Bacteriological Quality Of Milk; In Selected Dairy Farm At Haramaya District

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Abstract: Milk is a complex biological fluid which easily contaminated and invaded by bacteria. It is an ideal growing medium for microorganisms, which once get access to milk, will multiply rapidly and spoil the milk or render it unsafe for human consumption or unfit for further processing. A cross sectional study was conducted from October 2014 to march 2015 in four commercial private and one governmental dairy farm which are found in and around Haramaya district, with the main objective of determining the bacteriological quality of milk. Raw milk samples were collected from milking equipment and directly from the teat as soon as milking of the cow. The samples were collected aseptically in sterilized test tubes that were labeled and placed in icebox until transported to the laboratory. They were put in a refrigerator at 4^{o}C and culturing was conducted within 24 hours. At the time of sampling process, the hygienic and sanitary practices in all studied dairy farms have been evaluated. The sample collection was conducted in five farms in which only one farm applies machine milking and use warm water before and after milking. Only one farm conducts milking in the milking room while the rest of the farms done milking in the cow barn. Different coliform counts were recorded between milk samples collected under different variables and all raw milk samples collected at different sampling points have shown highly significant variation ($p<0.05$) with an overall mean of 2.1 $\log_{10}$ cfu/ml coliform counts. Raw milk samples collected from local breed dairy cows and from farms those conduct semi-intensive production system exhibited higher coliform count (2.13 $\log_{10}$ cfu/ml for local breed and 2.32 $\log_{10}$cfu/ml for semi-intensive production system) than cross breeds and intensive production system which were 1.86 $\log_{10}$cfu/ml and 2.05 $\log_{10}$cfu / ml respectively. Raw milk samples taken from milking equipments were found with higher coliform count than samples taken directly from teat. There was significant variation among samples taken from different production system at the equipment sampling point with an overall mean of total bacterial count of 6.8 $\log_{10}$ cfu/ml. It was shown that the total bacterial count from semi-intensive production system (7.42 $\log_{10}$cfu/ml) was significantly higher than intensive production system (6.18 $\log_{10}$ cfu/ml) at the equipment sampling point. The high total bacterial count was found within farms those conduct milking in cow barn and hand milkers.

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1. Introduction

Milk is a complex biological fluid which easily contaminated and invaded by bacteria. It is an ideal growing medium for microorganisms, which once get access to milk, will multiply rapidly and spoil the milk or render it unsafe for human consumption or unfit for further processing (Asaminew and Eyasu, 2011). Because of the specific production, it is impossible to avoid contamination of milk with microorganism.

Microbial contamination of milk can originate from different sources like air, milking equipment, feed, soil, grass and feces (Abrahamsen *et al*., 2007). The number and types of microorganisms in milk immediately after milking are affected by animal and equipment cleanliness, season and animal health (Tadesse *et al*., 2004). The feeding and housing strategies of dairy cows may bring difference in microbial quality. Water for washing of milking machine and milking equipment also involve some of the reasons for the presence of a high number of microorganisms in milk (Biruk*et al*., 2009).

There is constant challenge to those involved in milk production to prevent or minimize the entry and subsequent growth of microorganisms even though the safety of dairy products with respect to food bornediseases is a great concern around the world (Kurwijila, 2006). This is especially true in developing nations where production of milk and dairy products take place under unhygienic conditions and traditional production practices with poor safety (Hoppe *et al*., 2006). Therefore, examination for the presence and number of microorganisms is an integral part of any quality control or quality assurance plan and it may be applied to a number of areas such as raw materials, intermediate samples, finished products and environmental or equipment sites (Biruk *et al*., 2009).

In developing nations, a poorly structured dairy industry entails that milk usage is frequently

unpasteurized. Therefore, the need to measure the hygienic quality of milk is towards the understanding of the microbial load in milk (Abrahamsen *et al*., 2007). High population of microorganisms in aseptically drawn milk samples is an indication of unhygienic condition of milk production. Hygienic milk only originates from mastitis free and healthy animals (Zelalem and Faye, 2006). Cows suffering from a disease may secret the pathogenic organism, which cause disease, in the milk they produce.

