Assessment of Bacteriologic Quality of Raw Cow Milk at Different Critical Points in Mekelle, Ethiopia

Shunda, D., Habtamu, T. and Endale, B. *

Mekelle University, College of Veterinary Medicine, P.O.Box:2084, Mekelle, Ethiopia

* Corresponding author: endalebalcha@yahoo.com
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Abstract

The study was conducted from November 2011 to April 2012 in to assess the bacteriologic quality of raw cows milk at different critical points in the value chain in Mekelle, Ethiopia. A total of 180 milk samples were collected from different sites and analyzed for bacterial load using standard plate count technique and isolation of pathogenic bacteria was conducted. The mean ± SE bacterial count for all the milk samples was 7.39 ± 0.207 log_{10} cfu/ml. The mean bacterial count in the different sites was 7.35±0.180, 7.35±0.180, 7.42 ± 0.272 log_{10} cfu/ml from dairy farms, vending shops and homes/cafeterias, respectively. However, there was no significant difference (p>0.05) among the sites in the value chain. The major bacterial isolates were Staphylococcus aureus, Streptococcus sp., Escherichia coli and other coliforms with frequency of isolation of 26.7%, 26.7%, 44.4 % and 62.2%, respectively. Therefore there is a need of training for persons at the various value chains on strict hygienic measures to improve the bacteriological safety of cow milk.

Keywords: Milk, Bacterial load, value chain, Mekelle, Ethiopia

Introduction

In Ethiopia, one of the developing countries, urban and peri-urban dairying constitutes an important sector of the agricultural production system (Yitaye et al., 2009). Livestock represents major national resources and form an integral part of agricultural production system (Gebrewold et al., 2000). Cows contribute to about 95% of the total annual milk produced by cows and camels at national level (CSA, 2010).

Milk is considered as one of the most important diet items of many people. Nutritionally, milk has been defined as the most nearly “perfect food”. It is a compensatory part of daily diet especially for the expectant mothers as well as growing children (Javaid et al., 2009; Olatunji et al., 2012).

The safety of dairy products with respect to food born disease is of 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). Microbial load is a major factor in determining milk quality (Ahmed, 2009; Fatine et al., 2012). It indicates the hygienic level exercised during milking, cleanliness of the milk utensils, condition of storage, manner of transport as well as the cleanliness of the udder of the individual animals. 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 further processing. These microorganisms are indicators of both manner of handling milk from milking till consumption and the quality of the milk (Lunder and Brenne, 1996).

An increasing number of people are consuming raw unpasteurized milk (Oliver et al., 2009). The consumption of raw milk and its derivatives is common in Ethiopia (Yilma, 2003), which is not safe from consumer health point of view as it may lead to the transmission of various diseases. Raw or processed milk is a well known food medium that supports the growth of several microbes with resultant spoilage of the product or infections (intoxications) in consumers (Oliver et al., 2005).

Even though milk represents an important place in the nutrition of consumers as well as nutrition and income of producers, there is limited work so far undertaken regarding assessment of bacteriological quality of raw cow milk in northern Ethiopia in general and in Mekelle in particular. Therefore the aim of the present work was to assess the bacteriological quality of raw cows, milk at different critical points in the value chain in Mekelle, Ethiopia.

**Materials and Methods**

**Study area**

The study was conducted for a period of six months from November 2011 to April 2012 at selected dairy farms, milk vending shops and houses or cafeterias in Mekelle, capital city of Tigray region, Northern Ethiopia.

**Collection and processing of milk samples**

About 15-20 ml of milk samples were collected aseptically from dairy farms, milk vending shops and house/cafeterias using sterile test tubes. The samples were collected from milk containers and milking buckets immediately after milking for bacteriological analysis. A total of 45
samples; 15 from dairy farms, 15 from milk vending shops and 15 from house or cafeterias were collected at weekly intervals for 4 weeks. Each specimen was labeled, placed in ice box and transported to the laboratory. They were put in a refrigerator at 4°C and culturing was conducted within 24 hrs as described by Quin et al. (2004).

**Standard Plate Count**

The total bacterial count was made by adding 1 ml of milk sample into sterile test tube having 9 ml peptone water. After thoroughly mixing, the sample was serially diluted up to 1:10^7 and duplicate samples (1 ml) were pour plated using 15-20 ml standard plate count agar solution and mixed thoroughly. The plated sample was allowed to solidify and then incubated at 30°C for 48 hours. Colony counts were made using colony counter (Marth, 1978).

**Bacterial Isolation**

Milk samples were examined following standard procedure where about one standard loop full (0.01ml) of each milk samples was streaked on nutrient agar. Plates were incubated aerobically at 37°C for up to 72 hrs and checked for any bacterial growth. Suspected colonies were identified morphologically, microscopically and biochemically according to Quinn et al. (2004).

**Data analysis**

The data was entered into excel spread sheet and analyzed using a statistical software (SPSS version 15.0). Then Log_{10} transformation of bacterial count was done, before the analysis. Percentages were also used to express the proportion of bacterial isolation and milk quality grade based on Indian standards. The differences in bacterial load between the milk sample from dairy farms, milk vending shops and houses/cafeterias were compared. The results were reported as significant for p < 0.05.

**Results and Discussion**

The microbial content of milk indicates the hygienic levels during milking that include cleanliness of the milking utensils, proper storage and transport as well as the wholesomeness of the udder of the individual cow (Spreer, 1998). Standard plate count (SPC) is one of the most commonly used microbial quality tests for milk and milk products.
The overall mean bacterial count of cow’s milk in the study area was 7.39 $\log_{10}$ cfu/ml ($2.45 \times 10^7$) as shown in Table 1.

