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Full Length Research Paper

Microbiological quality and impact of hygienic practices on raw cow's milk obtained from pastoralists and market. The case of Yabello District, Borana zone, Ethiopia

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Abstract

The aim of this study was to assess general handling practices and microbial quality of raw cow's milk produced and marketed in Borana areas. A total of ninety pastoralists were randomly selected and interviewed on milk handling practices. The result of this study indicated that, majority of pastoralists use animal skin/hide (55.6%) for milking. 33.3% of them use plastic equipment for transporting their milk to the market point. All of the pastoralists were not washing udder before milking and only 3.3 % of the milkers washed their hands before milking. For microbial quality parameters sixty raw milk samples were taken from pastoralists and market. The samples were collected using random sampling method. The overall mean total bacterial count, coliform count, spore-forming bacterial count and yeast and mould count of raw milk samples obtained in the study area were 8.149 ± 0.043, 6.323 ± 0.028, 5.297 ± 0.031 and 4.363 ± 0.038 log 10 cfu/ml, respectively. The microbial quality of milk samples obtained from market were significantly higher (P<0.05) than milk samples obtained from pastoral household. The microbial quality of raw cow's milk produced and marketed in the study area was poor and it is beyond the standard limits of raw quality milk. Therefore, improving hygienic practices and handling of milk along dairy value chain is important.

Key words: Hygienic practices, microbial quality, raw milk, pastoralist

INTRODUCTION

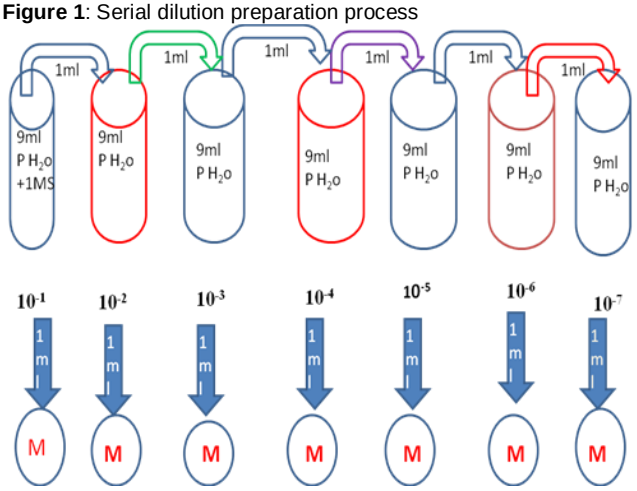
Milk is one of the most common food sources in the human diet and is also a product that is directly available for consumption (Grimaud *et al*., 2009). Being a nutritious food, it is an excellent growth medium for bacteria, originating from either mastitis or from contamination of the milk with environmental spoilage as well as pathogenic microorganisms during milking or milk handling process (Pospescu and Angel, 2009). Due to the highly perishable nature of milk and mishandling, the amount produced is subjected to high post-harvest losses. Post harvest losses up to 40% of milk and its derivatives have been reported from milking to consumption (Felleke, 2003). Further losses incurred are quality losses by storing in unclean storage utensil, which is prone to high microbial contamination. Losses in spillage and contamination occur where handling during and after milking are traditional and care is not satisfactory. So, 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 dairy products take place under rather unsanitary conditions and poor production practices (Zelalem and Faye, 2006).Milk produced at smallholders farm in Ethiopia is marketed without any form of pasteurization or quality control measures. Although, there is no study conducted on quality of raw cow's milk collected from milk producers and marketed the study area. In addition, there is no formal quality

Table 1: Microbial growth media and incubation period

Type of microbial count	Growth media	Incubation period	Color formed
Total bacteria	Standard plate count agar (SPCA)	32°C for 48 hours	Mixed color may occur
Coliform (E. *coli)*	Violet Red Bile Agar (VRBA)	32^{0}C for 24 hours	Dark red colonies
Spore forming bacteria	Standard plate count agar (SPCA)	30^{0}C for 3days	Dark white
Yeast and molds	Potato Dextrose Agar (PDA).	25^{0}C for 3 to 5 days	Blue green color

Source: McLandsborough (2005), Richardson (1985), Yousef and Carlstrom (2003).

Figure 1: Serial dilution preparation process



NB. Ml (milliliter), PH_2O (peptone water), MS (milk sample) and M (media)

control system in place to monitor and controls the quality of milk produced and sold in the study area.