Whatever the milk is used for during processing, the hygienic standard of the produced milk at farm level forms the basis of the quality of the ultimate milk products (Olatunji *et al*., 2012). Most of the milk in Ethiopia is produced by small holder farmers. Their production units are widely dispersed in rural areas with a poor infrastructure, while most of the markets are in urban areas (Abebe *et al*., 2012). The efficient production of milk under good hygienic conditions is the key to successful dairying. The principal constraint in particularly smallholder farmers is a high level of bacteria count in the milk (Dehinenet*et al*., 2013). Therefore, the objective of this study is to assess the milk hygiene and microbial quality of milk collected from Haramaya university dairy farm and the surrounding areas.

2. Materials And Methods

2.1. Study Area Description

The study was conducted in four commercial private and one governmental dairy farm which are found in and around Haramaya district. The district is found in eastern Harerghe zone of Oromia region at 506 km distance to the east of Addis Ababa, between Harar and Dire Dawa town.

Haramaya, Aweday and Harar towns are the areas that were included in the study. The first two towns are found nearby and lie at an altitude of 2000 meters above sea level within the geographical location of $41^{o}59^{1}58^{11}$ latitude and $09^{0}10^{1}24^{11}$ longitudes. They receive an average rainfall of $900mm^{3}$ with the mean annual temperature and relative humidity 18^{0}c and 65% respectively (HADB, 2009). Harar town, in which the three studied dairy farms are found, is located at a distance of 525 km to the east of Addis Ababa. It receives an average rain fall that ranges between 275-$1000mm^{3}$ and geographically located at an altitude of 1800 meters above sea level and at $42^{0}03^{1}03^{11}$ latitude and $09^{0}11^{1}49^{11}$ longitudes (HAOR, 2009).

The three private farms, Shira, Yeshitela and Tesfaye dairy farms are found in Harar town while Maya and Haramaya University dairy farms are located in Aweday town and Haramaya University respectively. The Haramaya university dairy farm is an institutional farm with the prime purpose of teaching and research aid while the rest of farms are private and business centered commercial dairy farms.

2.2. Study Population

A total of 276 milk sampleswere collected from one government dairy farm (Haramaya university dairy farm) and four private dairy farms (Maya, Shira, Yeshitela and tesfaye). All lactating dairy cows of the farms were included to collect raw milk samples from milking equipment and directly from teats irrespective of their parity age, body condition, and lactation stage and disease condition. Among 128 sampled dairy cows, 13.3% were local breeds while the remaining 86.7% were cross breeds.

2.3. Study Design

A cross-sectional study was conductedfrom November 2014-March 2015to determine the hygienic and microbial quality of milk sample taken from the above mentioned sites.

2.4. Study Methodology

2.4.1. Total bacterial count

For each samples taken, 1 ml of sample was added into sterile test tube that had 9 ml of peptone water. Appropriate decimal dilutions of milk samples were pour-plated on Standard Plate Count Agar (SPCA) media and uniformly mixed over the surface of the plate with spreader. Then, it was allowed to solidify and incubated at 37^{o}C for 48 hours (Wehr and Frank, 2004). Colony count was made using colony counter.

2.4.2. Coliform count

One ml of milk sample was added into sterile test tube that had 9 ml of peptone water. Appropriate decimal dilutions of milk samples were pour-plated on Violet Red Bile Agar (VRBA) media. After thoroughly mixing, the plated sample will be allowed to solidify and incubated at 37^{o}C for 24 hours. Colony count was made by colony counter. Dark colonies were considered as coliform colonies (Wehr and Frank, 2004).

2.4.3. Questionnaire survey

Questionnaire was used to collect information from dairy farm managers and employee of the dairy farms. The personal observation and information that were collected includes the hygienic practices at the dairy farms, sanitation status of the barn, hygienic status of pre-milking and post-harvesting procedures practiced in dairy farms and other conditions thought to affect the hygienic quality of milk.

2.5. Sample Collection

Raw milk samples were collected from milking equipment and directly from the teat as soon as milking of the cow. The samples were collected aseptically in sterilized test tubes that were labeled and placed in icebox until transported to the laboratory. They were put in a refrigerator at 4^{o}C and culturing was conducted within 24 hours.

