A Review on Microbiological Quality of Ethiopian Raw Bovine Milk

Mulugojjam Adugna[1]* Aleme Asresie[2]
1.College of Natural and Computational Sciences, Department of Biology, Debre Tabor University, Debre Tabor, Ethiopia
2.College of Agriculture and Environmental Sciences, Department of Animal Sciences, Adigrat University, Adigrat, Ethiopia
*Email of corresponding author: mgojjama@gmail.com

Abstract
This paper has reviewed researches that obtained from peer-reviewed literature published within 2000 to 2014 on microbiological quality of raw bovine milk in different parts of Ethiopia. Ethiopia has the largest livestock production in Africa. 83% of milk is produced from cow and the left is from camel and goat. Almost all cattle in the country is local breeds and during 2013 cow milk production potential of the country was about 2.9 billion liters, the average lactation period per cow is estimated to be about six months, and average milk yield per cow per day is about 1.37 liters. Samples of raw milk produced and/or transported to consumers in different parts of the country showed that almost all microbiological counts was above the international accepted standard level (>10^5cfu/ml and >10^2cfu/ml for AMBC and Entrobacteriaceae/coliform counts, respectively) and different pathogenic (spoilage) bacteria have identified, it is probably because of problem related with health of milking cows, poor production and handling practices, and contaminants from milking environment. Therefore, awareness creation about quality milk production and good handling practices produced, transported until consumption is necessary; the concerned body shall control quality of milk regularly and also set standard for microbial quality.
Keywords: Bovine; Ethiopia; microbes; quality; raw milk

Introduction

Ethiopia has the largest livestock production in Africa; CSA (Central Statistical Agency of Ethiopia) (2014) stated that the total cattle population of the country in 2013 was estimated to be about 55.03 million. Out of this total cattle population, the female cattle constitute about 55.38% and the remaining 44.62% were male cattle, from this 6,675,466 and 10,731,656 were dairy and milking cows, respectively. On the other hand, the result indicated that 98.71% of the total cattle in the country were local breeds. The remaining were hybrid and exotic breeds that accounted for about 1.15 and 0.14%, respectively. A total cow milk production for the country during 2013 was about 2.9 billion liters with the average lactation period per cow is estimated to be about six months, and average milk yield per cow per day is about 1.37 liters. Cows are common sources of milk (83%) in Ethiopia and the left 17% is from camel and goat (USAID, 2010). In the country households consume 82.9% of the milk collected (produced), 10% of the milk is processed into products with longer shelf life, 6.61% is sold and 0.43% used for wages (CSA, 2009). Estimates according to USAID (2010), showed that Ethiopian per capita milk consumption was 17 liter.

Raw milk, complete nutritious fluid, is an ideal medium for the growth of various types of microbes. It might be a vehicle for the transmission of a wide range of pathogenic microbe diseases. The common bacterial diseases that can be transmitted through consumption of milk that produced from diseased cows and handled with poor hygienic practices are including tuberculosis, typhoid, brucellosis, diphtheria and anthrax. In terms of economic point of view due to untreated raw milk is highly perishable, it has short shelf life and may cause wastage or/and poor quality product production (Fernandes, 2008; Pandey and Voskuil, 2011). Even if milk produced from mammary gland of healthy mammals is sterile fluid (Fernandes, 2008), contamination of microbes starts from udder of milking animal, poor milking practice, milking environment (contaminated air, excreta of animals), milking utensils, poor handling practices (lack of treatment like cooling with refrigerator, appropriate heating and others) and lack of cold chain transportation and storage system until table for consumption (Robinson, 1990). Even if Ethiopia has the largest livestock production in Africa, most of its milk production and handling practice is poor. Therefore, the intention of this paper is to review research results that obtained from peer-reviewed literature published within 2000 to 2014 in different parts of Ethiopia on microbiological quality of raw bovine milk.

Microbes load in raw bovine milk

The mesophilic microorganism is one of the general and extensive microbiological indicators of food quality, indicating the degree of freshness, improper handling temperature and sanitation control during processing, transport and storage, it can also suggest the presence of bacterially produced enzymes (Hayes and Boor, 2001;

Herrera, 2001). The aerobic mesophilic bacterial count does not indicate the sources of bacterial contamination in milk, or the identity of production faults leading to high counts. Counts of psychrotrophs, thermoduric organisms, spores, *Streptococci* and coliforms may assist in the diagnosis of faults, but are not infallible. In any case, these additional tests are normally impracticable for routine grading and they are mainly used for advisory, investigational and survey purposes (Robinson, 1990).

Aerobic mesophilic bacterial count (AMBC)

