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Handling, Processing and Composition of Cow Milk Under Two Traditional Farming Systems in Kebribeyah District of Fafan Zone, Somali Regional State, Ethiopia

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ABSTRACT

The aim of this study was to assess handling, processing & chemical composition of cow milk in Kebribeyah district. The study had a survey and laboratory works. For the survey study, two production systems namely pastoral and agro-pastoral were considered. From each production system, two kebeles were selected purposively based on accessibility and potential of cow milk production. One hundred twenty households were randomly selected from purposively selected kebeles. For the laboratory part, forty samples of cow milk were analysed for chemical composition. The overall average lactation length and daily milk off-take of cow in this study were 256 days and 2.06 litres, respectively. None of the respondents washed the udder of the cow and only 6.7% of the pastoralists and 20% agro-pastoralists wash their hands before milking. Milk handling equipment were mainly plastic materials. *Acacia ethaica, B. minimifolia, Blanites galabra* and *Solanum carense* were the most commonly used smoking plant species in the area. The majority of the respondents (85.8%) produced traditional butter (*Subag*) and few households (10%) produced sour milk (*Ciir*), while very few (4.2%) households produced traditional cheese (*Burcad*). However, milk processing in the area is limited to wet season; when there is abundance of fodder. The average values of total solids, fat, protein, lactose and ash were 13.19%, 4.67%, 3.45%, 5.18% and 0.72%, respectively. However, significance differences ($P<0.05$) were found between pastoral and ago-pastoral production systems in terms of total solids, fat, and protein. The chemical properties of milk samples obtained from pastoral and agro-pastoral areas were within the acceptable standard levels settled by different scholars. In general, milk producers should also be supported with strong extension service by way of introducing improved dairy technologies, improved milk handling and processing equipments. Furthermore, there is a need for further investigations on composition with various farming systems.

INTRODUCTION

Ethiopia possess the largest livestock population in Africa, with 70 million cattle, 42.9 million sheep, 52.5 million goats, 2.15 million horses, 10.80 million donkeys, 0.38 million mules, 8.1 million camels, and 57 million chickens (CSA, 2021). Livestock production in Ethiopia is mainly on smallholder farming system, with livestock having a multipurpose use (Tadesse *et al.*, 2020).

Dairy production is used as an enterprise and economically viable and greatly contributes to poverty reduction, food security, increased family nutrition and income and job opportunity creation (Kumar, 2014). It plays a vital role in economic development, especially in developing countries as both driving economic growth and profiting from it. It is a valuable device to increase income, employment, food and foreign exchange earnings as well as better nutrition as an engine of growth. The share of animal products in total food budget increases faster than that of cereals due to relatively high-income elasticity of demand for animal products (Dayanandan, 2011).

Milk is the natural product obtained from the secretion of the mammary gland of lactating mammals. It is a highly nutritious substance which contains macro and micronutrients of fats, proteins, carbohydrates, vitamins, minerals and active compounds having a role in health protection (Merwan *et al.*, 2018). Cow milk is the utmost used up in the world followed by that of goat, camel, and donkey(Cissé *et al.*, 2019). In Ethiopia, cows contribute around 95% of the total annual milk produced in the country (CSA, 2021).

Milk has a complex biochemical composition and high water activity. Due to its high nutritive value, raw milk serves a good medium for microbial growth that degrades the milk quality and shelf-life. The demand of consumers for safe and high quality milk has placed a significant responsibility on dairy producers, retailers and manufacturers producing and marketing safe milk and milk products (Mennane *et al.*, 2007). Adverse environmental condition is highly affecting the quality of milk and milk products. In areas where the climate is hot and humid, the raw milk gets easily fermented and spoiled during storage unless it is refrigerated or preserved. However, such storage facilities are not readily available in rural areas and cooling systems are not feasible due to lack of the required dairy infrastructure (Gemechu *et al.*, 2015).

Chemical composition of milk is variable and influenced by genetic factors like breed and environmental stress such as stage of lactation, changes in feeding, etc. Milk composition and production are the interaction of many elements within the cow and external environments

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(O'Connor, 1995) accepted that the dairymen can alter many of these factors to achieve milk production and increase profit. However, it is generally accepted that the dairymen can alter many of these factors to achieve milk production and increase profit.

