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# Preventive Veterinary Medicine

# Milk production, quality, and consumption in Jimma (Ethiopia): Facts and producers', retailers', and consumers' perspectives

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## ARTICLE INFO

## ABSTRACT

Four studies were performed to quantify milk production, quality and consumption in the town Jimma, Ethiopia. First, 47 dairy farmers and 44 milk retailers were interviewed to gain more insights in dairy farming and marketing, and associated constraints. Second, bulk milk samples ($n = 188$) were collected for 4 consecutive weeks to investigate milk quality [Total Bacterial Counts (TBC), Coliform Counts (CC), Somatic Cell Counts (SCC), and antimicrobial residues]. Third, (bulk) milk samples from 32 farms, 46 milk retailers and the 3 local milk collection centers were collected to determine the presence of oxacillin susceptible–and oxacillin resistant Staphylococcus aureus. Fourth, 208 adult inhabitants were interviewed to gain more insight in milk consumption and associated concerns of consumers. The average dairy farm included in the studies consisted of 5 lactating cows, produced 43 liters of milk per day and was owned by male, literate adults. Milk was sold to retailers (71% of the production) and directly to customers (25%) without any quality control, whereas 4% was self-consumed. Shortage of animal nutrition and adulteration of the milk were the main constraints for farmers and retailers, respectively. The median TBC, CC and SCC were 122,500 CFU/mL, 1,005 CFU/mL and 609,500 cells/mL, respectively. Antimicrobial residues were detected in 20% of all samples. In general, the milk quality was considered to be poor (TBC > 10,000 CFU/mL, and/or CC > 100 CFU/mL, and/or SCC > 400,000 cells/mL and/or presence of antimicrobial residues) in 97% of all samples. S. aureus was isolated from 12 (38%), 13 (33%), and 2 out of 3 of the milk samples originating from the dairy farms, the milk retailers, and the milk collection centers, respectively. Seven (26%) of the isolates were resistant to oxacillin suggesting the presence of MRSA (Lee, 2003). Local milk is occasionally consumed by adults but more frequently by children. Adults mainly drink spontaneously fermented milk (57% of 105 interviewees consuming local milk) whereas most milk for children is boiled (86% of 110 households with children consuming local milk). Most consumers are concerned about adulteration and milk borne diseases but not about antimicrobial residues. Educated consumers (secondary school or higher) were more likely to boil milk for own consumption, to be concerned about antimicrobial residues in milk, to be concerned about milk borne diseases and to be willing to pay more for milk with proven good quality compared to poorly educated consumers.

We conclude that milk quality incentives should be introduced in Jimma, and investments should be made in knowledge transfer, training, milk collection systems and a central milk quality lab.

## 1. Introduction

The demand for milk in cities of developing countries increases due to population growth and urbanization (Narrod et al., 2011). In response, smallholder dairy farms are mushrooming in e.g. Jimma and other Ethiopian towns (Mekonnen et al., 2006). Typically, Holstein–Zebu crossbreed dairy cows are milked with limited or no access to pasture (Tolosa et al., 2013). The smallholders are responsible for 98% of the milk produced. The milk flow and supply chain in Ethiopia is quite complex and in many cases still immature in terms of capacity, organization and infrastructure (Yilma et al., 2011). Only a limited proportion of the milk is bought and sold by the 3 local milk collection centers that have been established by the dairy cooperatives in Jimma in 2011. Most the milk is directly sold

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to retailers and/or consumers, most often in producer-owned milk shops.

Intramammary infections (IMI) lead to an increase in somatic cell count (SCC), (in) directly affecting milk shelf-life and components (Ma et al., 2000). High-quality milk has a low SCC and bacteria count, and is free of foodborne pathogens and antimicrobial residues (Oliver et al., 2009). Although milk has a high nutritional value (Gaucheron, 2011), it constitutes a good growth medium for bacteria of which some are pathogenic for humans (Jayarao and Henning, 2001). Bacteria in milk originate from shedding cows with IMI, unclean milking practices or improper milk handling (Hayes et al., 2001; Zadoks et al., 2004). Among other pathogens in milk, *Staphylococcus aureus* can cause severe disease in humans, and is difficult to treat in case of the presence of antimicrobial resistance (Xu et al., 2014). Accurate information on milk quality in Jimma and the whole of Ethiopia is scarce.