Even if Ethiopia has no milk quality standard, O'Connor (1995) stated that AMBC values may range from <1000cfu/ml, where contamination during production is minimal, to >1 x 10^6cfu/ml of milk. The initial AMBC values in milk, e.g. >1 x 10^5cfu/ml, are evidence of serious faults in production hygiene, where as the production of milk having AMBC values <20, 000cfu/ml reflects good hygienic practices. The bacterial load in fresh raw milk should be less than 50,000cfu/ml when it reaches the collection point or processing plant (Pandey and Voskuil, 2011). Contaminant microorganisms might be derived from one or any combination of the main sources of contamination described above. According to Shunda Dingeta *et al.* (2013) the mean AMBC value of 180 samples that collected from dairy farms, vending shops and homes/cafeterias in Mekelle, Northern Ethiopia was 7.35±0.180, 7.35±0.180 and 7.42±0.272 log cfu/ml, respectively. A total of 40 fresh whole milk samples that collected in and around Boditti town, Southern Ethiopia and the mean value of total AMBC was 6.36±0.24 log cfu/ml (Asrat *et al*., 2012). A total of 40 raw milk samples were also tested for AMBC from producers of two agro-ecoilogies (*Dega* and *Woina Dega*) in Ezha district of the Gurage zone, Southern Ethiopia and the value was 9.82 log cfu/ml (Abebe Bereda, 2012). A total of 78 milk samples were also collected directly from the udder, storage containers at farm level (bulk) and distribution containers upon arrival at selling points in Hawassa, Southern Ethiopia and the overall mean value of AMBC was 4.57, 7.28 and 10.28 log cfu ml^{-1}, respectively (Haile Welearegay *et al*., 2012). On the other hand 100 samples collected in Jimma, Western Ethiopia showed that mean count of 7.5±0.8 and 6.06±0.6 log cfu $ml^{-1}$for AMBC and lactic acid bacteria, respectively (Alebel Wubet *et al*., 2013). Milk samples were also collected in Jimma from 47dairy herds 4 times and the mean value of total AMBC was 9.62×10^5cfu/ml (Tadele Tolosa, 2013). A total of 100 raw cow milk samples, 88 from individual farmers and 12were also collected in dairy farms in Jimma, the overall mean AMBC, lactic acid bacteria and Staphylococci counts was 8.7±1.34 and 8.27±0.98 log cfu/ml, 4.24±0.76 and 4.94±0.31log cfu/ml, and 5.27±0.31 and 5.18±0.64 log cfu/ml, respectively (Tadesse and Bacha, 2014). A total of 30 cow milk samples were collected from dairy farms and milk vendors in Dire Dawa town, Eastern Ethiopia and the average AMBC was 5.84±0.629 and 9.137±0.885 log cfu/ml, respectively. Milk samples collected from milk vendors were significantly higher (P<0.05) than milk samples obtained from dairy farms (Teklemichael Tesfay *et al.*, 2013). The mean AMBC of milk samples collected at 39 samples taken from producers (farmers) and 45 samples from dairy cooperatives in Bahir Dar Zuria and Mecha district, North-western Ethiopia was 7.61±0.12 and 7.56±0.13 log cfu/ml, respectively; in terms of breed the mean AMBC of 45 and 39 milk samples collected from local and cross breeds was 7.70±0.13 and 7.47±0.11 log cfu/ml, respectively. The overall mean of AMBC collected from 30 milk samples in Shambu, Fincha and Kombolcha was 9.73±0.49, 9.62±0.31 and 9.78±0.38 log cfu/ml, respectively (Demissu Hundie, 2014). Alganesh (2002) reported that total AMBC of 30 cow milk samples produced in Bila Sayo and Guto Wayu districts of Eastern Wollega, Ethiopia was 7.4x10^7 and 2x10^7 cfu/ml, respectively, milk samples collected from Bila Sayo were significantly (p<0.05) higher than those from Guto Wayu. 96 raw cow milk samples were also collected from cow udder and storage containers in six kebeles of Abaya District of Borana pastoral area of Oromia Regional State and was evaluated for total AMBC and *Staphylococci* count, its minimum and maximum value was 6 and 8.47 log cfu ml^{-1} and 6.08 and 8.10 log cfu ml^{-1}, respectively (Tollossa Worku, 2012). The total mean AMBC of 11 samples and lactic acid bacterial counts of 5 samples of milk collected from 3 producers and 5 different dairy product shops counted by Zelalem Yilma and Bernard Faye (2006) was 8.38 and 7.68 log cfu ml^{-1} and 6.97 and 6.81 log cfu ml^{-1}, respectively. According to Dehinenet *et al.* (2013) 60 milk samples from 6 districts on each site 10 samples was collected in Amhara and Oromia National Regional States, Ethiopia and the total mean AMBC was 1.1x10^8cfu/ml. Average AMBC of 9.10 log cfu/ml were counted from 135 whole milk samples that collected at 10 dairy potential areas in the Ethiopian highlands (Zelalem Yilma, 2012). A total of 60 milk samples were collected from three private (Genesis, Alfa and Alibiera) and one Governmental (Ethiopian Meat and Dairy Technology Institute (EMDTI)) dairy farms. All lactating cows in these dairy farms were included to collect 9 raw milk samples directly from milking buckets (container in which milking is done) and 51 raw milk samples from containers (storage milk containers after milking) and the result of AMBC with <10000 was 3(5%) and >500,000 was 48(85.71%) from milk containers and the result of total AMBC with <50,000 was 1(1.66%) and >500,000 was 8(14.29%) from milking buckets (Solomon Mosu *et al*., 2013). Study conducted in Debre Brhan, Selale and Holeta showed that the average value of total AMBC of whole milk samples were 7.6log cfu/ml (Samson Ghilu *et al*., 2012).

Almost all milk samples collected from different parts of Ethiopia has showed poor quality (AMBC>10^5cfu/ml according to O'Connor, 1995) different Authors suggested that milking practice as well as handling of milk from producers to distributers (consumers) were poor, it might be due to lack of knowledge about clean milk production like cleaning of udder of milking cow before milking, poor washing of milker hands and milking utensils with clean water, time elapsed since milking for storing and transporting without utilization of refrigerator, keeping the health of milking animals, the milking environment may also contain contaminants and high environmental temperature may also contribute for increasing load of microbes. The recommended idea was the concerned body shall take intervention to improve the quality of milk produced in the country through awareness creation for each stakeholder from producers to consumers. Cost of milk shall be related with the quality of milk by formulating quality standards which may motivate producers 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 aerated 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 refrigerator (cold chain transport), if possible appropriate machine milking is better and finally the consumers should treat milk with heat appropriately.

