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Utilization and quality of goat milk in Hadiya zone, Southern Ethiopia

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The aim of this study was to understand the utilization of goat milk, its chemical and microbial qualities in selected kebele's representing arid (kolla) and semi arid (Woyina Dega) type of agro-ecologies. There are cultural taboos in the consumption of goat milk in certain societies. The small amount of goat milk utilization by family members could be a reflection of the low milk yield/doe/day in Woyina-Dega (0.29) and Kolla (0.31). About 88% of goat keeping households in Woyina-Dega and 74.1% in kolla provide goat milk primarily for children. The households provide goat milk for their family for several reasons such as part of the normal diet/meal; its reputed medicinal value; it strengthens their children; cures fast bone fractures; and provides resistance to illnesses when consumed by sick individuals. About 84% in woyina dega and 67% in kolla add water to goat milk with the intention of increasing the quantity and softening goat's milk typical strong taste and odor. The samples were aseptically collected in two rounds from local milking does. Average aerobic mesophilic bacterial count, and coliform were 9.7 and 4.89 $\log_{10}$ cfu mL^{-1}, respectively. The overall value of total solid, fat, protein, lactose, ash and moisture content of the collected samples were 13.57, 4.91, 3.48, 4.84, 0.40 and 86.42%, respectively. There was no significant variation observed in microbial count and gross chemical composition of local goat milk samples taken from the two agro-ecologies. Information on the utilization, microbial and chemical properties of goat milk is essential to make further improvement interventions.

Key words: Goat milk, consumption, microbial quality, chemical composition

INTRODUCTION

In many tropical countries, goats are important especially to the livelihood of the poor in rural areas. This is due mainly to their efficiency in terms of meat and milk production, low cost of maintenance, a great adaptive feature to the tropical harsh environment and their inherent suitability for small-scale production (Silanikove, 2000; Misra and Singh, 2002; Degen, 2007). In Ethiopia, where milk makes an important part of the diet and also contributes to the household income for livestock keepers, local goats are very important livestock species. Goat milk is widely consumed (usually in its fresh state) wherever it is produced. Generally, the majority of smallholder farmers in rural Ethiopia are resource poor and therefore do not afford buying cattle and accordingly producing meat and/or milk, or even the products per*se* on a regular basis. The demand for goat milk and its products is increasing in many countries due mainly to the increasing reputation of associated good health effects (Klinger and Rosenthal, 1997). However, improper handling and the low productivity of goat milk remain to be a major problem limiting its consumption.

On the other hand, consumers are more concerned about quality aspects and the hygienic conditions of milk. Considering the quality aspects of goat milk is,

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therefore, essential, from consumer health point of view. Little is known about the microbial load of local goat milk produced in West (Woyina-Dega agro-ecology for humid) and East Badawacho (Kolla agro-ecology for semi-arid) districts. A commonly used procedure to measure the sanitary quality of milk is to estimate indicator bacterial counts in milk samples and determine the gross milk chemical compositions. Aseptically drawn milk from healthy udders contains between 500 and 1000 ml^{-l}. High initial counts (more than 10^5 bacteria $ml^{-1)}$ are evidence of poor production hygiene (O'Connor, 1994; Fekadu and Abrahamsen, 1997). In proportion to the numbers present, existence of coliform bacteria in dairy products is suggestive of fecal contamination and unsanitary practices during production, processing and/or storage (Richardson, 1985). In this study to measure the sanitary quality of the milk, aerobic mesophilic bacterial count (AMBC) and Coliform count (CC) were considered. In addition, gross chemical compositions namely percent contents of milk fat, protein, lactose, ash and total solids were considered. The current study, therefore, reports on the microbial load and chemical composition of milk from local goat breed found in West (Woyina- Dega) and East Badawacho (Kolla) Districts.

MATERIALS AND METHODS

Description of the study area

The study was conducted in Eastern and Western Badawacho district, Hadiya zone, of Southern Nations, Nationalities, and People's Region (SNNPR). Eastern Badawacho district being a low-land represents '*Kolla*' (Semi-arid as well as sub-humid), while Western Badawacho being mid-altitude area represents '*Woyina-Dega*' (sub humid) type of climate. Eastern and Western Badawacho districts were selected purposively based on the importance of goat production in the area. It is located at about 345 km and 357 km, respectively, from Addis Ababa along the main road to Arba-Minch.

