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Handling Practice and Microbial Quality of Raw Cow's Milk Produced and Marketed In Adigrat Town, North Eastern Tigray

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Abstract

Milk is a yellowish-white non-transparent liquid secreted by the mammary glands of all mammals. It is the primary source of nutrition and food for offspring of mammals before they are able to eat and digest other types of food. Study was conducted in Adigrat town, Northern Ethiopia, aimed to assess the general handling practice and microbial quality of raw cow's milk. A total of 47 respondents were randomly selected from dairy cooperative milk producing center. A total of 3 sample of raw cow's milk were collected at morning to investigate the microbial quality of raw cow's milk. The entire sample was collected using random proportional sampling method. The overall mean of coliform count, spore forming bacterial count, *staphylococcus aurous* bacterial count and aerobic mesophilic bacterial count of raw cow's milk obtained in the study area were, $9.5*10^4$, $3.6*10^4$, $9.91*10^4$ and $7.4*10^4$ cfu/ml, respectively. *Staphylococcus aurous* count, coliform count, aerobic mesophilic bacteria count were significantly higher than spore forming bacteria count in the study area ($P < 0.05$). The overall hygienic status and the sanitary condition and handling practices of the vendors were not to the standard. The milk is sold to unsuspecting clients who are likely to get food-borne diseases. This study recommends training of dairy cooperative milk producers on hygiene, sanitation and the establishment of code of practice for dairy cooperative milk producers.
Keywords: Raw milk, microbial quality, handling practice

Introduction

Milk is a yellowish-white non-transparent liquid secreted by the mammary glands of all mammals. It is the primary source of nutrition and food for offspring of mammals before they are able to eat and digest other types of food. It contains in a balanced form of all the necessary and digestible elements for building and maintaining the human and animal body (Pandey and Voskuil, 2011). The main composition of milk is water (87 – 88%); the remaining part is total milk solids which include carbohydrates, fat, proteins and ash or minerals. This composition is not constant, the average percentages of milk components vary with species and breeds of animal, season, feeds, stage of lactation and health and physiological status of a particular animal (Pandey and Voskuil, 2011). Sometimes the composition might even change from day to day, depending on feeding and climate, but also during milking the first milk differs from the last milk drops (Pandey and Voskuil, 2011). Moreover, milk is an excellent source of high quality protein, vitamins, minerals such as calcium and phosphorus. Fresh milk has a pleasant soft and sweet taste and carries hardly any smell. Milk and milk products have important role in feeding the rural and urban population of Ethiopia owing to its high nutritional value. Milk is produced daily, sold for cash or readily processed. It is a cash crop in the milk shed areas that enables families to buy other foodstuffs and significantly contributing to the household food security. Given the long tradition of using milk and milk products by the Ethiopian societies, there is no doubt that increasing smallholder dairy production and productivity would bring about a conspicuous impact on improving the welfare of women, children and the nation's population at large (MOA, 1998).

The safety of dairy products with respect to food-borne diseases is a great concern around the world. This is especially true in developing countries where production of milk and various milk products takes place under unsanitary conditions and poor production practices (Mogessie, 1990). The microbial content of milk is a major feature in determining its quality. It shows the hygienic level exercised during milk production and handling, that is cleanliness of the milking utensils, condition of storage, manner of transport as well as the cleanliness of the udder of the individual animal (Coorevits *et al*., 2008). The number and types of micro-organisms in milk immediately after milking are affected by factors such as lack of knowledge about clean milk production, use of unclean milking equipment and lack of potable water for cleaning purposes contributing to the poor hygienic quality of raw milk (Bekele and Bayileyegn, 2000). Milk from a healthy udder contains few bacteria but it picks up many bacteria from the time it leaves the teat of the cow until it is used for consumption or further processing. These micro-organisms are indicators of both the manner of handling milk from milking till consumption and the

quality of the milk. Milk produced under hygienic conditions from healthy animals should not contain more than 5×10^5 bacteria per milliliter (mL) of milk (O'Connor, 1994).