MATERIAL AND METHODS

Study Area

Borana Zone is bordered to the south by Kenya, to the West by the Southern Nations, Nationalities, and Peoples Region (SNNPR), to the north by Guji zone and on the east by the Somali Region. The Borana zone covers an area of about 50,000 km^2 (Homann *et al*., 2008).The Borana rangelands are characterized by arid and semi-arid climate, with pockets of sub humid land. The average annual rainfall ranges between 350 and 900 mm, with a considerable inter-annual variability of 21% to 68% (Homann, 2008). Rainfall is bimodal, 60% of the rainfall occurs between March and May (main rainy season) followed by a minor peak between September and November (short rainy season) (Coppock, 1994).

Study Design

The study has two parts. *i'e* survey and laboratory analysis. The survey work was conducted at pastoral household level and microbiological qualities of milk samples were determined in laboratory analysis.

Survey and Household Sampling Procedure

The field survey was conducted to assess milk handling and hygienic practices in the study area. A single-visit-multiple-subject survey method was employed (ILCA, 1990). For data collection, semi-structured questionnaire were prepared and pre-tested. Household milk producers (Pastoralists) that involved in the study were selected based on potential of milk production, market orientation and willingness of the households to provide information. Purposive sampling method was used to select respondents and peasant associations from the district. A total of 90 respondents were interviewed during the survey work.

Milk Sample Collection and Transportation System

A total of sixty of raw cow's milk samples were collected at morning from pastoral households and market to assess the microbial quality of raw cows' milk. The samples were collected from milk containers immediately after milking for analysis. During collection, approximately 300 ml raw milk sample was taken from the owner's container. The milk samples taken from the different containers at market levels were pooled in sterilized containers and thoroughly mixed and then, placed into sterile glass bottles. Consequently, samples were labeled and put in icebox (4°C) to restrict microbial multiplication and transported as early as possible to analysis the microbial loads.

Microbiological Quality Tests

The microbial tests considered for determination of the bacterial load in raw milk samples were Standard Plate Count (SPC), Coliform Count (CC), spore-forming bacteria and yeast and mould using appropriate media. For determination of standard plate count and coliform count, peptone water was sterilized by autoclaving at 121ºC for 15 minutes. The laboratory processes were indicated in Table 1 and Figure 1.

Data Management and Statistical Analysis

Data collected during the survey were analyzed using Statistical Package for Social Sciences version 12 (SPSS, 1999). The

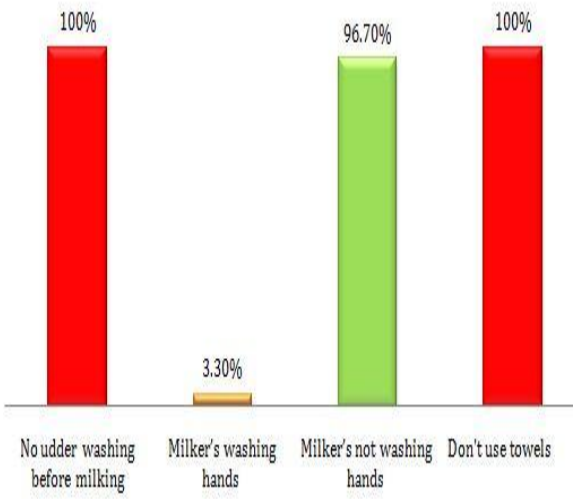


Figure 2: Milking procedures in the study area

General Linear Model (GLM) procedure of SAS (2009) was used to analyze milk microbial quality. Microbial count data were first transformed to logarithmic values (log10) before subjected to statistical analysis. Mean comparisons were done using the Least Significant Difference (LSD) technique when analysis of variance shows significant differences between means. Differences were considered statistically significant at 5% level of significance.

The following model was used for the analysis of milk microbial quality:

$Yij = \mu + \beta i + eij$

Where,

Yij = individual observation for each test, μ = the overall mean,

β = the ith milk source effect (i=1, 2), eij = the error term

RESULT AND DISCUSSION

Hygienic Quality of Milk during Productions

Barn Cleaning Practices

Maintaining the sanitary condition of barn is important for the production of good quality milk. Clean, dry and comfortable bedding condition is important to minimize the growth of pathogenic microorganisms. As observed in the present study the entire respondents were not use bedding material for their animals. Practices that expose the teat end to organic bedding sources, wet and muddy pens increase the risk of occurrence of mastitis and milk contamination (Ruegg, 2006). In the current study, 56.7% of the respondents clean the barn once a week, while 38.9% clean more than once a week and only 4.4% of them reported to clean once a month. However, proper and clean housing environment is a prerequisite to produce milk and milk products of acceptable quality (Asaminew, 2007).