Entrobactericeae count

There are more than 25 genera belonging to family Enterobacteriaceae (Joklik *et al*., 1992) and 74 members of this family are important in food microbiology because they include: intestinal pathogens, the most widely used indicators of hygiene, sanitation, and food safety and they can be important agents of food spoilage (Lund *et al*., 2000). All genera except *Erwinia, Obesumbacterium, Xenorhbdus, Rhanella, Cedecea and tatumella* and possibly *Edwardsiella, Providencia* can be considered to have potential associations with milk (Robinson, 1990). Enterobacteriaceae are Gram-negative, facultatively anaerobic, rod-shaped bacteria that are motile or non-motile and that ferment glucose, often with gas production that inhabit the intestine of man and other animals sometimes causing disease (Joklik *et al*., 1992; Lund *et al*., 2000). Some can act as opportunistic pathogen. None of the members are particularly heat resistant and thus, all are easily eliminated from milk by pasteurization or other equivalent heat treatments (Robinson, 1990; Joklik *et al*., 1992). It includes coliform groups (as *E. coli*, *Klebsiella, Enterobacter*, lactose positive biotypes of *Citrobacter, Serratia* and *Hafnia*), found in soil and water, on plants, and in human and animal intestines (Lund *et al*., 2000). The fecal coliform group is restricted to organisms that grow in the gastrointestinal tract of humans and warm-blooded animals and includes members of at least three genera *Escherichia*, *Klebsiella* and *Enterobacter* (Herrera, 2001). The overall mean of coliform count for a total of 78 milk samples collected directly from the udder, storage containers at farm level (bulk) and distribution containers upon arrival at selling points in Hawassa was 2.47, 4.93 and 6.52 log cfu ml^{-1}, respectively (Haile Welearegay *et al*, 2012). A total of 40 fresh whole milk samples were also collected in and around Boditti town and the mean value of coliform count was 4.3±0.22 log cfu/ml (Asrat *et al.*, 2012). A total of 40 raw milk samples were also aseptically collected and tested for coliform and Entrobacteriacea count from producers of two agro-ecoilogies (*Dega* and *Woina Dega*) in Ezha district of the Gurage zone, Southern Ethiopia and the average value was 4.03 and 4.15 log cfu/ml, respectively (Abebe Bereda, 2012). According to Teklemichael Tesfay *et al*., (2013) the average coliform and *Escherichia coli* counts from dairy farms and milk vendors was 4.13±0.76 and 6.2±0.418 log cfu/ml, and 3.64±0.78 and 5±0.44 log cfu/ml, respectively. Milk samples collected from vendors were significantly higher ($P<0.05$) than milk samples collected from dairy farms. The mean coliform count of milk samples collected at 39 samples taken from farmers and 45 samples taken from dairy cooperatives in Bahir Dar Zuria and Mecha district was 4.41±0.16 and 4.55±0.15 log cfu/ml, respectively and in terms of breed the mean coliform count of 45 and 39 milk samples collected from local and cross breeds was 4.52±0.15 and 4.45±0.15 log cfu/ml, respectively. A total of 100 raw cow milk samples, 88 from individual farmers and 12dairy farms, were collected and the overall mean counts of total coliform was 5.85±0.483 and 5.91±0.19log cfu/ml, respectively (Tadesse and Bacha, 2014). Milk samples were also collected in Jimma from 47dairy herds 4 times and the mean value of total bacterial count was 2.26×10^5cfu/ml (Tadele Tolosa, 2013). On the other research that conducted in Jimma with 100 milk samples mean coliform count was 5.9±0.4 log cfu ml^{-1} (Alebel Wubet *et al*., 2013). 96 raw cow milk samples that collected from cow udder and storage containers in six kebeles of Abaya District of Borana pastoral area of Oromia Regional state was evaluated for fecal coliform and coliform count, its minimum and maximum value was 3.79 and 7.38 14 log cfu ml^{-1} and 6.26 and 8.14 log cfu ml^{-1}, respectively (Tollossa Worku, 2012). Alganesh (2002) reported that mean coliform count of 30 cow milk samples produced in Bila Sayo and Guto Wayu districts of Eastern Wollega was $6.8\text{x}10^4$±0.26 and $1.4\text{x}10^4$±0.26 cfu/ml, respectively. On the other hand, the total mean coliform counts of milk collected from three producers and five different dairy product shops, from 11samples and 5samples, was 6.57 log cfu ml^{-1} and 5.41±0.04 log cfu ml^{-1}, respectively (Zelalem Yilma and Bernard Faye, 2006). According to Dehinenet *et al.* (2013) 60 Milk samples from 6 districts was collected in Amhara and Oromia National Regional States, Ethiopia and the mean total coliform count was $3.0\text{x}10^4$cfu/ml. Average Enterobacteriaceae and coliform count of 5.48 and 4.58 log cfu/ml were observed from 135 whole milk samples that collected at 10 dairy potential areas in the

Ethiopian highlands (Zelalem Yilma, 2012). The overall mean of coliform count from 30 milk samples collected from Shambu, Fincha and Kombolcha was 5.6±0.38, 5.7±0.09 and 5.4±0.33 log cfu/ml, respectively (Demissu Hundie, 2014). Study conducted in Debre Brhan, Selale and Holeta showed that the average value of coliform and Entrobacteriaceae count of whole milk samples were 3.2 and 3.6 log cfu/ml, respectively (Samson Ghilu *et al*., 2012). A total of 60 raw milk samples, 15 and 45 from machine and hand milking, respectively were collected from three private (Genesis, Alfa and Alibiera) and one Governmental (Ethiopian Meat and Dairy Technology Institute (EMDTI)) dairy farms; and the result of coliform count from 0-10, 10-50, 50-100, 100-500 and >500 was 1(6.6%), 1(6.6%), 1(6.6%), 12(80%) and 0; and 8(17.7%), 15(33.3%), 3(6.7%), 14 (31%) and 5(11%), respectively (Solomon Mosu *et al*., 2013).