In Ethiopia, in general and in the study area in particular milk and milk products are important for family consumption and as a source of income through sale of products such as butter and Ayib - Ethiopian cottage cheese. Consequently, the products must be of high hygienic quality. Though in less developed areas especially in hot tropics, the production of products of safe and high quality is important, the prevailing situation is far from the ideal condition (DeGraaf *et al*., 1997). Poor hygiene, practiced by handlers of milk and milk products, may lead to the introduction of pathogenic micro-organisms into the products. Since they do not undergo further processing before consumption, these foods may pose risk to the consumers. Therefore, provision of milk and milk products of good hygienic quality is desirable from consumer health point of view (Zelalem, 2010). So far there is no, study conducted on quality of raw milk collected from dairy cooperative milk collection center in Adigrat town which is essential to make improvement interventions. In addition there is no formal quality control system in place to monitor and control the quality of milk produced and sold in the town. The aim of this study was, therefore, to assess the general handling practice and microbial quality of raw cow milk produced and marketed in Adigrat town.

Materials and Methods

Study Area

The study was conducted on dairy cooperative milk producer center in eastern zone of Tigray in Adigrat town. Adigrat town found in northern part of Ethiopia at 921 km far from Addis Ababa, which is the capital city of Ethiopia and 115 km from mekelle town of Tigray regional state. Adigrat town has altitude ranging from 200-300 meters above sea level and also located at 14° 16' 34''N latitude and 40° 27' 5'' longitudes. The annual rain fall of the area most of the time occurs from May to August.

Research Design

The study involve both cross-sectional survey method aimed to assess handling practices and laboratory-based investigation aimed to determine microbial quality of raw cow's milk produced and marketed in Adigrat town. Respondents were selected using simple random sampling technique and interviewed using a semi structured questionnaires and samples of raw cow's milk was collected at morning from dairy cooperative milk producer centers from purposively selected three urban *Kebeles* which have large number of customers.

Sources of Data and Sampling Techniques

Milk samples were collected from the dairy cooperative milk producers' centers and questionnaires were employed to collect data from selected respondents. Among those selected respondents dairy producers was involved. All the samples were collected using proportional random sampling method.

Milk Sample Collection

Samples of raw cow milk were collected at morning from dairy cooperative milk producers' center from purposively selected three urban *Kebele*. Samples of raw milk was aseptically take twice at different times (May to June 2015) from each sampling point in five days interval. During collection, the raw milk sample was aseptically collected from bulk milk container of producers and placed into sterile glass bottles. Subsequently, samples was labeled and put into icebox and then transported to the Biology Department laboratory of Adigrat University to analyze microbial quality. The analyses were performed within two to three hours after sampling.

Microbial Analysis

The microbial analyses of milk samples include the determination of aerobic mesophilic bacteria, coliform bacteria, Spore-forming bacteria, and *Staphylococcus aurous* using appropriate media. All media used for microbial analyses was sterilized before use according to the manufacturer's guidelines.

Coliform Bacteria Count

One ml of milk sample was added into sterile test tube containing nine ml peptone water to prepare serial dilution of up to 10^{-7} and mixed thoroughly. Appropriate decimal dilutions was surface plated in duplicate and incubated at 32^0C for 24 hours on Violet Red Bile Agar and typical dark red colonies on plates were consider as coliforms and counted. This was followed by a confirmatory test by transferring four to five typical colonies

from each plate and inoculating into tubes containing 2% Brilliant Green Lactose Bile Broth. Gas production within 48 hours of incubation at 35^0C was considered as sufficient evidence for the presence of coliforms (Richardson, 1985).

Spore-Forming Bacteria Count

The enumeration of spore-forming bacteria was done using plate count agar following the methods recommended by McLandsborough (2005). Milk samples was heated at 80°C for 10 minutes in water bath and volumes of 0.1 ml of appropriate dilutions were surface plated as for the standard plate count using plate count agar. All plates were incubated in an inverted position for 3 days at 30^0C and colonies were counted.