Milking and Milk Handling Practices

Hygienic production of milk is important for the safety of consumers. In Ethiopia, there is no standard hygienic condition followed by producers during milk production. The hygienic conditions are different according to the production system, adapted practices, level of awareness, and availability of resources (Zelalem, 2003). In the present study, majority of the respondents (87.8%) reported that; they do not get training previously on milk handling system, milk utilization, preservation and marketing.While the remaining 12.2% of them got training offered by different Non-Governmental Organizations. Milk can be contaminated by microorganisms at any point from production to consumption. FSA (2006) indicated that cleaning of the udder before milking is important to remove both visible dirt and bacteria from the outer surface of the udder. Getachew (2003b) also indicated that milk producers should follow hygienic practices (clean utensils, washing milker's hands, washing the udder, use of individual towels) during milking and handling, before delivery to consumers or processors. In this study, substandard milking procedure was observed (Figure 2)

Milking Vessels and Transporting Equipment

The equipment used for milking, transportation and storage determine the quality of milk and milk products. Types of milk containers determine the qualities of milk, especially during transportations of milk to the selling point. Milk storage and transportation are aimed at having good quality milk available where and when needed for processing (Walstra *et al.*, 1999). Therefore, producers need to pay particular attention for the type as well as cleanliness of milk equipment. Types of milking vessels and transportation tools were indicated in Figure 3 and 4. Majority of the respondents the means of milk transportation in the study area were on foot (71.1%) while the remaining were using animal back (16.7%) and public transport vehicle (12.2%).

Smoking and Source of Water Used for Cleaning Milk Vessels

Degree of cleanliness of milking equipments depends on the procedure which is adopted for cleaning and sanitizing. For example there will be less number of resistant and thermoduric bacteria on the surface of equipments which are washed with hot water. Majority of households in the study area were practicing washing and smoking of the milking utensils regularly before and after milking. Procedures of cleaning and disinfection of milking utensils prior to milk collection reported here in,

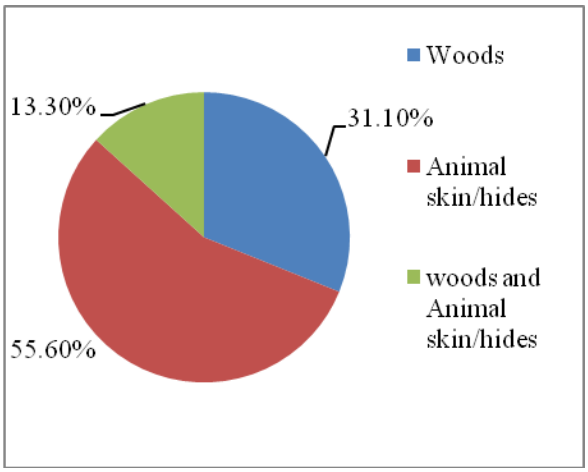
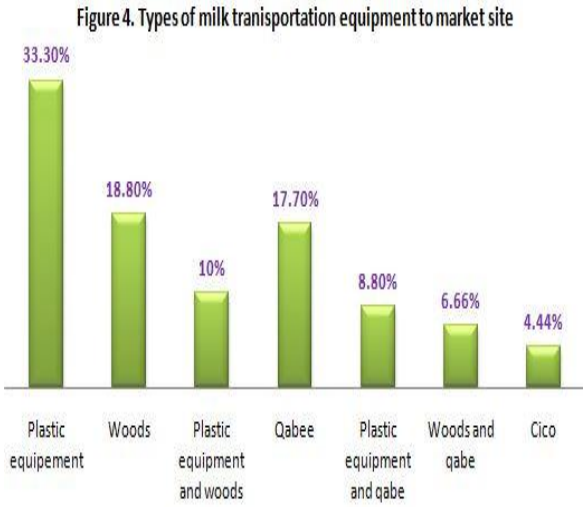


Figure 3: Type of milking vessels in the study area



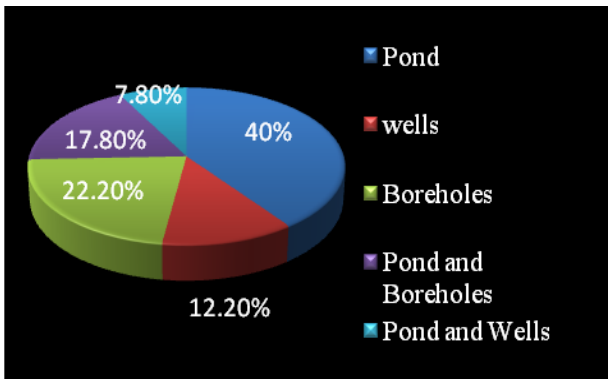


Figure 4: Type of water source used for cleaning purpose

were similar to previous results from Ethiopia (Gonfa *et al.,* 2001; Sintayehu *et al.,* 2008). According to the local understanding, the practice of smoking the vessel by burning wooden chips of specific trees has an advantage of imparting special taste and odor to the product, and to disinfect the vessels, thus reducing the numbers of micro-organisms and thereby extending the shelf life of the product. Similarly, low acid production was observed in milk samples stored in smoked containers (Helen and Eyasu, 2007). Therefore, efficient cleaning and sanitation of dairy farm utensils could help to improve the quality of raw milk and its products.