Western consumers are highly concerned about the quality of milk and other animal products (Aumaître, 1999; Noordhuizen and Metz, 2005). Whether consumers in African cities such as Jimma share this concern is largely unknown. The risk of milkborne diseases does not only depend on microbiological characteristics but also on milk processing before consumption (Lejeune and Rajala-Schultz, 2009). In Ethiopia, milk is often not pasteurized but consumed after spontaneous fermentation at the household level (Gonfa et al., 2001). Spontaneous fermentation helps in extending the storage life of the milk. During the spontaneous fermentation, the lactic acid bacteria present in the raw milk convert the lactose into lactic acid, lowering the pH of the milk and thus resulting in a reduced bacterial count. Some of the lactic acid bacteria also produce bacteriocins that inhibit the growth of disease-causing pathogens (Gillor et al., 2008). Yet, the frequency and type of milk consumed by adults and children, being more susceptible to milk borne diseases, is unknown in cities such as Jimma.

The objectives of this research were to characterize dairy farming and marketing, to study milk quality, to detect the presence of (oxacillin resistant) *S. aureus* in raw (bulk) milk and to quantify milk consumption in Jimma, Ethiopia.

## 2. Materials and methods

### 2.1. Study area

Jimma is a medium-sized town with approximately 140,000 inhabitants located in Oromia Regional State, Jimma Zone, 352 km South-West of the capital, Addis Ababa in Ethiopia. Jimma has an altitude of about 1780 m above the sea level and an annual rainfall ranging from 1400 to 1900 mm. Temperature varies between 6 °C and 31 °C (Alemu et al., 2011). The area is mainly known for its coffee production but crop and livestock production are important agricultural activities as well.

### 2.2. Questionnaire on dairy farming, milk production and marketing

As (dairy) farmers and retailers are not registered in Ethiopia, their exact total number is unknown, also in Jimma. Yet, 47 smallholder dairy farmers and 44 milk retailers were selected based on their willingness to cooperate, encompassing a large majority of those present in Jimma (total number estimated at 60). All were interviewed face-to-face by the first author between July and August 2009. Closed and open questions were asked to gain more insight in dairy farming and marketing, and associated constraints (Table 1).

In all 47 herds, different types of antimicrobials were used to treat sick animal against different infectious diseases including mastitis. With a cow level prevalence of clinical and subclinical mastitis of 11 and 62%, respectively, and a blind quarter prevalence of 6%, mastitis is one of the most common infectious diseases for which antimicrobials are used (Tolosa et al., 2013; Tolosa et al., 2015). All except from one herd used Lactaclox® (i.e., a combination of ampicillin and loxacillin) for the intramammary treatment of mastitis. Sixteen (34%), 13 (28%), 10 (21%), and 8 (17%) herds used Lactaclox® and oxytetracycline, Lactaclox®, Lactaclox®,oxytetracycline and penicillin–streptomycin, and Lactaclox® and penicillin–streptomycin, respectively. On 54% of the herds, antimicrobials and other drugs used for the treatment of diseases were prescribed and administered by a veterinarian on the herd, on 24% of the participating herds sick animals were treated at a veterinary clinic in the neighbourhood and 22% of the farmers treated their animals themselves based on their own experiences. Animals suffering from clinical mastitis are treated for a maximum of 3 consecutive days. No precise information was available on the treatment strategies applied for other diseases than mastitis.

### 2.3. Longitudinal study on milk quality

Bulk milk samples of the aforementioned dairy farms were aseptically collected once a week for four consecutive times between December 2009 and January 2010. For the enumeration of TBC and CC, serial dilutions ($10^{-1}, 10^{-2}, 10^{-3}$ and $10^{-4}$) were plated on Petrifilm Aerobic Count Plates (3 M, Saint Paul, MN, US) and Petrifilm Coliform Count Plates (3 M, Saint Paul, MN, US) according to the manufacturer's instructions. After 24 h of incubation at 37 °C, plates were read using a semi-automated colony counter (Stuart, Bibby Sterilin, Stone, UK). The SCC was measured with a DeLaval Direct Cell Counter (DeLaval, Tumba, Sweden). The Copan Milk Test (Copan Italia, Brescia, Italy) was used to determine the presence or absence of antimicrobial residues in the milk samples according to the manufacturer's instructions.

**Table 1**
Questions asked to 47 dairy farmers and 46 milk retailers on dairy farming and marketing in Jimma (Ethiopia) using a face-to-face questionnaire.

| Farmers/retailers | Question |
|---|---|
| Farmers | Age (in years) |
| | Gender (male/female) |
| | Education (elementary school or lower/secondary school or higher) |
| | Herd size (number of lactating animals) |
| | Total daily milk production in liters |
| | Proportion of milk for own consumption, sold directly to customers and sold to milk retailers |
| Both | Average selling price of milk per liter in Birr |
| | Concerns about antimicrobial residues (yes/no) |
| | Concerns about milk quality (yes/no) |
| | Interest in the establishment of a central milk quality laboratory (yes/no) |
| | Main constraint (open question) |