Staphylococcus aurous count

Sterile pipettes were used to place 0.1ml aliquots from each dilution in to two properly labeled mannitol salt agar (MSA) plates. The plates was spread and incubated at 37ċ for 48hrs, typical staphylococcus colonies appeared as golden yellow, smooth, circular, convex and moist were count. For confirmation four to five of typical colonies per MSA plate was streaked on mannitol salt agar, which was followed by catalyses test and gram stain (ISO, 1999; Yousef and Carlstrom, 2003).

Aerobic mesophilic bacterial count

Aerobic mesophilic bacterial count was done by incubating surface plated duplicate decimal dilutions of milk samples on plate count agar at 32±2°C for 48 hours. Dilutions with the total number of colonies on a plate between 30 to 300 per plates were selected and colonies were counted (Richardson, 1985).

Survey of the handling practices of the milk handlers

Census was performed to identify the existing number of raw milk sellers. A semi-structured questionnaire and a checklist covering topics on various aspects relating to milk safety and milk handling practices among the sellers were prepared. These consisted of four categories, i.e., (i) general characteristics of sellers, (ii) milk handling, and storage practices, (iii) personal hygiene (iv) care of utensils, and (v) hygienic status of vending environments and waste disposal practices. The questionnaires were completed by means of face-to-face interviews. The checklist was used to assess the physical layout of the stall, the hygiene of the milk selling areas and the personal hygiene of the milk handlers.

Statistical Analysis

Data collected through the survey was analyzed using simple descriptive statistics (i.e. means and percentage). On the other hand, the number of microorganisms (colony forming unit) per milliliter of milk was calculated according to FDA (2001) formula. Data from microbial counts was first transformed to logarithmic values (log10) before statistical analysis. When analysis of variance shows significant differences between means and differences will be considered significant at ($p < 0.05$).

Result and Discussion

The General Characteristics of Sellers
Table-1 shows the characteristics of cooperative milk producer centers in Adigrat town. The results show that most respondents (61.7%) were male with 21-31years. Peak prevalence in education is primary school level with 44.4% of all those surveyed. Most of the respondents (42.56%) are peasants and additionally they are the member of cooperative milk collection center.

Table.1. General Characteristics of raw caw's milk sellers in Adigart town April to June 2015.

Items	Variable	Number of respondents	Percentage
Sex	Male	29	61.7%
	Female	18	38.3%
	Total	**47**	**100%**
Marital status of respondent	Single	10	21.27%
	Double	37	78.73%
	Total	**47**	**100%**
Age structure of the respondents	15-20 year	8	17.02%
	21 -30 year	16	34.04%
	31- 40 year	13	27.67%
	41 -50 year	10	21.27%
	Total	**47**	**100%**
Level of education of the respondents	Illiterate	5	10.63
	Elementary school	19	40.44
	Secondary school	8	17.02
	Higher education	13	27.65
	Religious school only	2	4.26
	Total	**47**	**100%**
Respondent occupations	Merchant	11	23.40%
	Peasant	20	42.56%
	Private workers	11	23.40%
	Government officials	5	10.64%
	Total	**47**	**100%**

Milk Handling Practice, Storage, and Status Of Personal Hygiene

All dairy cooperative milk collection center milk their cows by using hand milking either washing cow teats or letting calf to suckle its dam for minutes to stimulate milk let-down. About 82.98 dairy cooperative milk collection center milk their cows using hand milking by calf suckling without washing the teat while 17.2% of milk dairy cooperative milk collection center milk their cows by hand after washing the teat (table2) . Calf suckling facilitates the contamination of the milk from infected calf while milking. So washing teat after calf suckling was counted as removing contaminant from the teat as well as delaying the contamination of milk occurred from the saliva of the calf. Dairy cooperative milk collection center milk their cows twice a day (morning and evening) while the cows are outside of the where materials for ting the cow available or under a tree shade. 95.75% of dairy cooperative milk collection center do not cleaned the udder and teats of cows before milking. they believe that during calf suckling for milk letdown, the teats get washed by the saliva of calf and therefore it is not as such important to wash the teats before milking (table2) .These was significantly favorable situation for microbial contamination of milk because cow's dung's and flies infested the cow's udder and teat in barn. Nevertheless, only about 4.25% of dairy cooperative milk collection center wash the teats and udder of the cow's before milking. However, it was observed that most of them did not use detergents for cleaning of udder and teats rather they cleaned only by tap water. Gran *et al.* (2002) reported that insufficient cleaning of the udder may result in contamination of milk. The use of detergent and good-quality water for cleaning could be expected to remove milk remains, including microorganisms that affect the microbial quality of milk. However, in this study, the result showed that most of the dairy cooperative milk collection center did not wash their hands using detergents prior to milking (Table 2). Apart from this, dust particles from unclean udder and from the body of the cows can contaminate the milk .Overall, about 95.75% of dairy cooperative milk collection center do not use towel after washing to dry the udders. However about 4.25% of dairy cooperative milk use common towel for each cows after washing the udder. These practices may favor contamination of milk from the udder and teats of infected cows. Poor hygienic condition of milking area and failure to use separate towel for individual cows could be high chance of contamination of the milk with pathogenic microorganisms. However, massaging with bare hand and the utilization of separate towel was yet not practiced (table2). About 59.57% of the dairy cooperative milk collection center respondents indicated that laborers were not specifically involved in either milking or sanitation. According to these respondents, the employees were engaged in several additional