UK hygiene and food safety regulation has stated that coliform count requirement for raw cows milk for direct consumption should be <100 cfu ml^{-1} (Hickey, 2009) but in different parts of Ethiopia the value of Entrobacteriaceae and coliform count that reported by different authors was high number (almost all coliform counts was >4log cfu/ml) and the suspected causes were poor hygienic practices during production and subsequent handling, since they are mainly of fecal origin the initial contamination of the milk samples either from the milking cows (related with subclinical coliform mastitis, improper udder preparation, negligence on post-milking teat dipping and lack of herd health management), the milkers (improper hand washing, fecal contamination), milk containers (improper sanitation, cleaning with contaminated water, absence of detergents and/or disinfectants to wash) and the milking environment (contamination from dust), improper handling of milk (improperly washed or contaminated utensil for handling and storing milk) and transportation with ambient temperature. Therefore, to improve milk quality producers should check the health and hygiene of milking animals regularly, milking has to be conducted safe from fecal matter contamination, milking utensils and milker hands have to be washed well, water for washing utensils/hands should be free from contamination, handling, storing and transportation should be conducted with appropriate cooling system and even the vendors, retailers and consumers should maintain the quality and safety of milk for consumption.

Spore-forming bacteria counts

Raw milk may contain a number of organisms known as thermodurics that can survive mild pasteurization treatments. These are generally Gram-positives members of the genera *Micrococcus, Microbacterium, Lactobacillus* occasionally *Streptococci, Enterococcus*, and spore forming bacteria; *Bacillus* and *Clostridium* but 1–10% of strains of the Gram-negative *Alcaligenes tolerans* may also survive (Ruegg and Reinemann, 2002; Adams and Moss, 2008), Thermoduric bacteria are typically found in soil and often form spores (Ingall, 1998). Research conducted in Jimma showed that mean count of spore forming bacteria from 100 milk samples was 4.2±0.4 log cfu ml^{-1} (Alebel Wubet *et al*., 2013). The average spore forming bacterial count from dairy farms and milk vendors was 4.798±0.745 and 6.392±0.154 log cfu/ml, respectively. Milk samples collected from milk vendors were significantly higher ($P<0.05$) than milk samples obtained from dairy farms (Teklemichael Tesfay *et al*., 2013). These bacteria group may retain their activity and can affect quality of a post-pasteurized product and consumption of milk that contained these bacteria/or their harmful metabolites might affect the health of the consumer.

Yeast and mold counts

Yeasts and molds commonly associated with milk and milk products are: *Saccharomyces* spp. /*Kluyveromyces* spp., *Candida* spp., *Torulopsis* spp.; and *Penicillium* spp., *Rhizophus* spp., *Aspergillus* spp., *Geotrichum Candidum*, *Alternaria* spp., *Cladosporium* spp., respectively (Vishweshwar and Krishnaiah, 2005). The overall mean of yeast and mold count for a total of 78 milk samples collected directly from the udder, storage containers at farm level (bulk) and distribution containers upon arrival at selling points in Hawassa was 3.03, 4.65 and 7.13 log cfu ml^{-1}, respectively (Haile Welearegay *et al*, 2012). Mean count of yeast and molds was reported as 5.1±0.5 and 3.7±0.6 log cfu ml^{-1}, respectively from 100 milk samples collected in Jimma (Alebel Wubet *et al*., 2013). A total of 100 raw cow milk samples, 88 from individual farmers and 12dairy farms, were also collected in Jimma and the overall mean counts of yeast and molds was 4.9±0.6 and 4.7±0.52log cfu/ml and 4.61±0.5 and 4.09±0.2352log cfu/ml, respectively (Tadesse and Bacha, 2014). Yeast and molds may be found as part of the normal flora of a food product on inadequately sanitized equipment or as airborne contaminants. Different groups of fungi are found in soil, barn dust, feeds, manure, and unclean utensils. They can produce toxic metabolites, resistance to freezing environments, and cause off odors and off flavors of foods (Herrera, 2001) and, which can spoil/reduce shelf life of milk and may also pose serious health problems to the consumer.

Microbes identified in bovine milk samples

The predominant types of bacteria from inside a healthy udder are *Micrococcus, Streptococcus,* and *Corynebacterium***.** Contaminants from animals, feed, soil, water and utensils predominantly have lactic acid bacteria; *Micrococcus, Staphylococcus and Enterococcus, Bacillus* and *Clostridium* spores; and coliforms;