2.6. Statistical Analysis

The number of microorganisms that form the counted colonyper milliliter of milk was calculated by the following formula APHA (1992) and SPSS version 17.0 was used for descriptive statistics.

$$N=\frac{\Sigma C}{[(n1x1)+(0.1xn2)]xd}$$

Where: N = number of colonies per milliliter of milk,

$\sum c$ = sum of colonies on plates is counted,

n_1= number of plates on lower dilution will be counted,

n_2 = number of plates in next higher dilution is counted and

d = dilution from which the first counts will be obtained.

3. Results

Sanitary practices during milking procedures in the studied farms

At the time of sampling process, the hygienic and sanitary practices in all studied dairy farms have been evaluated. The sample collection was conducted in five farms in which only one farm applies machine milking and use warm water before and after milking. Only one farm conducts milking in the milking room while the rest of the farms done milking in the cow barn. The hygiene and sanitary measures taken by the farms before, during and immediately after milking procedures were generally up to the substandard. This holds true particularly for private dairy farms who responded not using warm water for cleaning udder and milking equipments. The governmental farm included in this study had a better access to dairy facilities such as warm water and appropriate milking equipmentsthat were easily cleaned and disinfected as compared to the private dairy farms.

Table 1: hygienic and sanitary practices conducted in the studied dairy farms

Farms	Water used	Equipment used	Milking method	Milking place
HU (N= 12)	Warm	Almunium can	Machine	Milking room
Maya (N= 5)	Cold	Plastic bag	Hand	Cow barn
Shira (N= 3)	Cold	Plastic bag and almunium can	Hand	Cow barn
Yeshitela (N= 9)	Cold	Plastic bag	Hand	Cow barn
Tesfaye (N= 5)	Cold	Plastic bag	Hand	Cow barn

Different coliform counts were recorded between milk samples collected under different variables and all raw milk samples collected at different sampling points have shownhighly significant variation ($p<0.05$) with an overall mean of 2.1 $\log_{10}$ cfu/ml coliform counts. Raw milk samples collected from local breed dairy cows and from farms those conduct semi-intensive production system exhibited higher coliform count (2.13 $\log_{10}$ cfu/ml for local breed and 2.32 $\log_{10}$cfu/ml for semi-intensive production system) than cross breeds and intensive production system which were 1.86 $\log_{10}$cfu/ml and 2.05 $\log_{10}$cfu / ml respectively. Raw milk samples taken from milking equipments were found with higher coliform count than samples taken directly from teat.

Table 2: variation of means (±SE) of microbial count in teat and equipment samples with different production system

Production system	TBC in $\log_{10}$cfu/ml	t-value	p-value	CC in $\log_{10}$cfu/ml	t-value	p-value
Intensive (N= 20)	6.18 ± 1.18	-0.78	0.00	2.05 ± 1.17	-0.85	0.00
Semi-intensive (N= 54)	7.42 ± 0.94			2.32 ± 0.80		

There was significant variation among samples taken from different production system at the equipment sampling point with an overall mean of total bacterial count of 6.8 $\log_{10}$ cfu/ml. It was shown that the total bacterial count from semi-intensive production system (7.42 $\log_{10}$cfu/ml) was significantly higher than intensive production system (6.18 $\log_{10}$ cfu/ml) at the equipment sampling point. The high total bacterial count was found within farms those conduct milking in cow barn and hand milkers.

Table 3: means (±SE) of coliform count from teat samples within the breed variations

breed	N	Total coliform counts from teat samples ($\log_{10}$cfu/ml)	t-value	p-value
local	17	2.13 ± 1.23	0.68	0.00
Cross	111	1.86 ± 0.65		

Table 4: variation of teat sample coliform counts within different production system

Production system	CC (log_{10}cfu/ml)	t-value	p-value
Intensive (N= 40)	1.76 ± 0.72		
Semi-intensive (N= 88)	1.96 ± 0.79	-0.62	0.001