workloads other than milking and cleaning (Table 2). Thus, it was possible that those employees who were engaged in milking and other additional assignments like cleaning may contaminate the milk as most of them were not using detergents for washing their hands. This might be increasing the microbial counts of the milk marketed in the study area. But, about 40.43% of dairy cooperative milk collection center do have separate worker for milking the cow, selling and cleaning the vending environment (table2).using refrigerator for storage of milk after milking is not practiced by the whole dairy cooperative milk collection center and they store milks at room temperature until it was distributed to Adigrat town. So far, storing of milk at room temperature encourage the contamination of milk by pathogenic microorganisms. Wearing separate cloth during milking is not practiced by Adigrat dairy cooperative milk collection center and they often wear their own cloth while milking. So poor hygienic condition of cloth contaminate milks while milking and selling.

Table 2 Milk handling, storage practice and status of personal hygiene of dairy cooperative milk collection center (n=47)

Variables	Frequency (%)
Technique of milking	
Washing teat	17.02
Calf suckling	82.98
Frequency of milking	
Once a day	
Twice a day	100
Practice of washing the udder and teats before milking	
Yes	4.25
No	95.75
The habit of washing the teat with detergent	
Yes	
No	100
The practice of washing teats with tap water	
Yes	80.85
No	19.5
Use of towel for drying udder	
Common towel	4.25
Individual towel for each cow	**0**
Massage with bare hand	**0**
Do not wash the udder	95.75
The presence of separate place for milking the cow	
Yes	36.17
No	63.83
Presence of separate worker for milking the cow	
Yes	59.57
No	40.43
Storage method before selling milk	
At room temperature	100
Use of refrigerator	
Practice of washing hands with soap before milking	
Yes	21.28
No	78.72
The presence of separate cloth wearied during milking	
Yes	
No	100

Care Of Milk Utensils

The type of utensils used for transportation, collection and storage of milk by milk sellers were found to be different (Table 3). Most of them used plastic containers; plastic jars (jerry-can) and the rest used stainless steel. As indicated in Table3 46.8% of the dairy cooperative milk collection centers use plastic buckets for collection of milk,38.3% uses plastic jar(jerry-cans) for transportation of milk and about 14.9% of them utilize stainless

