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RESEARCH ARTICLE

Assessment of Dairy Production System, Handling, Processing and Utilization Practices in South Ari and Malle District of South Omo Zone, Ethiopia

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Abstract: Milk is produced, processed and utilized in different parts of Ethiopia and the majority in rural areas is processed at the household level into milk products using traditional technologies and marketed through informal channels. This study was initiated to assess and describe the traditional knowledge of milk production, handling, processing and utilization practices in South Ari and Malle district. Three dairy potential Kebeles from each district were selected via a purposive sampling procedure. Then, 196 households were selected through a systematic random sampling procedure. Data were collected using a semi-structure questionnaire and analyzed by SPSS (Version 23) software. There was a significant difference ($P < 0.05$) in livestock composition across the study districts. About 75% in South Ari and 72.9% in Malle have their own grazing land. Feed shortage (73%) and improved breed access (26%) in South Ari, and feed shortage (52.1%), drought (44.8%) in Malle were among the main constraints affecting dairying. About 65% of South Ari used plastic buckets for milking and clay pots for fermentation and churning. In Malle 88.5% used calabash containers for milking, accumulation and churning. The average days of raw milk fermentation before churning in South Ari and Malle were 4.2 ± 0.1 and 2.9 ± 0.0 days. The average butter-making time was 63.4 ± 1.8 minutes in both districts. The amount of milk fermented and butter produced from this fermented milk is significantly different ($P < 0.05$) across districts. Nearly 95% of South Ari milk is traditionally processed into yogurt, butter, buttermilk and cheese; and used for home consumption and marketing. However, in Malle 72.9% of yogurt and buttermilk processing is used for home consumption; and 26% of butter processing is only used for marketing. It is possibly concluded that dairy production was commonly practiced and it was a good source of income in both districts. Therefore, it is vigorous to support the dairy linkage with extension services by enhancing the input provision.

Keywords: Milk production; Handling; Processing; South Omo; Utilization practices

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1. Introduction

Agriculture is the lifeblood and the main economic backbone of Ethiopia and livestock is an essential share of the agricultural sector [1]. Ethiopia has the huge livestock population in Africa and the estimated livestock population in Ethiopia were 70 million head of cattle, 42.9 million sheep, 52.5 million goats, 2.15 million horses, 10.80 million donkeys, 0.38 million mules and about 8.1 million camels [2]. Livestock husbandry in Ethiopia is an essential and integral sector of agriculture and rural livelihood contributing about 17%-25.3% of the national gross domestic product (GDP) and 39%-49% of agricultural GDP and over 50% of household income [3], 12%-15% of the export earnings and 60%-70% provide for employment [4]. The livestock in Ethiopia is amended to different agroecologies of the highlands (mixed livestock farming system) to the lowlands (extensive nomadic farming system) [5]. Despite the current immense potential for the dairy sector due to vast livestock resources and promising environmental conditions, the potential of the dairy industry in Ethiopia has not been boosted [6]. Now a day, the dairy sector has persisted constrained by multi-faceted production and reproduction-related constraints among which feed sources and feeding systems, poor genetic potential, poor health follow-up, poor access to services and inputs, low adoption and limited access to improved technologies, marketing and other factors are listed [7]. Currently, Ethiopia has a deficiency of dairy products and due to this imports these products from other countries [8]. Furthermore, to increase dairy production from each animal, it is better to increase the productivity of these animals in terms of improved management practice because the current milk production per cow is relatively low even with fairly some potential for improvement. This low production potential of milk needs to further improve the productivity of dairy cattle through improving animal health, particularly udder and reproductive health [9].

In Ethiopia, the huge majority of milk produced and processed in rural areas is at the home level into milk products such as yogurt, Butter, Ghee, and Cheese using old-style technologies and marketed through informal channels [10]. Diversified fermented milk products are made and consumed in many parts of the country. As it is known that milk is exceedingly perishable by nature, consequently it requires emphasizing care starting from production up to consumption particularly in handling during milking, collection and succeeding storage and transportation. In the fact that, milk is fairly perishable and a high percentage of it is consumed in a relatively natural state due to this, milk and its products handling to preserve its natural characteristics are very vital [11]. The less perishability of milk products, the longer the smallholders can preserve it to gain a good price and the surplus—made during the milk production season can be also stored for consumption during the season of the products in short supply. In different parts of the country the milk producers add different spices to butter as a preservative way to enhance its natural flavor for cooking [11].

Storage stability problems of dairy products are intensified by ambient temperatures and distances that producers have to travel to bring the products to market places making it necessary for smallholders to seek products with a better shelf life. The first step that the product handlers can take to ensure a high-quality product is to make assured that the production and industrialized process are should be hygienic [11]. The southern nation is the highest and second region in milk production potential next to Oromia region in Ethiopia [12]. Though the kinds of materials utilized for milking, storage and processing differ from place to place, about 50% of milk producers used traditional clay pots for churning milk, about 25% used plastic vessels, 6.3% aluminum cans and 18.3% used calabash in the southern part of Ethiopia [13]. Additionally, a clay pot or calabash is used as a churner to make butter in the Gurage zone [14] and also the clay pot is used for churning milk (100%) in West Shewa Zone, Oromia Region [15]. Therefore, the aim of this study was to assess and describe the traditional knowledge of milk production, handling, processing and utilization practices in South Ari and Malle district.

2. Materials and Methods

2.1 Study Areas

The study was conducted in milk-producing potential areas in and around South Ari and Malle district (Table 1).

Table 1. Study areas.

Parameters	Districts	
	South Ari	Malle
Areas	1520 km^2	1432 km^2
Altitude	850-2800 m above sea level	600-1500 m above sea level
Mean annual rainfall	100-1600 mm	800-1200 mm
Temperature	15 and 35°C	18-35°C

Sources: Demerew, G. [5].