West Badawacho is situated at altitudes ranging from 1750 to 2100 m.a.s.l, receives an average annual rainfall of 800-1200mm with ambient temperature ranging from 11 to 27.°C (WBARDO, 2008).

Eastern Badawacho is situated at elevation ranging from 1500 to 2200 m.a.s.l. The annual rainfall distribution of the area ranges from 800 to 1300mm. The area has a mean annual temperature ranging from 17.6 to 33.6°C (East Badwacho Ministry of Agriculture and Rural Development, 2008).

Study procedure

The study had two parts: a survey to understand the utilization of goat milk by the community; and laboratory work to evaluate the microbial as well as chemical composition of goat milk produced and consumed in both areas.

Survey study

A pre-tested structured questionnaire was used to gather the required information on the utilization and quality of goat's milk. There are a total of 56 Kebeles (smallest administrative unit) in the two districts (34 Kebeles in Eastern and 22 in Western Badawacho). Three kebeles from each of the two districts representing two agro-ecologies were selected purposively considering the importance of goat production and in terms of goat population. All the three selected kebeles from Eastern Badawacho district represent the kolla agro-ecology (Semi-arid). A total of 15 goat keeping households that also have the habit of goat milk utilization were randomly selected from each Kebele and interviewed making the total number of interviewees 90.

Microbial and chemical properties of goat milk

Milk sampling procedure

A total of 60 milk samples from thirty local does kept at West and East Badawacho districts were collected to study their microbial and chemical properties. Fresh milk samples were collected from 5 local dairy goat keepers from each of the six kebeles in a two time visit in two weeks interval – two samples from the same household and the same doe. The sample does were identified by the help of the owners as well as their specific phenotypic characters particularly coat color noted by the sampler. Samples were collected aseptically following standard procedures (Richardson, 1985). Accordingly, 10 ml of milk samples were transferred into sterile sampling bottles, which were then securely capped, labeled with permanent markers and kept in an ice box filled with ice packs and brought to Holeta Agricultural Research Center, Dairy Technology laboratory of the Ethiopian Institute of Agricultural Research (EIAR).

Laboratory analysis

Aerobic Mesophilic Bacterial Count (AMBC): Milk samples were diluted in 0.1% peptone water (25ml of samples in 225ml of 0.1% peptone water for initial dilution and by transferring 1 ml of the previous dilution in 9ml of 0.1% peptone water).AMBC was made on plate count agar (PCA)(oxide, Uk) by incubating aerobically surface plated duplicate plates with appropriate decimal dilutions of goat milk samples at 32^oC for 48hr. As recommended by Richardson (1985), plats with colony counts between 30 and 300 were selected and all counts were made in duplicates.

Coliform Count (CC): Appropriate decimal dilutions of goat milk samples were made in the same manner as for

AMBC and surface plated on Desoxycholate Agar (DA) plate and enumeration was made after incubating the plates at 32^{o}C for 24hr (Richardson, 1985). Dilutions were selected for plate counts of between 15 and 150 colonies. Typical dark red colonies (> 0.05 mm in diameter) were considered as coliforms and counted accordingly.

Chemical composition

Total Solids (TS) content was determined by oven drying 5gm of goat milk samples at 100^{o}C for 3 hrs (AOAC, 1995). Determination of fat percent was performed by using sulfuric acid and amyl alcohol following the standard procedure described in the Gerber method (AOAC, 1995). Protein content was determined using potassium oxalate, sodium hydroxide (NaOH), formaldehyde and phenolphthalein with formaldehyde titration method according to the technique described by O'Connor (1995). Lactose content was calculated by subtracting the sum of fat, protein and ash contents from total solids. Moisture content was also calculated by subtracting total solids content from 100.

Statistical Analysis

The data collected through the survey on goat milk utilization were analyzed using descriptive and inferential statistics using SPSS software (ver.16). Microbial counts obtained from goat milk samples collected from the two agro ecologies were first $\log_{10}$ transformed. Both $\log_{10}$ transformed microbial counts and gross chemical composition of goat milk samples were then subjected to statistical analysis using the General Linear Model (GLM) procedure of the Statistical Analysis System (SAS) software (ver. 9.2 version (SAS, 2009). *T* test (Least Significant Difference, LSD) was used for mean separation and differences were considered significant when $P<0.05$.