Pseudomonas, Alcaligenes and *Flavobacterium*. Pathogens such as *Salmonella, Lis. monocytogenes, Yer. enterocolitica*, and *Cam. jejuni* can also come from some of the mentioned contaminant. During refrigerated storage (at dairy farms and processing plants) before pasteurization, only psychrotrophs, *Pseudomonas, Flavobacterium, Alcaligenes*, and some coliforms and *Bacillus* spp. can grow and affect the acceptance quality of raw milk (e.g., by making flavor and texture undesirable). Heat-stable enzymes (proteinases and lipases), can also be produced and affect the product quality, even after pasteurization of raw milk. Psychrotrophic pathogens (*Lis. monocytogenes* and *Yer. enterocolitica*) can multiply in refrigerated raw milk during storage (Ray, 2005). According to Shunda Dingeta *et al.* (2013) the major bacterial isolates of 180 samples that collected from dairy farms, vending shops and homes/cafeterias in Mekelle were *S. aureus, Streptococcus* sp., *E. coli* and other coliforms with frequency of isolation of 26.7%, 26.7%, 44.4 % and 62.2%, respectively. *Bacillus* spp. (33.9%), *Aeromonas* spp. (27.1%), *Pseudomonas* spp. (24.6%) and *Acinitobacter* spp. (14.4%) were isolated from 118 bacterial colony of aerobic mesophilic bacteria; from 105 bacterial colony of lactic acid bacteria *Lactobacillus* spp. (32.4%), *Lactococcus* spp. (27.6%), *Enterococcus* spp.(21.9%) and *Aeromonas* spp.(18.1%) were isolated and from 84 bacterial colony of coliforms; *Esherichia* spp (30.9%), *Citrobacter* spp. (26.2%), *Entrobacter* spp.(22.6%) and *Klebsiella* spp. (20.3%) were isolated (Alebel Wubet *et al*., 2013). The pathogenic bacteria detected from 16 milk samples of the dairy farms and 12 milk samples from vendors were detected for *S. aureus* and *Salmonella* spp. and the result was 3(18.75%), 4(25%) and 5(41.7%), 6(50%), respectively (Teklemichael Tesfay *et al.*, 2013). The major bacteria isolates from positive milk samples that collected from cow udder and storage containers in six kebeles of Abaya district of Borana pastoral area of Oromia Regional state were *S. aureus*, *S. intermidus*, *S. epidermidus, and Micrococcus luteus, E. coli, Klebsiella, Enterobacter, Citrobacter, Proteus, Pseudomonas, Salmonella, Shigella* and *Yersinia spp*. Moreover, milk appeared to be contaminated with environmental bacterial agents such as *E. coli, Proteus* spp, *Citrobacter* spp, *Enterobacter* spp, *Klebseilla* spp, *Pseudomonas* spp, and *Yerisina* spp from positive milk samples that taken directly from the udder and storage containers (Tollossa Worku, 2012). Legesse Garedew *et al.* (2012) has identified Gram-negative bacteria from a total of 107 raw and pasteurized cow milk samples that collected at critical control points in Gondar town and its suburbs; a total of 92 raw milk samples were collected critical control points (CCPs). The CCPs were the teat during milking (CCP-1), 34 milk samples from milking buckets were collected and *E. coli* 5(45.46%), *Klebsiella pneumonia* 4(36.36%), *Enterobacter aerogenes* 1(9.09%) and *Alcaligenes feacalis* 1(9.09%) were isolated; at farm level (CCP-2) 33 milk samples were also collected and *E. coli* 4(30.77%), *Pseudomonas aeruginosa* 3(23.08%), *Klebsiella pneumonia* 2(15.39%), *Enterobacter aerogenes* 1(7.69%), *Citrobacter freundi* 1(7.69%), *Proteus mirabilis* 1(7.69%) and *Alcaligenes feacalis* 1(7.69%) were identified; from transport containers at milk collection centers (CCP-3) 12 samples were also collected and *E. coli* 4(26.66%), *Pseudomonas aeruginosa* 4(26.66%), *Klebsiella pneumonia* 3(20.00%), *Enterobacter aerogenes* 1(6.67%), *Citrobacter freundi* 1(6.67%), *Proteus mirabilis* 1(6.67%) and *Alcaligenes feacalis* 1(6.67%) were identified, at transportation containers up on arrival at the processing plant (CCP-4) 13 samples were also collected and *E. coli* 3(20.00%), *Pseudomonas aeruginosa* 3(20.00%), *Enterobacter aerogenes* 1(6.67%), *Citrobacter freundi* 2(13.33%), *Proteus mirabilis* 1(6.67%), *Proteus vulgaris* 2(13.33%), *Alcaligenes feacalis* 2(13.33%) and *Acinetobacter calcoaceticus* 1(6.67%) were identified. Tadesse and Bacha (2014) reported that aerobic mesophilic bacterial flora was cultivated from 88 raw milk samples that collected from individual farmers and *Staphylococcus* spp. (19%), *Enterobacteriaceae* (10%), *Micrococcus* spp. (9%), *Pseudomonas* spp. (8%), *Bacillus* spp. (8%) and *Aeromonas* (2%) were identified. Similarly, the most predominant genera in 12 raw milk samples of dairy farms were: S*taphylococcus* spp. (10%), *Enterobacteriaceae* (7*%), Pseudomonas* spp. (5%), *Micrococcus* spp. (5%), *Bacillus* spp. (4%) and *Aeromonas* spp (1%). In general, the aerobic mesophilic bacterial flora of raw milk samples was dominated by *Staphylococcus* isolates, in both farm groups. However, the major isolates belonged to 3 genera of lactic acid bacteria; which were dominated by *Lactobacillus* followed by *Streptococcus* and *Leuconostoc*. Among pathogenic bacteria of public health significance *S. aureus* and *Salmonella* spp. were also detected in 34 (34%) and 20 (20%) raw milk samples, respectively. Poly-microbial isolation from milk and different milking containers was conducted in Jimma town by Tadesse Getahun and Solomon Gebre-Selassie (2003) and isolated bacteria from teats milk were *S.aureus, E.coli* and *Shigella* spp. from swab milking utensils *S.aureus, Entrobacter* spp*., Klebsiella spp.,Streptococci* spp*., Pseudomonas* spp., were also isolated and *S.aureus, Enter.aerogenes*, *Entrobacter* spp., *Citrobacter* spp., *E.coli, Klebsiella ozanae* and *Yersinia* spp. were also isolated from bulk cans. 200 milk and milk products (cottage cheese, ice cream and youghurt) were collected and bacteriological isolation was carried out and 7(14%) prevalence of *Listeria* was observed. *Listeria monocytogenes* 8(4%) were the dominant species followed by *Listeria innocua* 3(1.5%) and *Listeria seeligeri* 2(1%) (Molalign Bitew *et al*., 2011). The level of contamination of informally marketed milk with *S. aureus* at farms and milk collection centers in Debre Zeit that conducted with 170 raw farm milk, 25 mixed bulk milk and 20 pasteurized and packaged milk samples were collected from 14 milk collection centers and *S.aureus* was isolated from 44% of farm bulk milk and 72% of milk collection centers bulk milk but not in pasteurized milk samples. Milk produced and collected in peri-urban areas were significantly more contaminated with *S. aureus* (64%) than milk produced and collected in urban areas (38%). The overall contamination rate at collection centers (72%) was significantly higher than at farm level (33%) (Fanta Dessisa et al., 2011). A plot study was conducted to establish baseline data on the microbiological quality of milk throughout central Ethiopia and 119 fresh bovine milk samples were collected from individual farmers and 29 samples from bulk milk collection centers at Selale, Asela, Akaki and Debre Zeit to determine the prevalence of *Salmonella entrica* and *S. aureus* and 26.1% of pooled samples and 51.7% of combined bulk tank samples were *S.aureus* positive; in the contrary *Salmonella* was not found in both samples (Sophia Dailey *et al*., 2011).