2.2 Sampling Procedure and Data Collection

A rapid pre-study survey was conducted at the zone level with the help of Agricultural Development Offices

to identify milk producers who reared dairy cattle and milk production potential areas in both district's agro-ecological zones; for this current study South Ari and Malle district were purposively selected depend on the potential of milk production and from the total Kebeles in the two districts in the first phase potential sites (Kebeles) in milk production was purposely selected with the assistance of the office of agriculture information. In the second phase, from the potential Kebeles six Kebeles were selected randomly each three Kebeles from a district. In the third phase, the numbers of sampled households from each sampled site were determined from the lists of these households by using proportional to the size. Hence, the relative homogeneity of households based on their socioeconomic features and living style sample was drawn through a simple random sampling technique from each selected Kebele.

Accordingly, a total of 196 households (100 households from South Ari and 96 households from Malle) representing the two districts and who had at least one dairy cow and were interested to participate in the study were selected through a systematic random sampling procedure and individually interviewed using a semi-structured questionnaire. The questionnaire was designed based on how to get information related to milk production and its utilization which includes milk product types, methods of handling, processing and marketing. Furthermore, to validate the survey information a semi-structured questionnaire was prepared and information on their status was collected from key informants or producers who were found within the two districts. Primary and secondary data were used for the analysis. Different age and gender groups such as elders, youth and women were involved in the study.

2.3 Sample Size Determination

The basic factors to be considered to determine the appropriate sample size are the level of precision required by users, the confidence level desired and the degree of variability. It is determined by using a simplified formula provided by Kothari [16].

$$n = \frac{z^2 pqN}{e^2(N-1)+z^2 pq}$$

where, n is the sample size for a finite population; n is the size of the population which was the number of households in the districts; p: population reliability (or frequency estimated for a sample of size n); p was 0.5 which was taken for all developing countries population and p + q= 1. e: margin of error considered was 7%. Zα/2: normal reduced variable at 0.05 level of significance and z 1.96. The sampling unit in this study was households and the sampling frame was all the six Kebeles household lists that were available in the Kebeles. Therefore, based on the above formula the number of households to be sampled was determined.

2.4 Statistical Analysis

The data collected were coded and analyzed qualitatively and quantitatively using SPSS version 23.0 (IBM, USA) software for all the statistical analyses to compute descriptive statistics for the variables. Descriptive statistics, like means, percentages and standard error of the means were used to present the results. The Chi-square (χ^2) test was used to compare proportions of categorical variables among the districts. A t-test was used to compare means. The differences were considered significant at $p < 0.05$.

3. Results and Discussion

3.1 Livestock Composition

The study indicated that there was a statistical difference ($P < 0.05$) in livestock composition across study districts (Table 2). The numbers of goats, cattle, sheep and chickens were higher in ($P < 0.05$) the Malle district. There was no significant difference in the numbers of cross-breed cattle reared between the two studied districts. The current results for the number of goats and sheep were higher than Ayeneshet [17] who reported 6.66 and 5.59 goats and sheep, respectively in North Gondar Zone. The cattle holdings in the Malle district are higher than those reported by Girma [18]. This indicates that following goat, cattle holding per household are the second highest proportion in the Malle district. The high numbers of cattle followed by goats, particularly in the lowlands may be due to the local culture and cattle are considered sources of wealth and social pride, often given off as dowry; these show cattle play various roles in the livelihood of their keepers [5].

Table 2. Livestock species (mean ± SE).

Livestock species	Districts		
	South Ari	Malle	Overall
Cattle (local)	5.8 ± 0.3^b	12.2 ± 0.9^a	9.0 ± 0.5
Cattle (cross)	3.6 ± 0.3	2.5 ± 0.3	3.4 ± 0.2
Goats	1.7 ± 0.4^b	13.6 ± 1.7^a	11.2 ± 1.4
Sheep	3.7 ± 0.3^b	5.5 ± 0.9^a	4.4 ± 0.4
Chicken (local)	3.7 ± 0.3^b	5.5 ± 0.9^a	4.4 ± 0.4
Chicken (cross)	6.5 ± 0.5	6.6 ± 0.6	6.5 ± 0.3

n = number of respondents; SE = standard error; a;b = values with different superscripts in a row differ significantly $P < 0.05$.

3.2 Feed Source and Feeding Practices

Feed resources and feeding practices in the studied areas are presented in Table 3. The accessibility of feed resources in the study districts depends on the seasons. As respondents revealed, crop residues and natural pasture are the major sources of feed in the study areas with 55% and 53.1% for South Ari and Malle district, respectively. However, most of the research studies reported that natural pastures are dominant as a source of animal feed [19-21]. It has been also reported that the pasture quality has been declining over time. This can be ascribed to bush encroachments, overgrazing and other many anthropogenic factors. The majority in South Ari (75%) and Malle (72.9%) districts have grazing land for their livestock. This result was similar to the report of CSA [2] which reported grazing is the major type of feed (54.54%) followed by crop residue which is 31.13%. Nearest to the current result, in the central highlands of Ethiopia, the dominant sources of dairy cattle feed resources were crop residues, hay, communal pasture, private pasture, concentrates and improved forage [22,23]. About 61% of South Ari district private grazing holders and about 39.6% of Malle district communal grazing landholders were observed as the main sources of green fodder. The current result is also comparable with the result of Ayeneshet [17] in the Alefa district North Gondar Zone. Free grazing is reported to predominate in the Malle district (63.5%). Overstocking livestock in one place may excessively lead to overgrazing and there may be fights among the bulls, particularly during the mating (breeding) season. However, keeping cattle together has numerous merits as it requires less labor, it provides safety to the cows and their calves. Demerew et al. [5] reported that feeding cattle through rotational grazing is better than continuous grazing to improve natural grazing pastures in terms of quantity and quality. On the other hand, the zero-grazing feeding technique will also increase productivity compared to rotational grazing [17].