Plants species that are frequently used for smoking milk vessels in the study area were *Balanites aegyptica* (Badena okole), *Terminalla brownii (*Biressa), *Olea africana* (Ejersa), *Premna resinosa* (Tetessa), and *Combretum mole* (Rukesa). As respondents reported, the reasons that they use these plants were that: they give good flavor, aroma and increase shelf life of the milk as well as slow milk fermentation process.

The main sources of water that Borana Pastoral community used for cleaning proposes are indicated in Figure 5. Bonfoh *et al., (*2006) reported that, besides udder infection and water quality, hygienic behavior with respect to hand washing, containers cleaning and disinfection are the key areas that need hygiene intervention. About, 75.6% of the respondents used cold water while 22.4% of them used warm water for cleaning milk utensils. When water from non tap sources is used for cleaning purpose; it is important that producers should at least filter and heat treat it before use because the quality of water determines the amount of bacterial counts (Zelalem 2009).

Microbiological Load of Raw Cows' Milk

Total Bacterial Count

The mean total bacterial count was significantly different ($P < 0.05$) among milk samples collected from household milk producers and market. The total bacterial count obtained in this study is generally high compared to the acceptable level of 1 x 10^5 bacteria per ml of raw milk (O'Connor 1994). The total bacterial count obtained from market was significantly higher ($P < 0.05$) than milk samples collected from household milk producers (Table 2). This might be due to further contamination of the milk during transportation, use of poorly cleaned milk containers polled and even absence of cooling systems at milk selling points. In general, lack of knowledge about clean milk production might have contributed to the poor hygienic quality of milk produced in the study area.

Coliform Count

The coliform count obtained from market was significantly higher ($P < 0.05$) than milk samples obtained from household milk producers.This might be due to further contamination of the milk during transportation, inadequately cleaned milking utensils, the practice of washing the milk containers together with other materials and absence or improper cooling systems at milk selling areas. The mean of coliform count observed in raw cow's milk samples collected from market and household milk producers was 6.455 ± 0.030 and 6.192 ± 0.027 $\log_{10}$ cfu/ml,

Table 2: Mean (±SD) microbial counts log_{10} cfu/ml) of raw cow's milk samples collected from market and household milk producers (pastoralists) in the study area.

Variables	Milk Source		Overall Mean
	Market(n=30)	HHMPs (n=30)	
TBC	8.343 ± 0.017^a	7.956 ± 0.069^b	8.149 ± 0.043
CC	6.455 ± 0.030^a	6.192 ± 0.027^b	6.323 ± 0.028
SFBC	5.363 ± 0.034^a	5.196 ± 0.029^b	5.297 ± 0.031
YMC	4.461 ± 0.044^a	4.266 ± 0.032^b	4.363 ± 0.038

Means followed by different superscript letters within a row are significantly different ($P < 0.05$), HHMPs = Household milk producers, TBC=Total bacterial count, CC= Coliform count, SFBC= Spore forming bacterial Count, YMC= Yeast and mould count, n= number of samples

respectively (Table 2). According to the European Union standards for coliform counts of raw milk should be less than 10^2 cfu/ml, respectively (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.

Spore Forming Bacterial Count

The average (±SD) values of spore-forming bacteria counts (SFBC)/ml of milk samples collected from market were significantly higher ($P < 0.05$) than raw milk samples obtained from household milk producers. The higher SFBC in milk samples obtained from market 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.

Yeast and Mould Count (YMC)

Yeast and mould are considered to be spoilage organisms. The mean of YMC found in the current study was 4.461 ± 0.044 and 4.266 ± 0.032 log_{10} cfu/ml for milk samples collected from market and household milk producers, respectively. Mean value of yeast and mould counts were significantly different ($P<0.05$) between milk samples collected from household milk producers and market (Table 2). The high YMC observed in milk obtained from market might be attributed to contamination from air, containers or poor personal hygiene of milk sellers.

CONCLUSIONS

The microbial qualities of the milk obtained in current study was poor, as judged from the high values of standard plate count (SPC),coliform count (CC), SFC, and yeast and mould counts which were significantly higher than the international standards safe for human consumption. These microbial loads may be due to poor hygienic standards during milking, and milk handling. Microbial qualities of raw milk are important from the consumers' health point of view as well as for further processing of milk and milk products. In general, the result of this study indicated that urgent measures are needed to ensure lean and safe milk production at pastoral community level through promotion of good hygienic practices and adequate sanitary measures at all stages from production to consumption.

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