According to CSA (2021) report, Somali region with 5.9 million cattle is one of the potential regional states in Ethiopia. Fafan Zone contributes 1.17million cattle. Among this cattle population, Kebribeyah district contributes 125,119 of cattle. The district has a high potential for dairy production due to high demand for milk and milk products. However, there is no study conducted in the area on milk handling, processing practices and milk quality that could be affordable to the resource poor. Thus, this study was carried out to evaluate milk handling practices, processing and chemical composition.

MATERIALS AND METHODS

Description of the Study Area

This research work was conducted in Kebribeyah distict of Fafan zone, somali regional state of Ethiopia from 2020 to 2021. Kebribeyah district is bordered on the south by the Degahbur Zone, on the southwest by the Fiq Zone, on the northwest by Gursum, on the north by Jigjiga and Awbere, on the northeast by Somalia, and on the east by Harshin districts. The district was named after Kebribeyah town, the administrative center of the district. The town is located 50 km and 680 km away from the Jigjiga and Addis Ababa, respectively. It has latitude and a longitude of 9°6'N 43°10'E with an average elevation of 1686 meters above sea level. The district is characterized by arid and semi-arid climate, warm climate and low relative humidity. The mean annual maximum and minimum temperatures of the district are 29OC and 14OC, respectively. The district receives bimodal rainfall, the long rainy season extending between July to September (long rainy season) and the short rainy season stretching from April to May; annual rainfall ranges between 700 mm to 900 mm. The district population is dominated by agro-pastoralists and pastoralists. Livestock production involves cattle, camels and small ruminants.

Study Design

The study was conducted in two parts; briefly, household survey and milk quality analysis. For the first part, a single-visit formal survey method was followed to gather the data focusing on assessing the milk handling and processing practices. The second part dealt with evaluating chemical composition of raw milk.

Sampling Technique and Sample Size

Kebribeyah district was selected purposively based on cattle population and potential of milk production. Secondly, study kebeles were stratified into two farming systems, namely pastoral and agro-pastoral. Two from pastoral and two agro-pastoral kebeles were selected for this study. Labashag and Qotoroble kebeles were selected and classified as agro-pastoral production system while Adadi and Garbile kebeles were selected as pastoral kebeles. Then, from each kebele, 30 households were selected randomly from those have lactating cow, which brings the total number of the households to 120.

Milk Sample Collection and Analysis

Raw cow milk samples were collected aseptically from morning pooled milk container from forty households (10 from each kebele) who were being surveyed, and approximately 100mL of milk was collected as per the procedure described by O'Connor (1995), in sterile containers and after thorough mixing. The samples were transported on ice box to Dairy Technology Laboratory in Haramaya University for analysis. The raw milk samples were analysed separately in duplicate using a rapid automatic milk analyser MilkoScan (MilkoScan FT1) to determine the percentage of fat, protein, lactose, solids-non-fat and ash. Total solids were calculated by summing all milk soilds. Determination of ash content was done according to the method of the AOAC (1990).

Data Collection

A rapid survey with animal production experts and veterinarians in the area and focused group discussions was made with key informants after designing check lists of issues to be covered. Semi-structured questionnaire was prepared in a way it can address the aim of the research. Questionnaires having open-ended and closed-ended were developed with main focus on dairy cattle production system, milk handling, processing techniques and types of dairy products that has to be manufactured and consumed in the area. In addition to this, field observation was made to enrich the collected data.

Data Analysis

Descriptive statistics was employed for data analysis using Statistical Procedures for Social Sciences (SPSS version 26.0). The data related chemical composition of milk was analysed using General Linear Model (GLM) procedure in SAS (2008); using the following model:

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

Where, Yij = observation, μ = overall mean, αi = production system (i=2; pastoral & agro-pastoral), eij = error

RESULTS AND DISCUSSION

Demographic Characteristics of the Households

Sex, age, and educational level of the respondents is summarized in Table 1. About 69.2% of the respondents were females and the rest 30.8% were males. The majority (65%) of the respondents were in the age category of 36 to 55 years. In regard to educational level, the majority (81.7%) of the respondents were illiterate. The increased level of illiteracy causes a disregard for hygienic dairy handling practices. The result indicates the need for educating farmers to get better opportunity to implement hygienic handling practices and efficient resource use. The role of education is obvious in affecting household

Table 1: Sex, age, and educational level of the households (%) in the study area

Descriptor	Pastoral (n=60)	Agro-pastoral (n=60)	Overall (n=120)	p
Sex				
Male	38.3	23.3	30.8	0.08
Female	61.7	76.7	69.2	
Age (years)				
20-35	18.3	20	19.2	
36-45	26.7	25	25.8	0.8
46-55	41.7	36.7	39.2	
> 55	13.3	18.3	15.8	
Educational level				
Illiterate	91.7	71.7	81.7	
Primary school	5	10	7.5	0.03
Secondary school	0	3.3	1.7	
Religious school	3.3	15	9.2	

n= number of respondents

income, technology adoption, demography, health and the whole socio-economic status of the family. Moreover, lack of education and training on hygienic milk production and postharvest handling practices expose raw milk for microbial contamination (Omore *et al*., 2005).