3.3 Major Problems Related to Dairy Cattle Production

3.3.1 Seasonal Feed Shortage and Supplementary Practice

Seasonal feed shortage is a common phenomenon in South Ari (97%) and Malle (94.8%) districts, respectively Table 4. The main season of feed shortage in South Ari (82%) and Malle (96.9%) districts was during prolonged seasonal fluctuation. During the short rainy season in both districts frequent feed shortages are common particularly in Malle the duration of the rainy season shortens and the drought is persistent. The common seasons of feed shortage in South Ari district were starting from the beginning of December to the end of February. In Malle district feed shortage starts from the middle of December to the end of April. The majority of the respondent in South Ari (92%) district practiced supply of supplementary feed to their dairy cow and while in Malle district only 33.33% were having experience giving supplementary feed. The rest 66.7% of respondents in this area have not practiced

Table 3. Feed resources and feeding practices (%).

Activities	Districts			
	South Ari	Malle	Overall	X^2
Have you grazing land for your animals?				0.44
Yes	75	72.9	74	
No	25	27.1	26	
What type of grazing land do you use?				0.04*
Communal	27	39.6	33.2	
Private	61	37.5	49.5	
What is feed sources for your animals?				0.09
Natural pasture	33	39.6	36.3	
Crop Residues	12	73	48.5	
Both (natural pasture & crop residues)	55	53.1	81.5	
Grazing/feeding methods animals?				0.00**
Stall feeding	3	0	1.5	
Zero grazing (cut and carry system)	4	0	2	
Open grazing (Herding)	13	63.5	38.2	
Tethering	80	36.5	58.2	

The values observed between the two Districts were significantly different at * ($X^2 < 0.05$);** ($X^2 < 0.01$); X^2 = Pearson Chi-square.

any supplementation. The reason for this is that the area is infected by prolonged drought and most of the time the animal used free grazing due to a shortage of fodder. In South Ari district 61.9% of forage that is frequently used as subsidized feeds was a mixture of Arkinti and Girawa (Figure 2a), white banana leaf or Gumiza (local name) (Figure 1b), Arkinti (local name) (Figure 1c), Girawa (Figure 1d), coffee leaf and crop residues. Particularly, the white banana variety is better in terms of resistance to drought, so it is fodder for cattle. The remaining supplementary feeds were improved forage (21.6%), gruel (*muk*) with salt (15.4%) and Atela (1.1%) whereas in Malle district 47.5% of respondents supplemented their dairy cow banana leaf (white) or Gumiza (local name), crop by product and coffee leaf (in some instance). In Malle Atela (37.5%), improved forage (12.5%) and Gruel (*muk*) with salt (2.5%) were used as supplementary feeds for the dairy cow during the dry season.

According to respondents, *Arkinti* (grass type) and *girawa* (leaf) by mixing together and boiled or mixed with boiling/steaming water and salt are added to it to increase milk yield when given to dairy cattle. The reason why it is boiled in boiling water is to reduce the bitterness of the milk from *girawa*. The respondents assumed that, when the animals eat *girawa* leaves it makes their blood bitter so that the flies and insects do not land on them and protected themselves. Because girawa has a bitter effect on milk, it is given to dairy cattle in small amounts or by mixing with *Arkinti* (grass type).

3.3.2 Constraints Related to Dairy Cattle Production

According to Sintayehu et al. [24] constraints and problems related to dairy production differ from one production system to another and from location to location. The current findings revealed that grazing land/feed shortage (73%) and limited access to improved breed (26%) are the major constraints limiting dairy cattle production in South Ari whereas feeding/grazing land shortage (52.1%) and prolonged drought and seasonal fluctuation (44.8%) are the main factors contributing for low production in dairying Table 4. A parallel result was noticed by Tsedey and Bereket [13] who reported that feed shortage (71%), low milk yield (69%) and unavailability of improved breed (68%) are listed as the main dairy production constraint in Dilla and Hawassa districts of Southern Ethiopia. The study of Jiregna et al. [25] reported that feed shortage in addition to diseases and poor genetic makeup of indigenous animals are also the main cause for lower production in Western Oromia. Similarly, Minale and Yilkal [26] in Chencha and Kucha Districts stated that feed shortage for dairy cattle was the central problem.

3.4 Type of Milk Storage and Processing Materials

The respondents across the two districts used different milking equipment for storage, milking and churning (Table 5). Among the interviewed respondents 65% and 88.5% used clay pot (Figure 2a) and calabash (Figure 2b) containers for milk storage/fermentation before processing in South Ari and Malle district, respectively. A comparable result to the current study by Shewangizaw and Addisu [27] was reported who used clay pots and a plastic bucket for milk storage and fermentation in Wolayita Sodo. Another report by Minale and Yilkal [26] showed the majority of about 92.5% and 97% of the milk producers in Chencha and Kucha districts used clay pots for milk storage, respectively. This result disagrees with different findings in the country [28,29,6] they reported that about 80%-100% were mostly used plastic containers. This result was also in contrast with Befekadu et al. [30] who reported all of the respondents reported to used equipment made from animal skin for milking in Borena zone. The finding by Pandey and Voskuil [31] reported the use of plastic vessels can be a potential source for milk contamination because it is difficult to remove all residual milk from such milk storages due to its soft nature, thus increasing the microbial load of milk.