Table 1. Mean ± SE of bacterial counts of milk at different value chain points

<table>
<thead>
<tr>
<th>Site</th>
<th>No. of samples (N)</th>
<th>Bacterial count Mean ±SE (cfu/ml)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy farm</td>
<td>60</td>
<td>7.35 ± 0.180</td>
<td>0.605</td>
</tr>
<tr>
<td>Milk vending shops</td>
<td>60</td>
<td>7.55 ± 0.180</td>
<td></td>
</tr>
<tr>
<td>Houses/ cafeterias</td>
<td>60</td>
<td>7.42 ± 0.272</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>180</td>
<td>7.39 ± 0.207</td>
<td></td>
</tr>
</tbody>
</table>

The result is comparable to the findings of Worku et al. (2012) who reported bacterial count from 7.36 – 7.88 $\log_{10}$ cfu/ml of raw cows’ milk in Borana, Ethiopia; Tassew and Seifu (2011) 7.58 $\log_{10}$ cfu/ml in Bahir Dar Zuria and Mecha district, Ethiopia and Mosu et al. (2013) 7.07 $\log_{10}$CFU/ml in Debre Zeit town, Ethiopia. However, the bacterial count obtained from current result was higher than that of Ashenafi and Beyene (1994) (2.1$x10^6$ cfu/ ml), Ombui et al. (1995) (10$^5$ cfu/ml) and Bonfoh et al. (2003) (10$^7$ cfu/ml). The higher count indicates substandard hygienic conditions practiced during production and subsequent handling. 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 total bacterial count is a good indicator for monitoring the sanitary conditions practiced during production, collection, and handling of raw milk (Fatine et al., 2012). Hence training of milk handlers about hygiene can significantly reduce the bacterial load in milk. A good example for this could be reduced total bacterial count observed in milk sampled from farmers who received training on hygienic milk production and handling (Nebiyu, 2008; Sintayehu et al., 2008).

The present result revealed that there is increment of bacterial count at each critical control points. The mean ± SE bacterial count was 7.35 ± 0.180 $\log_{10}$ cfu/ml in dairy farms, 7.41 ±0.158 $\log_{10}$ cfu/ml in milk vending shops and 7.42 ± 0.272 $\log_{10}$ cfu/ml in homes/cafeterias (Table 1). This could be due to improper handling, storage and transport time after the milk leaves the dairy farms. Milk produced under hygienic conditions from healthy cows should not contain more than 4.7 $\log_{10}$ cfu/ml (O’ Connor, 1994).
Out of 180 samples collected, *Staphylococcus aureus* was isolated from 48 samples (26.7%); *Streptococcus* species (26.7%); *E. coli* (44.4%) and other coliform bacterial (62.2%) (Table 2). The same organisms were reported in previous works (O’Connor, 1994, Worku *et al.*, 2012). The isolation of *S. aureus*, *Streptococci*, *E. coli* and other coliforms are incriminated as causes of subclinical and clinical mastitis in the cow which could be of environmental origin (Bonfoh *et al.*, 2003). The contribution of mastitis udder in the bacterial quality of cow milk is an established fact and therefore adequate control of mastitis could help to enhance the production of high quality dairy products (Mekbib *et al.*, 2010). The type and number of bacteria present in the milk influence the hygienic quality of milk. The isolates of *Staphylococcus spp* and coliform microorganisms can cause spoilage of the milk when present in raw milk (Doyle, 1997).

### Table 2. Bacterial isolates from raw milk

<table>
<thead>
<tr>
<th>Species of bacterial isolate</th>
<th>Sources of Sample</th>
<th>Dairy farm</th>
<th>Milk vending shops</th>
<th>House or cafeterias</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>S. aureus</em></td>
<td></td>
<td>24(13.3%)</td>
<td>8(4.4%)</td>
<td>16(8.9%)</td>
<td>48(26.7%)</td>
</tr>
<tr>
<td><em>Streptococcus spp</em></td>
<td></td>
<td>16(8.9%)</td>
<td>20(11.1%)</td>
<td>12(6.7%)</td>
<td>48(26.7%)</td>
</tr>
<tr>
<td><em>E. coli</em></td>
<td></td>
<td>20(11.1%)</td>
<td>20(11.1%)</td>
<td>40(22.2%)</td>
<td>80(44.4%)</td>
</tr>
<tr>
<td>Other coliforms</td>
<td></td>
<td>28(15.6%)</td>
<td>40(22.2%)</td>
<td>44(24.4%)</td>
<td>112(62.2%)</td>
</tr>
</tbody>
</table>

The result obtained in this study concluded that milk available to the consumer in Mekelle have a high bacterial load which is more than the acceptable limit according to American and European community member states, which is between $2 \times 10^5$ and $4 \times 10^5$ cfu/ml (APHA, 1995). They are also contaminated with *S. aureus*, *Streptococcus spp*, *E. coli* and other coliform bacterial spps contamination. It indicates that hygienic procedures are not strictly followed during milk production. Hence it warns the need for more strict preventive measure for the regular washing and sterilization of dairy equipment, utensils, milkers’ hand, udders, eradication of diseased animals, and pasteurization (boiling) of milk before collection and distribution for consumption. The magnitude of the problem of bacterial contamination deserves more elaborative studies from the point of production of milk and milk products to the point of consumption and at all intermediary levels.

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References