steel for storage of milk after milking. This is in line with the findings of Yitaye *et al.* (2009) and Teklemichael (2012) who reported that 83% of the surveyed urban dairy farms in Bahir Dar and Gondar and 75% of the surveyed in Dire Dawa town used plastic utensils, respectively. Since proper metal milk containers are expensive, milk producers use plastic containers which are difficult to clean and disinfect and thus it might contribute to poor quality of the milk (Omore *et al*., 2005). The left-over of milk and other dirt particles within the container may result in the contamination of milk. Omore *et al. (*2005) had also reported that lack of formal training and use of plastic containers are the main factors that contribute to the low quality of raw milk sold by producers and informal milk traders. Non- food grade plastic cans, buckets and Jerry-cans must not be used (Kurwijila, 2006). On the other hand, in the selected study area, the majority of milk producers and sellers were using plastic buckets for milking and milk collection. These types of equipment are not suitable for sanitizing and may contribute to the source of contamination of the milk samples. As indicated in table 3 about 76.6% of dairy cooperative milk collection centers clean milk containers with tap water; and 23.4% of them clean the milk utensil using hand dung water. Additionally, all of the dairy cooperative milk collection centers used tap water both for their animals and household use. Therefore tap water as well as hand dung water are naturally existing water, they contain aplenty of microorganisms including pathogenic microbes that may contaminate the milk utensil. But, the practice of using river water for cleaning utensil not observed due to the scarce of river water in the study area. Table 3 also depicts that the entire dairy cooperative milk collection center doesn't did not testing the quality of milk after milking.

Table 3 care of utensil used for collection, transportation and storage of milk. (N=47)

Variables	Frequency
Types of utensils	
Plastic buckets	46.8
Plastic jars(jerry cans	38.3
Stainless steel	14.9
Source of water for cleaning utensils	
Tap water	76.6
Hand dung water	23.4
Spring water	-
Practice of testing quality	
Yes	-
No	100

Hygienic Status Of Vending Environment And Practice Waste Disposal

As indicated in table-4 about 85.1 of the dairy cooperative milk collection center have separate vending environment. However about 14.9% of cooperative milk collection center have no separate vending environment. This situation is suitable for microbial contamination of milk; also files which rise from the dung of cows reproduce and infect the milk as far as the barn are not apart from the vending environment. All dairy cooperative milk collection centers were practiced sweeping the vending environment. About (91.5%) of dairy cooperative milk collection center sweep vending environments once a day and 8.5% of them sweep twice a day. However all of them do not sweep the vending environment using detergent. Detergents are expected as removing dust of the vending environment and Milk droplet dropped during selling milk in vending environment. However, droplets of milk dropped while selling were comfortable for growth microbes and files. This may leads to increased microorganisms in the milk and cause health problem among consumers. About 53.2% of dairy cooperative milk collection center have separate waste disposal place, but among 46.8% of them dispose the waste on field as fertilizer. Additionally some of them dry cow dung and utilize as fire wood for preparation of food.

Table -4. Hygienic status of vending environment and practice waste disposal (n=47)

Parameter	Frequency
The presence of separate vending environment	
yes	85.1
No	14.9
Practice of sweeping vending environment	
Yes	100
No	-
Practice of using detergent	
Yes	
No	100
Frequency of sweeping vending environment	
Once a day	91.5
Twice a day	8.5
Not at all	-
The presence of separate waste disposal site	
Yes	53.2
No	46.8

Microbial Quality of Raw Cow's Milk

Coliform count

The mean coliform count was significantly different ($P < 0.05$) among milk samples collected from dairy cooperative milk collection center (Table 5). On the other hand, there was marked difference among milk samples collected from dairy cooperative milk collection centers. The coliform count obtained from dairy cooperatives was significantly higher ($P < 0.05$) than other available bacterial counts. As indicated in table 5 coli form bacteria count is highly dominant count observed form the rest of bacteria aim to be counted. These was due to further contamination of the milk during transportation, inadequately cleaned milking utensils, the failure of using detergent for washing vending environments as well as hands before milking , the practice of washing the milk containers together with other materials and absence or improper cooling systems at milk selling points. The presence of coliforms in milk at small scale milk producers might be attributed to the initial contamination of the milk samples either from the lactating cows or the milkers, milk containers and the poor practice of cleaning milking area. The overall coli form count of raw cow's milk obtained in the current study ($9.5291*10^4$ cfu/ml) was slightly higher than the earlier findings of Asaminew (2007), Derese (2008), Gemechu *et al*(2014)), Ali and Abdelgadir (2011) and Abebe *et al.* (2012) who reported a coliform count of 4.49 log10 cfu/ml in milk samples in the West Shewa zone of Oromia region,4.999log10 cfu/ml sample collected from shashemane town , 4.84 log10 cfu/ml in milk samples collected from Bahir Dar milk shed, 4.18 ± 0.01 log10 cfu/ml for raw milk samples and 4.03 log10 cfu/ml in raw whole cow's milk in the Ezha districts of the Gurage zone, respectively. In the current study, the coliform count of raw milk collected from dairy cooperative milk collection centers was higher than that reported by Asaminew and Eyassu (2011) who found coliform count of (4.94 ± 0.23 log10 cfu/ml) in milk samples collected from dairy cooperatives in Bahir Dar Zuria district,Gemechu et al reported the higher coliform bacteria count(4.999log10 cfu/ml) from shashemane town. Correspondingly, Teklemichael (2012) reported lower mean values of coliform counts of (4.130 ± 0.757 log10 cfu/ml) from milk samples collected from Dire Dawa town dairy farms.. According to the European Union standards for coliform counts of raw milk should be less than 102 cfu/ml (Fernandes, 2009). The present study showed that the coliform count of all milk samples exceeds the standards given for raw milk by European Union and US regulations. Generally, the presence of high numbers of coliforms in milk indicates that the milk has been contaminated with fecal materials, unclean udder and teats of cow's, inefficient cleaning of the milking containers, poor hygiene of the milking environment, contaminated water and cows with subclinical or clinical coliform mastitis can all lead to elevated coliform count in raw milk (Jayarao *et al.,* 2004).