The majority of respondents in South Ari district used clay pots (82%) and plastic baths (16%) for churning/processing milk. This finding was parallel to Tsedey and

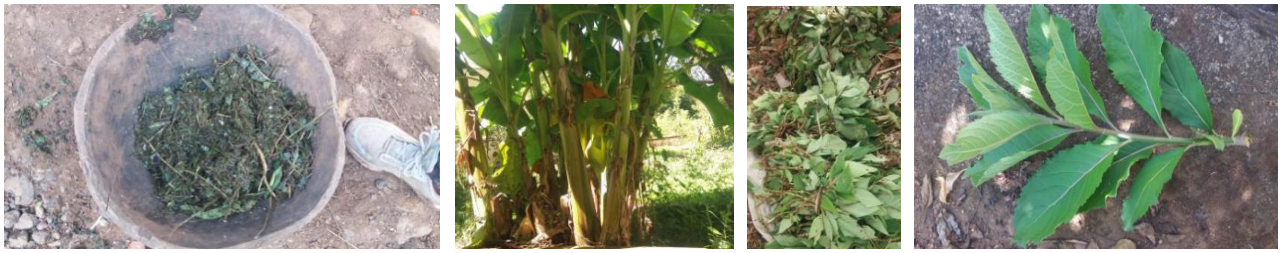

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Figure 1. Mixture of Arkinti and Girawa (a), Arkinti (c), Banan leaf (*Gumiza*) (b), Girawa leaf (d).

Table 4. Major problems related to dairy cattle production (%).

Activities	Districts			
	South Ari	Malle	Overall	X^2
Is there seasonal feed shortage?				0.33
Yes	97	94.8	95.9	
No	3	5.2	4.1	
Season of feed shortage				0.01**
Dry season	82	96.9	89.3	
Rainy season	18	3.1	10.7	
Do you supply supplementary feed to your cows?				0.00**
Yes	92	33.3	63.3	
No	8	66.7	36.7	
What are the feeds you supplemented?				0.00**
White banana leaf & Coffee leaf, Crop by product, Arkinti and Girawa	61.9	47.5	54.7	
Gruel (muk) with salt	15.4	2.5	8.9	
Improved forage	21.6	12.5	17.0	
Atela	1.1	37.5	19.3	
What are the major problems related to milk production?				
Feed or grazing land shortage	73	52.1	62.8	
Prolong drought and seasonal Fluctuation	1	44.8	22.4	
Diseases	0	3.1	1.5	
Access to improved breed	26	0	13.3	

The value observed between the two Districts significantly different at* ($X^2 < 0.05$);** ($X^2 < 0.01$); X^2 = Pearson Chi-square.

Bereket [13] who reported that about 50% of dairy producers used clay pots for churning and 25% plastic vessels in southern Ethiopia. The other reports showed that clay pot or calabash is used as a milk churner to make butter in the Gurage zone [14]. In South Ari, the plastic pitcher was used for milking and the plastic bucket was used for storage and transportation of milk sales. In the Malle district almost all respondents (100%) used calabash for milk churning/processing and clay and plastic containers are not commonly used this result is comparable with Sisay [32]. A comparable report was noticed by Onyango et al. [33] who reported the dried calabash, used as fermentation gourd. This result goes against the findings of FAO [15] who reported that the clay pot was used for milk churning and fermented milk (100%) in West Shewa Zone, Oromia Region. The present result was also consistent with the reports of Tigist [34] she observed Jerrycan, Calabash (Qill) and Mazzican were the materials used for milking and milk handling. A significant number (95%) of the respondents in South Ari district processed different milk products and used them for home consumption and marketing (yogurt, butter, buttermilk, cheese, and whey). Similar findings reported by Abraha [35] find that in the Southern Highlands of Tigray raya, 93.6% fresh milk, yogurt, buttermilk, butter, whey and cheese were among the common dairy products. Whereas in the Malle district, 72.9% of respondents processed only yogurt, butter, and buttermilk and the remaining 26% processed only butter for marketing. In Malle culture, dairy products such as butter, buttermilk, and yogurt (rarely) are used for home consumption while, cheese, whey and fresh milk are not commonly used or consumed at home; the study was able to notice that no dairy product is sold in the market except butter in Malle due to cultural restriction. According to the Malle community perception selling raw milk and cheese is considered as shame and they believe that selling these products reduces fertility, brings drought and is a manifestation of poverty.

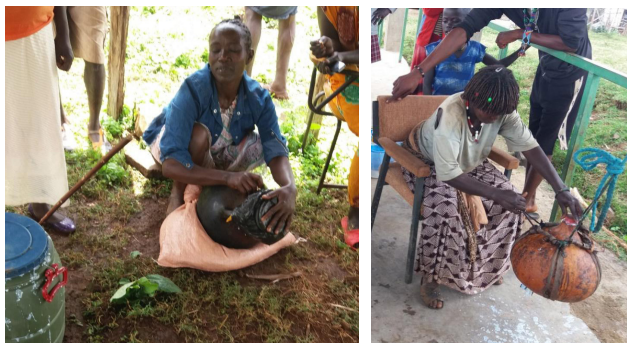

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Figure 2. The two major churning materials clay pot (a) and calabash (b).

Milk processing reason different from district to district even from place to place (Table 4). In South Ari 79% of respondents practice milk processing reason to increase household income via sales of processed products, 10% of respondents processed milk to have a variety of products, 9% of respondents assume that processed milk gives better income than fresh milk sales, the rest 2% processed milk for home consumption. The milk processing reason for this finding is comparable with the result of Befekadu et al. [30] that 72.73% of respondents in Borena zone processed the milk to diversify the products and for income generation. The result is also similar to Ayantu [36] who reported that milk is processed to increase the household's income, to diversify the product type for home consumption and to increase the shelf-life of the dairy products in Delbo water shed Wolayta zone. In Malle district, 62.5%, 28.1% and 9.4% of respondents' milk processing reason to have a variety of products, to increase household income via sales of processed products and processed milk give better income than fresh milk sales, respectively. This result agreed with Abraha [35] who reported that reason for processing milk is to diversify the products. Unless the milk producers could not produce a diversity of milk products, they could not acquire the expected value-added milk products.