The results of different researches in different parts of the country have showed the presence of pathogens like *Salmonella* spp*., Shigella* spp*., Lis. Monocytogenes* and *S. aureus* (Tadesse Getahun and Solomon Gebre-Selassie, 2003; Molalign Bitew *et al*., 2011; Tollossa Worku, 2012; Teklemichael Tesfay *et al*., 2013 and Tadesse and Bacha, 2014) and also spoilage bacteria; *Escherichia, Enterobacter, Klebsiella, Citrobacter, Aeromonas* and *Serratia,* are colon dwellers (coliforms) have been detected in milk samples from different parts of the country. Probably, Aeromonas and *Serratia* can be found in the environment and contaminate food. Thus, some *Klebsiella* spp. and *Enterobacter* spp.are found in soil, where they can multiply and reach high population levels and some *Escherichia coli* and *Bacillus cereus* are known toxin producers, which may cause gastroenteritis (Ray, 2005). Even if many groups of bacteria, like lactic acid bacteria and probiotics, have beneficial effects for health and for the production of fermented foods, the detected/isolated pathogenic bacteria, food spoiling microorganisms and their harmful metabolites like toxin may have health hazard effect and/or may deteriorate the quality of milk and also which may result wastage of produced/handled milk. Therefore, the stakeholders shall take intervention actions to improve quality and safety of milk.

Mastitis pathogens in bovine raw milk

Many microorganisms can cause mastitis, the most important being *S. aureus, E. coli, Strep. agalactiae, Strep. dysgalactiae, Strep. uberis, Pseudomonas aeruginosa* and *Corynebacterium pyogenes* (Adams and Moss, 2008), several of these are human pathogens and a number of other potential human pathogens such as *Salmonella, L. monocytogenes, Mycobacterium bovis* and *Mycobacterium tuberculosis* are also occasionally reported and also mastitis directly affect milk quality by raising the aerobic mesophilic bacterial count of raw milk (Hayes and Boor, 2001). Bacteria species from bovine clinical and sub-clinical mastitis were isolated from 180 lactating and non-lactating indigenous and crossbreed cows and the isolates were *S. aureus, S. epidermidis, Micrococcus* spp, *Strep. agalactiae, Strep. dysagalactiae, Strep. uberis,* Other *Streptococcus* spp, *Actinomyces pyogenes, Corynebacterium bovis, Corynebacterium ulcerans, Bacillus* spp, *E. coli and Pseudomonas aeruginosa* but the later two species were not found in sub-clinical mastitis (Hunderra Sori *et al*., 2005). Research conducted by Zeryehun, *et al.* (2013) reported that from 118 quarter samples in and around Addis Ababa 80(67.8%) were bacteriological positive, and the isolated bacteria were *S. aureus* 23 (28.7%), *Micrococcus* spp. 4(5%), *Streptococcus dysagalactie* 7(8.7%), *Streptococcus faecalis* 8(10%), *Streptococcus agalactiae* 17(21.2%) and *Pseudomonas aeroginosa* 15(18.7%). The prevalence of bovine mastitis caused by *S. aureus* was assessed in Bahir Dar, west Gojjam Ethiopia, from 313 local (Fogera) and cross breeds and 184(58.8%) were California mastitis test positive, samples were cultured from CMT positives, and 55 resulted growth of *S.aureus* (Hirut Dessie and Seid Oumer, 2011). Mastitis have different detrimental effects like it reduces production potential of the milking cow, lower quality milk production, may pose health problem when milk produced from mastitic udders consumed and veterinary fees for treatment of mastitic cows. According to Adams and Moss (2008) mastitis can be controlled by good milking hygiene, use of a disinfectant teat dip after milking and an antibiotic infusion at the end of lactation have helped to reduce streptococcal and staphylococcal infections but have had little success in preventing *E. coli* mastitis. Infected cows are treated by injection of antibiotics into the udder. Milk from these cows must be withheld from sale for several days following treatment because antibiotic residues can cause problems in sensitive consumers and inhibit starter culture activity in fermented milks.

