Mean for TBC was conducted for 10 samples per specific site and the highest mean (6.0± 0.25) while the lowest (5.3 ±0.15) was recorded in Asayita. Generally, lesser tested samples (4/60) were found to be contaminated with the total bacterial which exceeds $5.0x10^6$CFU/ml.

Based on these conclusive remarks, several key recommendations were put forward. First, public awareness activities should be expanded so that communities gain a deeper understanding of milk

hygiene and safety. In addition, broader efforts in bacterial isolation are strongly encouraged in order to identify the diverse bacterial species present in raw milk and highlight those with potential significance. Finally, it is essential that total bacterial counts be carried out more extensively, as this will provide a clearer picture of overall milk quality and help guide future interventions.

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**Ethics approval and consent to participate**

Ethical clearance was obtained from Samara University Research Ethical Review Committee (RERC) to assure that there will not be a potential risk to happen upon study participants. After thoroughly discussing the ultimate purpose and method of the study, a written support letter was sought from local authorities and concerned government officials. Similarly, written consent was obtained from interviewee before proceeding to data collection. All information that was obtained from the individual was treated confidentially.

**Consent for publication**

Not applicable.

**Availability of data and materials**

The datasets used during the current study are available from the corresponding author on reasonable request

**Competing interests**

The authors declare that no conflicts of interest exist.

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