3.5 Milk Processing and Utilization Practices

The system of milk production, milk processing and utilization varies according to the tribes and culture of the region. This makes the indigenous knowledge of milk production, milk processing and utilization practice peculiar to the specific area [37,30]. Cows are the foremost source of milk and which is the focus for processing many products in Ethiopia [38]. In the study districts, milk production and processing are carried out most often in the family households, and all operations in milk processing are done manually. Processing milk into varying products is an important measurement for the preservation of the product as a source of income and nutrients for consumption. Abebe et al. [38] stated that, milk is traditionally preserved into different products like butter, ghee and cheese. Meanwhile, preserved milk and its products are more stable than raw milk due to they are more acidic and comprise moisture. Befekadu et al. [30] indicated that milk that is naturally fermented is the base for processing the milk into more shelf-stable and, consumer preferences for fermented dairy products. According to Ethiopian culture, the common milk products that are produced in these study districts are raw whole milk, yogurt (*Ergo*), butter (*Kibe*), buttermilk (*Arera*), cheese (*Ayib*) and whey (*Aguat*). Traditional fermented milk products observed in this study were similar to Tsedey, A.[13] , Befekadu, T.[30], Kefyalew, G.[39]. Milk processing and utilization of these products varied in different parts of the country; from one area to another area and from household to household based on experience,

Table 5. Type of milking container, processing and storage materials in the study districts (%).

Activities	Districts			
	South Ari	Malle	Overall	X^2
What are milk storage materials before processing?				0.00**
Clay pot	65	7.3	36.7	
Metallic containers	30	0	15.3	
Plastic materials or improved churner	5	4.2	4.6	
Calabash	0	88.5	43.4	
Which milk product you processed?				0.00**
Yogurt	2	0	1	
Cheese	1	0	0.5	
Butter	2	26	14	
Yogurt, butter, butter milk	0	72.9	36.45	
Yogurt, butter, butter milk, cheese, whey	95	1	48.05	
What is your reason to process milk?				0.00**
To increase household income via sales of processed product	79	28.1	53.55	
Preference for home consumption	2	0	1	
Processed milk gives better income than fresh milk sales	9	9.4	9.2	
To have variety of product	10	62.5	36.25	
What kind of milk churning materials you used?				0.00**
Clay pot	82	0	41.8	
Calabash	2	100	50	
Plastic bath	16	0	8.2	

The value observed between the two Districts significantly different at * ($X^2 < 0.05$); ** ($X^2 < 0.01$); X^2 = Pearson Chi-square.

purpose, cultural reason and preference. Milk processing is typically deliberated to eliminate water from milk and/or minimize the moisture content of the products [38].

Raw milk (whole milk): This is milk that is milked or collected directly from the cow before being coagulated. In the study areas, especially in South Ari district raw milk was used as a source of income by selling it to city dwellers of milk suppliers. Others earn income by renting milk to their neighbors. In South Ari, raw milk is used as a supplement for children and orphaned pets (calf, kid and lamb). Raw milk is collected and comes from early morning before 8 a.m. or early evening after 6 p.m.

Yogurt (Ergo): The milk that is milked from the cow turns thick (naturally fermented) after a period of hours and days through the bacterial process (Figure 3). According to Desalegn [40] yogurt is the most common traditionally prepared fermented milk product in Ethiopia and yogurt is prepared through the natural fermentation of milk under the ambient temperature without the addition of appetizer cultures using traditional vessels under non-hygienic. Yogurt is nutritious, and palatable and it comprises all the milk components in a concentrated form. In the study areas, when the farmer is tired after work it gives great strength and it can be also used as a stable food for injured persons and children. In many Ethiopian parts, culturally yogurt is an important part of the traditional diet and is considered a big invitation when a distinguished or special guest received it at a home. It is further processed into more stable fermented milk products. According to respondents, preparing yogurt for home consumption can take two to three consecutive days, but it should be kept for three to six consecutive days to prepare other milk products like cheese and butter. The present result was equivalent to the result of Befekadu et al. [30] who reported 96% of the respondents described that the yogurt fermentation time for immediate usage is three days and the rest for long-term preparation takes six days. There is no sure length for the fermentation it is the visual appreciation of the gel that determined the finish of the processing [41]. The variation of fermentation time to prepare yogurt depends on the local environmental condition, on its purpose whether it is for home consumption or for the production of other products and hygiene of milking or storage equipment. In warmer climates, milk will curdle faster and in colder climates, it may take longer time to be curdled. If it is used for home consumption it needs a short day but, if it is to get other products it will be kept for a day. On the other hand, if milk storage is regularly cleaned and smoked it helps the milk to ferment quickly. To increase the taste of the yogurt and to improve its palatability the practice of adding local leaves called Tena Adam has been seen in many study areas.