Conclusion

Ethiopia has huge number of livestock and probability or potential to produce much amount of milk but in the contrary cow milk produced and handled in the country has poor microbial quality, therefore it might pose health problem and economic loss but if milk is produced and handled with good hygienic practices at the very beginning from healthy cow, to producers till consumers, it might be a way to get rid of poverty. So, the concerned bodies and those who are interested to improve milk and milk products shall practice good production and handling activities to improve quality of milk with improved technologies and skilled man/woman power.

Acknowledgement

We are deeply grateful and indebted to all sources of materials used for reviewed this manuscript have been duly acknowledged.

References

Abebe Bereda, Zelalem Yilma and Ajebu Nurfeta. 2012. Hygienic and microbial quality of raw whole cow's milk produced in *Ezha* district of the Gurage zone, Southern Ethiopia. Wudpecker J. Agric. Res. 1(11): 459 – 465.

Adams, M.R. and M.O. Moss. 2008. Food Microbiology (3rd edi.). University of Surrey, Guildford, UK. RSC publishing. 121-130.

Alebel Wubet, Anbessa Dabassa and Shiferaw Demissie. 2013. Bacteriological quality and detection of bovine mastitis pathogens of milk sold in Jimma town, South-western Ethiopia. International Journal of Current Research. 5(12): 3622-3627.

Alganesh Tola, L.N. Ofodile and Fekadu Beyene. 2002. Microbial Quality and Chemical Composition of Raw Whole Milk from Horro Cattle in East Wollega, Ethiopia.

Asaminew Tassew and Eyassu Seifu. 2011. Microbial quality of raw cow's milk collected from farmers and dairy cooperatives in Bahir Dar Zuria and Mecha district, Ethiopia. *Agric. Biol. J. N. Am.,* 2(1): 29-33.

Asrat, A., Y.Zelalem and N.Ajebush. 2012. Quality of fresh whole milk produced in and around Boditti,Wolaita, South Ethiopia. Afri. J. Ani. Biomed. Sci., 7 (2):95-99.

CSA (Federal Democratic Republic of Ethiopia Central Statistics Authority). 2014. Agricultural sample survey 2013/2014 (2006 EC). Vol. II. Report on livestock and livestock characteristics. Statistical Bulletin. Addis Ababa, Ethiopia.

Dehinenet, G., H. Mekonnen, M. Ashenafi and G. Emmanuelle. 2013. Determinants of raw milk quality under a smallholder production system in selected areas of Amhara and Oromia National Regional States, Ethiopia. Agric. Biol. J. N. Am. 4(1): 84-90

Demissu Hundie. 2014. Assessment on Peri-Urban Dairy Production System and Evaluation of Quality of Cows' Raw Milk: A Case of Shambu, Fincha and Kombolcha Towns of Horro Guduru Wollega Zone, Ethiopia. Sci. Technol. Arts Res. J. 3(3): 37-43.

Fanta Dessisa, Kohei Makita, Akafte Teklu, Girma Zewude and Delila Grace. 2011. Isolation and identification of *Staphylococcus aureus* from informally marketed bovine milk in urban and peri-urban areas of Debre-Zeit. In: Abstract book, 1st International Congress on Pathogens at the Human-Animal Interface (ICOPHAI): Impact, Limitationa and Needs in Developing Countries. United Nations Conference Center Addis Ababa, Ethiopia. Pp. 118.

Fernandes, R. 2008. Microbiology hand book dairy products. Leatherhead Food International Ltd. Cambridge, UK. Pp.1-3.

Joklik, Willett, Amos and Wilfert. 1992. Zinsser microbiology. APPLETON and LANGE, Norwalk, Connecticut. 538-543.

Haile Welearegay, Zelalem Yilma and Yosef Tekle-Giorgis. 2012. Hygienic practices and microbiological quality of raw milk produced under different farm size in Hawassa, Southern Ethiopia. Agricultural Research and Reviews. 1(4): 132 – 142.

Hayes, M., and Boor, K. 2001. Raw milk and fluid milk products. In: E.H. Marth and J.L. Steele (Editors.), Applied dairy microbiology (2nd edi), 59-76.

Herrera, A.G. 2001. Mesophilic Aerobic Microorganisms; Yeasts and Molds; Coliforms. In: J.F.T. Spencer and A.L. Ragout de Spencer (Editors). Food microbiology protocols. Humana Press Inc. Totowa, New Jersey. Pp. 25-29.

Hickey, M. 2009. Current Legislation of Market Milks. In: Tamime A.Y. (Editor). Milk processing and quality management. Wiley Blackwell publishing, UK. pp. 116.

Hirut Dessie and Seid Oumer. 2011. Isolation and identification of Staphylococcus aureus from bovine mastitic milk and their drug resistance patterns in Bahir Dar, Ethiopia. In: Abstract book, 1st International Congress on Pathogens at the Human-Animal Interface (ICOPHAI): Impact, Limitation and Needs in Developing Countries. United Nations Conference Center Addis Ababa, Ethiopia. Pp.54.

Hunderra Sori, Ademe Zerihun and Sintayehu Abdicho. 2005. Dairy Cattle Mastitis In and Around Sebeta, Ethiopia. *Intern J Appl Res Vet Med*. 3 (4): 332-338.