The following model was used for the analysis: $Yij = \mu + Ai + eij$

Where,

Yij = Log_{10} transformed microbial count or gross chemical composition of j^{th} milk sample taken from i^{th} agro-ecology.

μ = Over all mean value of the respective parameter

Ai = Effect of the i^{th} agro-ecology (i=2, East and West Badawacho)

eij=error

RESULTS AND DISCUSSION

Utilization and adulteration of goat milk in the study areas

Utilization of goat milk

According to sample respondent goat keepers, goat milk is primarily consumed by children followed by sick family members (Table 1). Several earlier studies conducted in different areas of the country also reported children to be the major consumers of goats' milk within the family (Animut *et al*., 2000; Merkel *et al*., 2001; Kedija *et al*., 2008). In addition, it is also provided for pregnant and nursing mothers, and elderly persons. In some areas, goat milk is preferred to cow's and ewe's milk to feed to children, as ingredient in certain hot drinks and believed to have some medicinal value (FARM-Africa, 1996). The consumption of milk and milk products vary geographically between the highlands and the lowlands and level of urbanization. In the lowlands, all segments of the population consume dairy products, while in the highlands major consumers include primarily children and some vulnerable groups of women (Ahmed *et al*., 2004).

The society in the study areas provide goat milk for their family as part of the normal diet/meal, reputed to have medicinal value, good to strengthen their children, cures fast bone fractures, and provides resistance to illnesses (Table 1). As reported by Kedija *et al.* (2008), goat milk producers in some parts of rural Ethiopia traditionally mix goat's milk with different herbs and apply on wounds as a curative measure. Though milk is produced in both study areas, the supply is much lower compared with the demand even for milk producer households. As observed during the survey, about 67% of the sample respondents in Woyina-Dega and 33.3% in Kolla reported to purchase cow's milk from the nearby local market through informal transaction for family consumption (data not presented).The study of SNV (2008) reported that 95% of the national milk was marketed through the informal channel in Ethiopia.

Concerning the quality of goat milk, the majority (about 64% in Woyina-Dega and 56% in Kolla) of the respondents reported that market milk is not usually of good quality mainly due to the use of unclean milk utensils (such as clay pot with no lid). As summarized in Table 2 , water shortage is critical in the study areas, which in turn could be accountable for the poor hygienic quality of goat milk. In addition to water scarcity, major sources of water used for cleaning purpose in most rural areas of Ethiopia include deep wells, rivers and ponds that are not recommended to use for cleaning purpose without further treatment (Yitaye, 2008). Another major factor affecting the quality of dairy products is related to inappropriate milking procedures and cleanliness of the milking utensils (Almaz *et al*., 2001; Sintayehu, 2008).

Table 1. Goat milk utilizers and reason of goat milk utilization within the family

Parameters	Agro-ecology Woyina dega (N = 45)	Kolla (N = 45)
Goat milk utilizers		
Mothers (Nursing mothers)	1(2.0%)	4(7.4%)
Children	44(88.0%)	40(74.1%)
Adults (aged people)	2(4.0%)	1(1.9%)
Sick	3(6.0%)	8(14.8%)
Pregnant mothers	-	1(1.9%)
Reasons for provision of goat milk as per respondent goat keepers		
To satisfy hunger	6(10.7%)	3(4.2%)
To strengthen our children	23(41.1%)	28(39.4%)
To cure bone fractures	1(1.8%)	-
For its medicinal value	20(23.3%)	39(43.2%)
To provide better resistance to illnesses	21(37.5%)	29(40.8%)

**N- number of respondents*

Table 2. Water shortage, reason for the shortage and source of drinking water in the area

Parameters	Agro-ecology Woyina-Dega (N = 45)	Kolla (N = 45)	Overall (N = 90)
Water shortage during dry season	28 (62.2)	39 (86.7)	67 (74.4)
Water shortage reason			
Run out of water from sources	25 (53.2)	37 (74.0)	62 (63.9)
Far distance of water points from homestead	3 (6.4)	1 (2.0)	4 (4.1)
Goats are list priority animals for watering	1 (2.1)	5 (10.0)	6 (6.20
Main sources of water			
Tap	32 (45.7)	6 (11.5)	38 (31.1)
River	23 (32.9)	14 (26.9)	37 (30.3)
Deep well	2 (2.9)	0	2 (1.6)
Pond	2 (2.9)	29 (55.8)	31 (25.4)
Rain	11 (15.7)	3 (5.8)	14 (11.5)