Milk Handling Practices

Milking and hygienic practices during milking

All of the interviewed households indicated that thy milk cows twice a day i.e. morning & evening. All of the respondents also do not wash the udder of the animal during milking. The result of this study also showed that 93.3% and 80% of the pastoralists and agro-pastoralists did not wash their hands during milking. This is a potential source for the contamination of milk with pathogenic microorganisms during milking. It also shows that there are no standard hygienic conditions followed by producers during milk production.

This might be related to low awareness and knowledge of the producers about sanitary milk production practices and requirements. Zelalem (2009) noted that the hygienic conditions are different according to the production system, adapted practices, level of awareness, and availability of resources.

Table 2: Hygienic milk production practices during milking in the study area

Variable	Pastoral	Agro-pastoral	Overall	p
Udder washing				
Udder washing before milking	-	-	-	
Not washing at all	100	100	100	
Hand washing before milking				
Yes	6.7	20	13.3	0.03
No	93.3	80	86.7	

Milking equipment, cleaning and smoking practices

The majority (76.7%) of the respondents regularly clean milk utensils. More than half (55.8%) of the sampled households used plastic materials, while 25% and 19.2% used clay pot and aluminum jars, respectively (Table 3). According to the survey, majority (75%) of the sampled households utilized unsanitary milk containers (made of plastic and clay pots) which facilitate spoilage of the products, while only 25% used hygienic and appropriate equipment for milk (stainless steel). According to information gathered through key informant interviews and focus group discussions, households in the area lacked sufficient access to proper milk-related equipment and also lacked the necessary expenditures. Lack of knowledge on clean milk production, use of unclean milking equipment coupled with lack of potable water for cleaning purpose contribute to the poor hygienic quality of dairy products in Ethiopia (Yilma and Faye, 2006). Since metal (stainless steel) milk containers are expensive, dependence on plastic containers is becoming more common here and there (Addisu et al., 2016).

The majority (85.8%) of the respondents practice smoking milk vessels and milk containers were generally fumigated with burned woods of selected trees. *Acacia ethaica* (Sogsog), *Blanites galabra* (Kadi), *Solanum Carense* (Kariir) and *Boscia minimifolia* (Maygaag) were mainly used plants for smoking milk utensils. Similarly, Seifu (2007) reported use of *Blanites galabra*, *Acacia ethaica*) and Olea Africana as smoking plants in Shinile and Jigjiga zones of Somali region.

Table 3: Milking equipment, cleaning and smoking practices

Variable	Pastoral	Agro-pastoral	Overall	p
Cleaning milk utensils regularly				
Yes	78.3	75	76.7	0.6
No	21.7	25	23.3	
Milking equipment				
Stainless steel	18.3	20	19.2	0.4
Plastic materials	51.7	60	55.8	
Clay pot	30	20	25	
Smoking milk containers				
Yes	83.3	88.3	85.8	0.4
No	16.7	11.7	14.2	
Purpose of smoking containers				
Give flavour & aroma	21.7	18.3	20	0.7
Increase shelf life	15	11.7	13.3	
Both	63.3	70	66.7	
Plants used for smoking				
Acacia ethaica (Sogsog)	41.7	26.7	34.2	0.3
Blanites galabra (Kadi)	16.7	23.3	20	
Solanum Carense (Kariir)	13.3	18.3	15.8	
Boscia minimifolia (Maygaag)	28.3	31.7	30	

Traditional Milk Processing Practices

The households in the study area practiced traditional milk processing practices to increase the shelf life and diversify the products. The majority of the respondents (85.8%) produced traditional butter (*Subag*) and few households (10%) produced sour milk (*Ciir*), while very few (4.2%) households produced traditional cheese (*Burcad*). The respondents in the study area mainly used traditional gourd (*Dhiil*) for milk processing. The information obtained from key informants interview and focus group discussion showed that milk processing is limited during wet season; when there is abundance of fodder and surplus milk. In general, the study indicates that milk processing in the area is limited, hence approaches for diversifying dairy products are essential in addition to dairy processing equipment and facilities.