N-indicates number of raw milk samples taken

4. Discussion

In this study the overall mean coliform count of 2.1 log_{10} cfu/ml was found, which is slightly higher than the acceptable limit of coliform count (1.69-2.00 log_{10} cfu/ml). This result shows differences with other literatures written in different parts of Ethiopia. For instance, it is higher than the one reported by Mosu*et al* (2013) who reported a mean coliform count of 1.82 log_{10} cfu/ml raw milk sample in the study conducted in Debrezeit town while it is lower than a study done by Alebel Wubet *et al* (2013) conducted in Jimma as 5.9 log_{10} cfu/mlcoliform count. It is obvious that samples collected from intensive and semi-intensive production systemshave shown highly significant variation in coliform count in which higher coliform count of 2.32 log_{10} cfu/ml has been recorder for raw milk samples from milking equipments. Breed difference also revealed significant variation ($p< 0.05$) in coliform count where cross breeds were found with lower coliform count (1.86 log_{10} cfu/ml in cross and 2.13 log_{10} cfu/ml in local breeds). According to Fikirneh *et al* (2012) report the presence of high percentage of fat and protein content in local breeds' raw milk is made the medium better for multiplication and growth of bacteria.

Milk samples collected under intensive production system at the point of milking equipment were found to have a better quality and lower degree of contamination than semi-intensive production system due to introduction of newly improved management techniques in the dairy farm industries. According to Aggad *et al* (2010) report coliform count usually indicates recent fecal contamination since these bacteria cannot survive outside of the intestine for long time and their amount is proportional to degree of contamination due to feces.

The study result for the overall mean total bacterial count was found 6.8 log_{10} cfu/ml which is higher than the standard limit established for acceptable level of milk and milk products. According to American and European community member states, the acceptable limit for TBC is between $2x10^5$ and $4x10^5$ cfu/ml (5.3-5.6 log_{10} cfu/ml) (APHA, 1992). In Fekadu's (1994) report, the minimum and maximum total bacterial count of raw cows' milk produced in southern parts of Ethiopia to be 6 to 8.8 log_{10}cfu/ml. Similarly, Alganesh (2002) reported total bacterial count of cows' milk produced in Bila Sayo and Guto Wayu districts of eastern Wollega to be 7.4×10^7 and 2.0×10^7 cfu/ml, respectively. This implies that, if the sanitary conditions in which milk has been produced and handled are substandard, they will subject the product to microbial contamination. As discussed in Teklemichael Tesfay *et al* (2013), the higher count indicates substandard hygienic conditions practiced due to less hygienic practices in pre-milking udder preparation, sub-optimal hygiene of milk handlers and poor sanitation practices associated with milking and storage equipments.

In general, the mean total bacterial count obtained in this study was high as compared to the acceptable standard value. However, it is lower than the report (7.58 log_{10} cfu/ml) of Asaminew and Eyasu (2011) done in Bahir Dar Zuria and Mecha district, Ethiopia. Milk sample taken from intensive production system can have better quality due to improved personal and farm hygiene. There is also strong linkage between the quality of raw milk and the standard of dairy farm facilities and workers hygiene. Kurwijila (2006) reports that improper hygienic practices pre and post milking as well as during milking processes affects the hygienic and microbial quality of milk.

In this study, it was shown that the total bacterial count in raw cows' milk samples was significantly associated with production system at the milking equipments sampling point. Milk collected from intensive production system has shown better microbial quality than the milk taken from semi-intensive production system. This also holds true in those dairy farms which apply warm water for udder and teat washing, use machine milking procedure and detergent for washing of milking equipments as well as in dairy farms those use teat dips.

5. Conclusions And Recommendations

Regardless of having a significance difference amongthe different sampling points, both total bacterial count and total coliform count testresults illustrated that the quality of milk in different production system was poor as compared with the establishedstandard level of raw milk quality. The study also showed that the microbial quality of raw cows' milk produced from four private semi-intensive and one governmental intensive dairy farms with local and cross breeds was substandard. Despite thefact that

high milk production was attained by usingcross-breed animals and practicing semi-intensive, the milkquality showed deterioration. Therefore, it is recommended that the value of milk shall be related with the quality of milk by formulating quality standards which may motivate the dairy farm owners to produce high quality milk. The health of milking cows should be checked continuously. The habit of good hygienic practice should be practiced like area of milking should be cleaned and free from contaminants, careful washing of hands before milking and cows udder with clean water, storing of milk within clean container, produced milk should be contained and transported within clean equipments, if possible appropriate machine milking is better and finally the consumers should treat milk with heat appropriately.

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