Table-5. Coliform bacteria counts of raw milk collected from dairy cooperative milk collection centers

No of samples	Dilution factor		Bacterial count	Average Cfu/ml
	10^{-2}	10^{-3}		
1	26350	145500	85925	$8.5925*10^4$
2	24900	101000	62950	$6.295*10^4$
3	20500	116500	137000	$1.37*10^5$
Total	2391.67	121000	95291.67	$9.5291*10^4$

Spore forming bacterial count

Mean spore forming bacterial count was significantly different ($P < 0.05$) among milk samples collected from the dairy cooperative milk collection centers. Spore forming bacteria count was negligible related to other bacterial count aim to be counted in the study area (table 6). On the other hand, there was marked difference of bacteria count among milk samples collected dairy cooperative milk collection center. The values of spore-forming bacteria counts (SFBC)/ml of milk samples collected from dairy cooperative milk collection centers were significantly ($p>0.05$) lower count related to other bacterial counts observed in the study area(Table 6). The mean SFBC of raw cow's milk obtained in this study ($3.6225*10^4$ cfu/ml) was lower than the earlier finding of Teklemichael (2012) who reported a spore forming bacterial count of 6.392 ± 0.154 log10 cfu/ml from milk vendors in Dire Dawa town. The relatively higher SFBC in milk samples obtained from dairy cooperative milk collection centers may indicate that there was poor environmental sanitation and poor handling practice at the selling sites. It could also be associated to the spores which transferred from feed, feces, bedding material and soil in to milk. Feces and bedding materials contaminate the cow's teats. Teat cleaning prior to milking only partly reduces attached dirt and spores (Vissers and Driehuis, 2007). In the study area, the survey result indicated the existence of poor hygienic condition of the milking environment, inefficient cleaning of milk utensils, use of plastic bucket for milking and collection might have contributed to the contamination of the milk by spore forming bacteria. In general, the raw milk sold by milk dairy cooperatives in Adigrat town do not meet the international standards set by regulatory agents and thus could pose health hazards to the consumers.

Table- 6 spore forming bacteria count of raw caw's milk collected from dairy cooperative milk collection center

No of sample	Dilution factors		Total bacterial count	Average Cfu/ml
	10^{-2}	10^{-3}		
1	12450	80000	46225	$4.6225*10^4$
2	14400	60500	37450	$3.745*10^4$
3	8500	41500	25000	$2.5*10^4$
Total	11783.3	60666.6	36225	$3.6225*10^4$

Staphylococcus aurous bacteria count

As human indicated in (table 8) staphylococcus aurous bacteria count was less significant with $9.91*10^4$ to coli form count. These describe that the milk was contaminated during milking from the udder, failure of washing hands before milking, and the storage environment after milking. The presence staphylococcus aurous bacteria milk describes that poor handling practice and personal hygiene as a far as staphylococcus aurous bacteria were predominant in nasal cavity.