Butter (*Kibe*): This is the result of the churning of fermented milk after days of raw milk accumulation. The fresh milk that is milked every day is added to the previously curdle milk until the required amount is accumulated. Butter can be extracted by hand pushing or rotating the churn on its base from 30 to 64 minutes. As respondents stated, the milk churning time to make butter would be determined by different factors such as the amount of milk, type and size of churner, cleanliness of churner, breed of cow and temperature of the local environment. The churning equipment used to churn the curd to make butter varies from place to place. After churning is completed, the butter grains are collected together by hand finally they wash the butter with cold water. The reason why it is washed with water is so that the butter become hardens and thickens. The other reason for adding water to the butter is if want it to last for a long time, particularly during fasting. This result was consistent with the reports of Befekadu et al. [30]. Apart from being a source of income and its nutritional value, butter has many functions in the

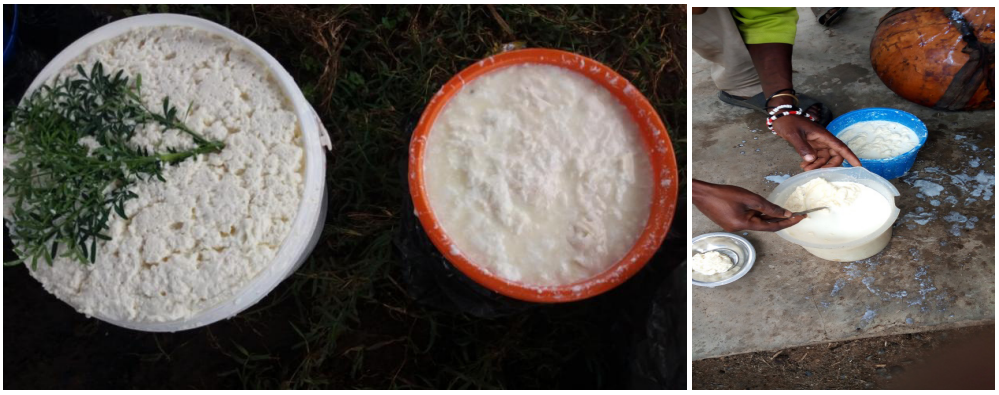

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Figure 3. Locally fermented Yogurt ready for agitation in South Ari and Malle district.

rural community. Among its benefits, it is used for cooking food in the form of Ghee (adding it to the stew), hair lubrication/cosmetics (hair cream) and remedy for headaches. Ghee is a very popular dairy product for making traditional chicken stew (*Ethiopian doro wot*) in Ethiopia, particularly during New Year and other festivals. Ghee is the butter-fat prepared chiefly from butter. As observed in the study areas, before processing butter different spices are added to improve its flavor and to add market or consumer attractive appearance of yellowish color.

Buttermilk (*Arera*): This is made after the butter is removed or separated from churned milk. It is a slightly thick milk product that remains after butter making. It is used in different forms for home consumption either directly or processed in to other cooked products (cheese and whey). Most of its characteristics and tasty are alike to those of ergo. According to Abebe et al. [38], Arera contains 91.5% moisture, 3.1% protein, 1.4% fat, 3.4% carbohydrate, and 0.6% ash. In both districts, it was possible to see that it is the most preferred milk-type product in both districts. It is often used as the main food in the home with a large family and it is often eaten with Fosesi (locally favorite food). On the other hand, in South Ari district cheese is sold, instead of using it as it is they convert it into cheese and use the cheese for market and domestic consumption. Zelalem and Inger [42] stated that buttermilk is directly consumed within the family or is changed to cheese (*Ayib*).

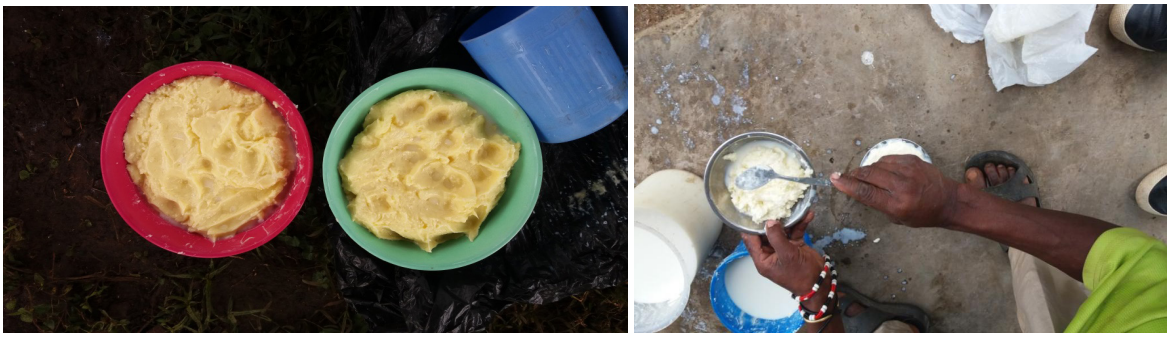
Cheese (*Ayib*): This is prepared by boiling or heating the remaining buttermilk after the butter is separated. The buttermilk is cooked or heated on a clay pot and kept for a few minutes, in order for the quality of the cheese to be good the heating fire should be moderate and not too much. For the making of this traditional Ethiopian cheese (*Ayib*), buttermilk is heated by a clay pot on a low fire to about 50 °C [43]. As stated by FAO [44], an average of 8 liters of *Arera* are required to yield one kilogram of Ayib and which having on an average of 20.42% total solid, 2.25% fat and 1.23% ash and an average moisture percentage being 79.58%. In South Ari, cheese is highly sought by consumers during the festivity season, so it is sold and used as an income source for the family just like butter. According to the culture of Malle community selling cheese is considered shameful, so the community does not have a culture of selling or buying cheese this cheese is not prepared by the community nor is it sold to the market. Some respondents have experience in adding spices to give the cheese a desirable aroma and extend its shelf life. This is applied after the cheese was drained sufficiently. The spices mainly used were *Ruta chalepensis* (Tena Adam), *Zingiber officinalis* (Zigibl) and *Turmeric* (Erd).