Adulteration of Goat Milk with Water

It was understood that goat keepers add water to goat milk. Reported reasons include to increase the quantity, soften goat's milk typical strong taste and odor, to decrease its density, and to increase its consumption/drinkability especially by children (Table 3). As stated by Donkin (2002), modifying goat's milk by diluting it with clean potable water may be needed to take account of the increased solute load compared to human milk. According to FARM-Africa (1996) as the demand for goat milk is high in a given household and the amount available is little, goat milk is diluted with some water to make sure that all the children in the household have access to it. There is one cultural belief related with drinking goat's milk where they believe that if children drink goat's milk without diluting, it may lead to deafness**.** Such practice of water addition to goat milk definitely alters the quality as well as the chemical composition of the milk.

Table 3. Adulteration of goat milk with water and reasons as per respondents

Parameters	Agro-ecology	
	Woyina-Dega (N=45)	**Kolla (N=45)**
Proportion of respondents adding water to goat milk	37(83.6%)	29(67.3%)
Proportion of respondents not adding water to goat milk	8 (16.4%)	16 (32.7%)
Reason for adding water		
To increase the quantity of milk	8 (16.4%)	12 (24.5 %)
To decrease its density	16 (32.7%)	14 (28.5%)
Traditional belief – consumption of goat milk without diluting with water makes children deaf	7 (14.3%)	5 (10.2%)
To change the odor (bad smell)	1 (2.1%)	-

Microbial quality and chemical composition of goat milk

Microbial quality

The consumption of goat milk in its natural state is a common practice in Woyina-Dega and Kolla agro-ecologies. Investigating the microbial properties of such milk is, therefore, essential from consumer health point of view. With regard to food hygiene and public health protection, evaluation of the microbiological status of raw goat milk is important as its consumption can represent a substantial health risk through causing food borne diseases to consumers.

The overall AMBC and CC observed in the current study were 9.7 and 4.89 log cfu/ml, respectively (Table 4). As observed from results , there is no significance variation in AMBC and coliform counts (P>0.05) between the samples taken from the Woyina-Dega and Kolla agro-ecologies. However, the values are much higher than the recommended values of $<10^5$ cfu/ml for AMBC and $<10^1$ cfu/ml for coliform count (Alehegne, 2004). Milk obtained from a healthy doe and handled following standard sanitary procedures should not have as much as the values observed in the present study. These high values imply that the hygienic handling conditions practiced in the study areas such as improper cleaning of the udder and milking containers before and after milking, improper cooling system and poor sanitation of the milker are substandard. An earlier report by Jayarao *et al*. (2004), indicated that the presence of high numbers of coliforms in milk shows that the milk has been contaminated with fecal materials, unclean udder and teats , inefficient cleaning of the milking containers, poor hygiene of the milking environment, contaminated water and animals with subclinical or clinical coliform mastitis can all lead to elevated coliform count in raw milk.

Table 4. Aerobic Mesophilic Bacterial Count (AMBC) and Coliform Count (CC) of goat milk samples

Agro-ecology	N	AMBC Log_{10} cfu/ml	CC log_{10} cfu/ml
Woyina- Dega	30	$9.56^a \pm 0.134$	$4.89^b \pm 0.171$
Kolla	30	$9.84^a \pm 0.131$	$4.89^b \pm 0.233$
Overall	60	9.70 ± 0.095	4.89 ± 0.144

N= number of samples taken; Aerobic Mesophilic Bacterial Count (AMBC), CC (Coliform count) :Mean with different superscripts within the same column are significantly (p<0.05) cfu= colony-forming units

Chemical composition

Goat milk like any other milk is a complex mixture with the major components being fat, protein, lactose and minerals, which are comparable with that of cow (Omo, 2003). Contents of the main milk constituents can vary considerably depending on the individual animal, breed, stage of lactation, age, and health status.

Herd management practices and environmental conditions also influence milk composition (O'Connor, 1995). Local goats had essentially the same milk composition in terms of total solids, fat, protein, lactose, ash and moisture content in both agro-ecologies considered (Figure 1).