Table 4: Preferred milk processed product in the study area

Preferred milk processed product	Pastoral	Agro-pastoral	Overall	p
Butter (*Subag*)	88.3	83.3	85.8	0.4
Sour milk (*Ciir*)	8.3	11.7	10	
Cheese (*Burcad*)	3.3	5	4.2	

Milk Composition

Chemical constituents such as fat, protein, total solids, solids non-fat, lactose, and ash of cow milk in the study area are presented in Table 5. The analysis of variance showed significant difference between pastoral and agro-pastoral area for fat, protein, total solids, and solids-non-fat, although lactose and ash indicated no such difference. Fat is the most valuable constituent of milk. Milk having a fair amount of fat is more valuable as food than milk, which is poor in fat content (Kearsan, 2005). The mean fat content in the study area was 4.67% which is lower compared with the average fat content of milk obtained in Walmera District with 5.46% as reported by Ketema et al. (2018) and that of Yabelo with 6.01% fat as reported by Gurmessa et al. (2015). The Food and Drug Administration (FDA) requires not less than 3.25% milk fat for fluid whole milk similarly to the U.S. Public Health Service (USPHS) Milk Ordinance and Code also recommended a minimum of 3.25% butterfat in farm milk (Raff, 2011). Thus, the fat content obtained in the current study fulfills the criteria set by both FDA and USPHS.

The protein level of the raw milk used in this investigation was 3.45%, which is greater than the 3.11% and 3.07 values reported for Jimma and Walmera, respectively, by Duguma (2022) and Ketema et al. (2018). According to Food and Drug Administration (FDA), a minimum protein content of whole milk is 2.73% (Raff, 2011). The value of protein content obtained in the current study fulfills the criteria developed by FDA for the consumers and the minimum of 3.2% recommended by the ESA (2009).

The overall average of lactose content in this study

showed 5.18%. According to the European Union Quality standards for unprocessed whole milk, the lactose content should not be less than 4.2% (Tamime, 2009).

The solids-non-fat (SNF) content of raw milk in the present study (8.52%) is higher than the minimum standard (8.25%) for SNF content of whole cow milk (FDA, 2010). The minimum SNF percent set by European Quality Standards for unprocessed whole milk is 8.5% (Tamime, 2009).

The total solids (TS) content of milk found in the present study is higher than the minimum standards for TS content of cow milk established by the European Union, which should be not <12.5% (FAO, 2000). According to the standards set by the ESA, the minimum average percent total solids content of unprocessed whole cow milk should not be less than 12.8 percent.

Generally, milk composition can be very variable depending on many factors such as: breed and the health condition of the animals, lactation period, feeding management (type & quality), season, method of milking (manual or automatic), age and the number of lactation, individual cows and environmental factors (Pandey & Voskuil, 2011).

Table 4: Milk composition in the study area

Variable	Pastoral (n=20)	Agro-pastoral (n=20)	Overall (N=40)
Fat (%)	5.12±0.001a	4.21±0.002b	4.67±0.001
Protein (%)	3.28±0.02b	3.62±0.01a	3.45±0.01
Lactose (%)	5.12±0.001	5.24±0.001	5.18±0.001
Ash	0.72±0.04	0.73±0.06	0.72±0.05
SNF (%)	8.28±0.02b	8.76±0.01a	8.52±0.01
TS (%)	13.40±0.03a	12.97±0.02b	13.19±0.02

Means followed by different superscript letters within a row are significantly different at P<0.05, TS= Total Solids, SNF= solids non-fat, n= number of samples taken, SE= standard error

CONCLUSION

In the current study, milk handling, processing of milk products, and composition of milk was assessed. The findings demonstrated that milk is handled improperly without adhering to the required standard and hygienic practices for dairy products. Milk processing in the area is limited, hence approaches for diversifying dairy products are essential in addition to processing equipment and facilities. The study revealed that fat, lactose, protein, solids non-fat, and ash contents of raw milk samples fulfilled standards set by ESA and FDA. Therefore, there is a need to raise producers' awareness on proper handling procedures of milk and milk products to reduce post-harvest loss and their potential spread and risks to human health and milk producers should be supported with strong extension service by way of introducing improved dairy technologies, improved milk handling and processing equipments. Furthermore, there is a need for further investigations on composition with various farming systems.

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