Whey (*Aguat*): This is the final by-product of milk that remains after the cheese has been removed from the heated buttermilk. It is the liquid form that leftovers after most of the fat and the protein in the milk are detached during the cheese making [43]. In South Ari whey have many functions which are used as food for humans and supplementation to animals such as milking cow, and calves and plowing ox by mixing with other feedstuff. As stated by Abebe et al. [38], it holds important nutrients such as proteins, minerals and carbohydrates.

3.6 Butter Making Practices

Butter-making and manipulation practices are presented in Table 6. In South Ari district 68% and 32% of the respondents processed and make butter from indigenous and cross-breed cattle, respectively. In Malle district, 91.7% and 8.3% of households processed and make butter from indigenous and cross-breed cattle respectively. The average days of raw milk fermentation before churning in South Ari and Malle district were 4.2 ± 0.1 and 2.9 ± 0.0 days, respectively. Approximate this result was reported by [37,6] milk deposited to produce fermented milk for three and five days in Mekelle milk shed, northern Ethiopia and Borana plateau, respectively. The average butter-making time from starting to finishing up was 1.05 hours (63.4 ± 1.8 minutes) in both districts. The average churning time in the current study is lower than the result of Befekadu et al. [30] in Borena plateau of Ethiopia which indicated 1.2 hours (72 minutes). In South Ari district 76%, 22%, and 2% of the respondents make butter in the evening, afternoon and morning, respectively (Figure 4a). In the mid and highland areas of the country, it is common to churn milk in the evening which is used to participate all the family members in churning when get together after work. On the other hand, in Malle district, almost all (99%) of respondents make butter in the morning (Figure 4b) and only 1% in the evening. It is not possible to churn milk and make butter during the daytime in the lowland areas because butter becomes melts. Because the environment is warm enough in the daytime to churn in the evening the heat of the day does not dissipate, so the butter melts or mixes with milk butter.

The amount of milk fermented and butter produced from this fermented milk is a significant difference ($P < 0.05$) across districts. This variation may be due to feeding availability and other management practice between the districts. From indigenous cows, the average amount of milk churned in one session (liter) and the average amount of butter produced from all this fermented milk (kg) was 7.3 ± 0.3l liters and 0.6 ± 0.0 kg butter in South Ari district. The amount of milk fermented for one churn



a b

Figure 4. Butter preparation practice in South Ari and Malle district.

in this study was lower than the result of Befekadu et al. [30] who reported the average volume of milk processed at each processing time is 7.82 liters in Borena zone. On the other hand, from the cross cow, the churned milk amount and butter produced from this fermented milk in this district were 6.9 ± 0.5 liters and 0.7 ± 0.0 kg butter. In Malle district, the result showed that, the average amount of milk churned in one session (liter) and the average amount of butter produced from all this fermented milk (kg) from indigenous and cross cows were 5.7 ± 0.1 liters; 4.6 ± 0.1 liters and 0.4 ± 0.0kg and 0.4 ± 0.0 kg milk and butter, respectively. This milk amount difference may be the feeding behavior and feed conversion efficiency of the two breeds. On the other hand, it is an area where frequent drought occurred, due to this it may not suitable for hybrid cattle. The purpose of the processing of butter across the two districts was a statistical difference difference ($X^2 < 0.05$). In South Ari district, most (75%) of butter is used for sale and some for consumption; most (20%) butter is used for consumption and some for sale; 3% used all butter for home consumption and 2% used butter for the purpose of sale only. On the other hand, in Malle district,

Table 6. Amount of fermented milk churned and amount butter from this fermented milk at a time (%).

Activities	Districts			
	South Ari	Malle	Overall	X^2
Which cow breed do you use to process butter?				0.00**
Indigenous	68	91.7	79.6	
Cross	32	8.3	20.4	
At what time do you make butter?				0.00**
Morning	2	99	49.5	
Afternoon	22	0	11.2	
Evening	76	1	39.3	
Butter making or churning time (minute)	62.9 ± 2.3	64.2 ± 2.7	63.4 ± 1.8	
Raw milk accumulation (day)	4.2 ± 0.1[a]	2.9 ± 0.0[b]	3.6 ± 0.0	
Milk amount churned and butter product from local cow				
Amount of milk churned in one session (liter)	7.3 ± 0.3[a]	5.7 ± 0.1[b]		
Amount of butter produced from all this milk (kg)	0.6 ± 0.0[a]	0.4 ± 0.0[b]		
Milk amount churned and butter product from cross cow				
Amount of milk churned in one session (liter)	6.9 ± 0.5[a]	4.6 ± 0.1[b]		
Amount of butter produced from all this milk (kg)	0.7 ± 0.0[a]	0.4 ± 0.0[b]		
Purpose of processing butter?				0.00**
All for sale	2	8.3	5.1	
All for home consumption	3	0	1.5	
Most of it for sale and some for consumption	75	86.5	80.6	
Most of it for consumption and some for sale	20	5.2	12.8	

The value observed between the two Districts significantly different at * ($X^2 < 0.05$);** ($X^2 < 0.01$); X^2 = Pearson Chi-square, a,b = values with different superscripts in a row differ significantly P < 0.05.

86.5% of respondents used butter for the purpose of most of it for sale and some of it for consumption the rest 8.3%, 5.2% used butter all for sale and most of it for consumption and some for sale, respectively.