Ingall, W. 1998. Milk quality and factors influencing the production of high quality milk. West Agro, Inc. Kansas City, MO.

Legesse Garedew, Ayalew Berhanu, Desalegne Mengesha and Getachew Tsegay. 2012. Identification of gram-negative bacteria from critical control points of raw and pasteurized cow milk consumed at Gondar town and its suburbs, Ethiopia. BMC Public Health, 12:950.

Lund, B.M., T.C. Baird-Parker and G.W. Gould. 2000. The microbiological safety and quality of food. Aspen Publishers, Inc. Gaithersburg, Maryland. 1396

Molalign Bitew, Wossila Mohamed, Diriba Muleta and Abebaw Gashaw. 2011. Study on Listeria monocytogenes and other Listeria species in milk and milk products in retail markets of Jimma town, Western Ethiopia. In: Abstract book, 1st International Congress on Pathogens at the Human-Animal

Interface (ICOPHAI): Impact, Limitationa and Needs in Developing Countries. United Nations Conference Center Addis Ababa, Ethiopia. Pp.104.

O'Connor, C.B. 1995. Rural dairy technology. ILRI Training Manual 1. International livestock research institute Addis Ababa, Ethiopia. Pp.34.

Pandey, G.S. and G.C.J. Voskuil. 2011. Manual on milk safety, quality and hygiene. Golden valley agricultural research trust, Lusaka Zambia. Pp 7-13.

Ray, B. 2005. Fundamental Food Microbiology (3rd edi.). CRC Press, Boca Raton London New York Washington, D.C.pp.45

Robinson, R.K (Editor). 1990. Dairy Microbiology (2nd eds.). Department of food science and technology, University of Reading, UK. 1: 37 – 77, 163 – 208.

Ruegg, P.L., and D.J. Reinemann. 2002. Milk Quality and Mastitis Tests. University of Wisconsin Extension Service.

Samson Ghilu, Zelalem Yilma and Sandip Banerjee. 2012. Assessment of Quality and Marketing of Milk and Milk Products in the Central Highlands of Ethiopia. LAP LAMBERT Academic Publishing.

Shunda Dingeta, Habtamu Tassew and Endale Balcha. 2013. Assessment of bacteriological quality of raw cow milk at different critical points in Mekelle, Ethiopia. Int. J. Livest. Res. 3(4): 42-48.

Solomon Mosu, Mulisa Megersa, Yibeltal Muhie, Desalegn Gebremedin and Simenew Keskes. '2013. Bacteriological quality of bovine raw milk at selected dairy farms in Debre Zeit town, Ethiopia. Journal of Food Sciences and Technology Research. 1(1): 1 – 8.

Sophia Dailey, Eyasu Tigabu, Pamela Fry, Getachew Tilahun and Juergan Greiling. 2011. Microbiological quality of milk produced in urban and peri-urban farms in Central Ethiopia and its public health effect. In: Abstract book, 1st International Congress on Pathogens at the Human-Animal Interface (ICOPHAI): Impact, Limitationa and Needs in Developing Countries. United Nations Conference Center Addis Ababa, Ethiopia. Pp.135.

Tadele Tolosa. 2013. S-QRMSDF study on quality of raw milk in small holder dairy farms in Jimma town, Southwestern Ethiopia. 2nd International Conference and Exhibition on Food Processing and Technology. Kansas City, USA.

Tadesse Getahun and Solomon Gebre-Selassie. 2003. Assessment of the bacteriological quality of milk at dairy farms and individual breeders in Jimma town, South western Ethiopia.Ethiopian Journal of Health Science. 13(1):21-29.

Teklemichael Tesfay, Ameha Kebede and Eyassu Seifu. 2013. Quality and safety of cow milk produced and marketed in Dire Dawa town, Eastern Ethiopia. *Int. J. Int Sci. Inn. Tech.* Sec. B, 2 (6): 01-05.

Tollossa Worku, Edessa Negera, Ajebu Nurfeta and Haile Welearegay. 2012. Microbiological quality and safety of raw milk collected from Borana pastoral community, Oromia Regional State. African Journal of Food Science and Technology. vol. 3(9): 213-222.

USAID. 2010. Ethiopian sanitary and phytosanitary standards and livestock and meat marketing program (SPS-LMM) Texas A&M University system. Feed resources assessment in Amhara national regional state. Addis Ababa, Ethiopia.

Vishweshwar**,** S.K. and N. Krishnaiah, 2005. Quality Control of Milk and Processing (for the course of dairying). State institute of vocational education director of intermediate education govt. of Andhra pradeshsindoor graphics, India.

Zelalem Yilma and Bernard Faye. 2006. Handling and Microbial Load of Cow's Milk and *Irgo* Fermented Milk Collected from Different Shops and Producers in Central Highlands of Ethiopia. *Eth. J. Anim. Prod.* 6(2): 67-82.

Zelalem Yilma. 2012. Microbial Properties of Ethiopian Marketed Milk and Milk Products and Associated Critical Points of Contamination: An Epidemiological Perspective, Epidemiology Insights, Dr. Maria De Lourdes Ribeiro De Souza Da Cunha (Ed.), ISBN: 978-953-51-0565-7, InTech, 297-322.

Zeryehun, T., T. Aya and R. Bayecha. 2013. Study on prevalence, bacterial pathogens and associated risk factors of bovine mastitis in small holder dairy farms in and around Addis Ababa, Ethiopia. The Journal of Animal and Plant Sciences. 23(1): 50-55.