Table 7 staphylococcus aurous bacteria count of raw cow's milk collected from dairy cooperative milk collection center

No of sample	Dilution factor		Total bacterial count	Average Cuf/ml
	10^{-2}	10^{-3}		
1	18400	297000	157700	$1.577*10^5$
2	15650	73500	44575	$4.4575*10^4$
3	30550	159500	95025	$9.5025*10^4$
Total	21533.3	176666.67	99100	$9.91*10^4$

Aerobic mesophilic bacterial count (AMBC)

The mean Aerobic mesophilic bacterial count was significantly different ($P>0.05$) incomparable to other bacteria counted with the current study (Table 8). The average AMBC of milk samples were7.385*104 cfu/mL. The overall mean AMBC observed in the current study was higher than the maximum acceptable limits given for raw milk intended for processing (1.0 × 105 cfu/mL) and direct human consumption (5.0 ×104 cfu/mL) (Bodman and Rice,1996). This high level of contamination of milk might be due to initial contamination originating from the udder surface, quality of cleaning water, milking utensils, waste disposal, cleaning of vending environmentsand the status of personal hygiene.The most frequent cause of high AMBC is poor hygienic practices during milking. Milk residues on equipment surfaces and vending environments provide nutrients for growth and multiplication of bacteria that contaminate milk of subsequent milking. Cows with mastitis (streptococcal and coli forms) and failure to cool milk rapidly to < 4.4°C and extremely hot and humid weather can also contribute to high standard plate count in raw milk. The aerobic mesophilic bacteria counts of milk observed in current study is lower than with the value (9.10 log cfu/mL) reported by Zelalem (2010) for milk samples collected from different parts of Ethiopia. This value is higher than total bacteria counts of milk in different part of Ethiopia, 6.36log/cfu/mL in *Wolayta* zone (Asrat, 2010), 108 cfu/mL in most of the dairy cooperatives operating in Ethiopia (Francesconi, 2006) and 7.6 log cfu/mL in Eastern *Wollega* (Alganesh *et al.,* 2007).Generally, the microbial qualities of milk in the current study are poor compared to bacteriological established standards of dairy products. As indicated by John (1995) the plate count of grade A raw milk should be less than 2× 105 cfu/mL, between 2 × 105 cfu/mL to

1 × 106 cfu/mL for grade B and greater or equal to 1 × 106 cfu/mL for grade C milk in USA. This implies that the sanitary conditions in which milk has been produced and handled are substandard subjecting the product to microbial contamination and multiplication. It is indicated that aerobic mesophilic bacterial count is a good indicator for monitoring the sanitary conditions practiced during production and handling of raw milk (Chambers, 2002)

Table 8 Aerobic mesophilic bacteria count of raw cow's milk collected from dairy cooperative milk collection center

No of sample	Dilution factor		Total bacterial count	Average Cfu/ml
	10^{-2}	10^{-3}		
1	25000	204500	114750	$1.1475*10^5$
2	11400	87000	49200	$4.92*10^4$
3	10200	105000	57600	$5.76*10^4$
Total	15533.3	132166.67	73850	$7.385*10^4$

Conclusions and Recommendation

Conclusion

The observed poor quality of milk produced by dairy cooperative collection center was probably due to the poor hygienic condition of the milking environment, absence of cooling system, poor sanitary condition of the milk containers, poor udder and teats cleaning practice, failure of washing and drying cow's udder, the absence of usage of detergent for cleaning vending environments, and the poor personal hygiene of the milkers. Additionally, very high microbial count observed in milk samples collected from dairy cooperative milk collection centers could be attributed to the absence of cooling systems, use of plastic containers for milk collection, mixing of milk obtained from different cows and the presence of further contamination at the milk selling sites. Generally, this study showed that the quality of the milk obtained from dairy cooperative milk collection centers was poor. Therefore, it was concluded that the microbial quality of raw cow's milk produced and marketed in the study area were poor and this suggests the need for improved hygienic practices and handling of milk at dairy cooperative milk collection center of Adigrat town.

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