3.7 Type of Milk and Milk Product Marketing

Types of milk product selling practices by the households are presented in Table 7. Milk is naturally perishable and it needs special handling to ensure better quality and extended shelf-life. Due to perishability and special requirement, milk and its products in the country are marketed at different places in safe and unsafe ways [13]. In South Ari district, 65% and 69% of households have experience selling raw milk and cheese; the rest 35% and 31% of respondents do not have the practice of selling it, respectively. Similar to this study Getabalew et al. [45] noticed that in Ethiopia, fresh milk, butter, fermented whole milk (*ergo*), cottage cheese and buttermilk are sold through both formal and informal marketing channels. Regarding cheese marketing the current finding agreed with Tesfaye [46] who stated that household was not selling traditional cottage cheese (*Ayib*) in all the surveyed areas of Metema district rather it was consumed by the family members and given to calves and pet animals together with the whey (*Aguat*). The study revealed that, 96% and 100% of the household experienced selling of butter in South Ari and Malle district, respectively. In contradiction to the current result Ayeneshet et al. [17] noticed that the majority (76.0%) of households' in Alefa district had no practice of selling milk and its products in North Gondar Zone. Similarly, Abebe et al. [38] in Gurage Zone noted that, cultural restrictions (*taboos*), inefficient milk production and poor market access were the main constraints to selling milk products.

About 72% and 95% of surveyed households have not experienced adulteration in South Ari and Malle district, respectively. The remaining 28% in South Ari and 5% in Malle district confirmed that they have practices of adulteration. Among these to be adulterated milk products were raw milk with water, butter with banana, cheese and yogurt. This result agreed with the report of Mekonen and Mengistu [47] who reported that 76.7% of milk samples collected from farmers around Bair Dar were free from adulterants. In the same way Asrat and Zelalem [48] reported that about 95% of the respondents in Boditti town and its surrounding areas agreed that there is an adulteration of milk and milk products. In line with this study Amistu et al. [49] noticed that the major type of adulteration reported by consumers was 67 and 33% of the butter they purchase is adulterated with banana and 'sheno lega' respectively in Damot Woyde Woreda, Southern Ethiopia. Adulteration is often implemented to purposely reduce the quality (increase the quantity) of milk to gain profit dishonestly. It is the intentional substitution, addition and abstraction of substances that adversely affect nature, substances and quality of milk and its products [50]. Adulteration is also the central medium to reduce the nutritive

Table 7. Types of milk products sold by the respondents in the study area (%).

Activities	Districts			
	South -Ari	Malle	Overall	X^2
Do you sale fresh milk?				0.00**
Yes	65	0	33.2	
No	35	100	66.8	
Do you sale butter?				0.06
Yes	96	100	98	
No	4	0	2	
Do you sale cheese?				0.00**
Yes	69	0	35.2	
No	31	100	64.8	
Is there adulteration practice in the communities?				0.00**
Yes	28	5	16.5	
No	72	95	83.5	
Methods of transportation to sale the products?				0.00**
On foot	67	95.8	81.1	
Through vehicle	6	0	3.1	
Motorbike	27	4.2	15.8	

The value observed between the two Districts significantly different at * ($X^2 < 0.05$); ** ($X^2 < 0.01$); X^2 = Pearson Chi-square.

value of milk due to the dilution effect and which is directly affecting the further processing of milk to produce other dairy products such as yogurt and cheese [50].

Nearly 67% and 95.8% of respondents' milk delivery and transportation to sell milk products were by foot in South Ari and Malle district, respectively. The rest 27% in South Ari and 4.2% in Malle used motorbikes for transportation to sell their products. A similar study by Fortunate [51] revealed the most common means of transport used by farmers in delivering milk was on foot in Tanzania. In the rural areas of the country, the milk production system accounts for about 97% of the total milk production in the country where it is difficult to transport the raw milk to the marketing places due to poor infrastructure [52]. The current findings are also in line with the view of Sintayehu et al. [24] and Yousuf [53] they reported that the distance from market centres mainly to urban sites had a major prohibiting effect on producers from selling raw milk to consumers of urban resident and other dairy producers who live a distance from urban centres it could fetch a comparatively lower selling price than farmers in close to urban areas. For increasing milk production the provision of assured marketing channels is the primary condition that is sufficiently profitable to milk producers [54].

4. Conclusions and Recommendation

The study was conducted in South Ari and Malle district of South Omo Zone, to assess and describe the indigenous knowledge of milk production, handling, processing and utilization practices. The majority of the respondents in South Ari (75%) and Malle (72.9%) districts have their own grazing land. Seasonal feed shortage is common in South Ari (97%) and Malle (94.8%) districts, respectively. About 92% in South Ari district practiced supply of supplementary feed and 33.33% in Malle district had the experience of giving supplementary feed for their dairy cow. Grazing feed shortage (73%) and limited access to improved breed (26%) in South Ari; and grazing land shortage (52.1%), prolonged drought and seasonal fluctuation (44.8%) in Malle were identified as constraints of dairying. Major milking and milk-handling utensils were clay pot (65%) and calabash (88.5%) in South Ari and Malle district, respectively. Milk is typically stored to produce ergo for either short-term (three days) fermented milk for home consumption or making butter and production of other products longer-term (up to six days) fermented milk. The milk products are separated by traditional hand churning. For making butter, fresh milk is collected over a period of three to six days in a traditional clay pot vessel. About 95% of the respondent in South Ari processed different milk products such as yogurt, butter, buttermilk, cheese and whey. All these milk products were used for home consumption and marketing. However, in Malle district, 72.9% of respondents processed only yogurt, butter, and buttermilk and 26% processed only butter for marketing. Therefore, it is concluded that supporting the dairying extension services in the areas via enhancing the input provision system for dairy producers is vital. More efforts are required to improve milking, milk handling and processing by creating awareness and standard utensils utilization. The majority of the dairy producers followed inadequate milk sanitary practices hence the milk sanitary practices of the study areas should be improved.

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Data Availability

All data are available in the main text or in the supporting materials, and raw data can be obtained from the corresponding author upon request.

Conflict of Interests

The authors have not declared any conflict of interests.

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