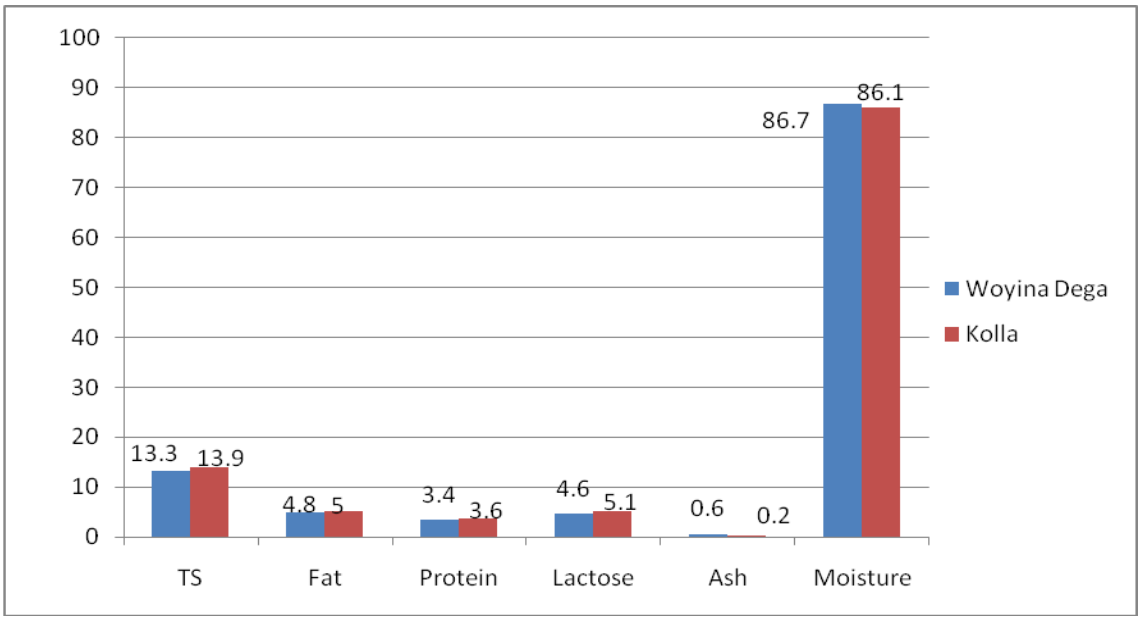

Figure 1. chemical compostion of goat milk in two agro-ecologies

The overall mean total solid, fat, protein, lactose, ash and moisture content in the current result was 13.57, 4.91, 3.48, 4.81, 0.40 and 86.42%, respectively (Figure 1). Haenlein (2002) reported the mean total solid, fat, protein and lactose contents of native Greek goat milk to be 13.28-14.55, 4.45-5.80, 3.46-3.69 and 4.39 - 5.02%, respectively. Eddle man (2008) also indicated that goat milk has 13.0, 4.1, 3.4, 4.7 and ash 0.77% of total solid, fat, protein, lactose and ash, respectively. Though these values are comparable with the values observed during the current study, gross chemical composition of goat milk can vary and different factors could be accountable. As indicated by Jenness (1980), for instance, goat milk composition showed marked variability due to breed, climate and breeding condition variations. The report of CBM (2009) also indicated that the composition of goat milk depends on season where in summer the yield of goat milk is high, while the fat and protein contents are low in the same season. Conversely, in the winter the yield of goat milk is low, and the fat and protein contents are higher.

CONCLUSION

Goat rearing is important in the sample Kebeles of East and West Badawacho districts. However, the hygienic handling conditions practiced in the study areas are sub-standard. This is mainly due to the use of unclean water mostly sourced from ponds and rivers for washing milking equipment. Moreover, adding unsanitized water to the milk and poor milk handling could have contributed to the increased bacterial load of goat milk samples in the study areas. The overall microbial loads are much higher than the recommended values for AMBC and for coliform count. Therefore, works need to be done to improve the quality of goat's milk. These can be achieved through different challenging but feasible means. Organizing training to both producers and development agents on different aspects of improved goat production is worth mentioning. Other practical strategies that help improve the quality and utilization of goat milk production include; implementing improved dairy goat breeding programs; proper collection, treatment, storage and utilization of natural water sources such as rain water; and improved post harvest utilization of goats' milk. In addition, improving the veterinary services provided at different levels is very critical.

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