Fermented Foods 3 (2026) 100016

Contents lists available at ScienceDirect

Fermented Foods

journal homepage: www.sciencedirect.com/journal/fermented-foods

A qualitative exploration of fermented milk processing traditionally practiced by the pokot ethnic group of Karamoja in Uganda

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ARTICLE INFO

Keywords:
Fermented milk
Traditional knowledge
Traditional foods
Pokot community
Pastoralism
Karamoja subregion
Uganda

ABSTRACT

Traditional food processing methods have the potential to combat malnutrition while providing sustainable livelihoods in communities such as the Karamojong devasted by a high burden of malnutrition and associated health consequences. The purpose of the current study was to document the traditional milk processing among the Pokot community in Karamoja subregion of Uganda, specifically focusing on the sour milk. A qualitative study involving five key informants and 46 Focus Group Discussion (FGD) participants was employed. We found that traditional knowledge of fermenting milk is passed by the older women to younger generations while in their childhood. We also observed that the Pokot ethnic community used burnt plant parts for treating fermentation vessels. Calabash or gourds were the most common fermentation vessels though some households used plastic jerricans as fermentation vessels. A traditionally fermented milk locally known as *lolon*, follows seven key steps: cleaning of the gourds, milking, sieving, boiling, defatting, fermentation, and draining. Our study demonstrates that milk processing by traditional methods by the Pokot ethnic community is culturally entrenched, initiated when the women are at a young age. Cultural identity associated with the milk processing among the Pokot reinforces food systems, therefore, we recommend the need for further empirical research beyond the current exploration such as innovations for improving and optimizing the process steps to improve food security and nutrition among the Pokot community in Karamoja subregion.

1. Introduction

Milk from dairy animals contribute at least 10% of the dietary protein and up to 50% of energy as well as essential vitamins and minerals such as calcium and zinc (Jans et al., 2017; Tremblay and Panahi, 2017) important for majority of pastoralists and agro-pastoralists in sub-Saharan Africa, thereby providing access to nutritious foods at an affordable cost. Fermented milk consumed in pastoral communities are largely processed by traditional methods (Karssa et al., 2025; Nuwemuhwezi and Ssemakula, 2017). Traditional milk preservation methods in sub-Saharan Africa include but are not limited to boiling, fermentation, smoking fermentation vessels, and the use of various additives such as moringa leaves and charcoal from specific tree species (Bereda and Kurtu, 2014). As such, there are numerous traditionally fermented sour milk products among pastoralist communities in Africa (Agyei et al., 2019; Behre et al., 2017; Owusu-kwarteng et al., 2017; Moonga et al., 2019). The methods for processing milk vary from one place to another and appear to be influenced by the culture.

The Karamoja sub-region, largely inhabited by pastoralists, and situated in north-eastern Uganda is characterized by high levels of malnutrition and food insecurity, partly due to limited livelihood options (United Nations Population Fund, 2018). The Karamojong traditionally depend on their animals for livelihood and food (Catley and Ayele, 2021). They obtain milk from cows, goats, and sheep, although the Pokot tribe of Amudat District also consume fresh or fermented donkey and camel milk (Muggaga et al., 2017). According to the Food Security and Nutrition Assessment Survey (FSNA) carried out in Karamoja sub-region in December 2017 by the United Nations International

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https://doi.org/10.1016/j.ferfo.2026.100016
Received 12 February 2026; Received in revised form 23 June 2026; Accepted 9 July 2026
Available online 10 July 2026
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Children's Emergency Fund (UNICEF, 2018), at least 55.9% of households had livestock which provides milk, beef, butter, blood, urine, and skin for consumption or sale. Blood, and urine, are sometime part of the non-plant ingredients for treating certain diseases and wounds in animals (Gradéa et al., 2009). In addition, fresh blood from animals is consumed as food together with raw milk in Karamoja (Olum et al., 2017).

Generally, the Ugandan dairy industry faces many challenges, such as low productivity, poor milk quality, and inadequate infrastructure (Paudyal, 2024). In Karamoja, poor infrastructure especially for key sectors such as roads, water and energy constitute major development limitations. For instance, most parts of Karamoja still have poor road network, most districts and rural centres still lack electricity connections, which inhibits economic activities in those areas (GoU, 2015). Yet, dairy plants use a lot of energy, and the processing methods such as pasteurization, homogenization, refrigeration, drying and packaging (Jabeen et al., 2026) can be difficult to perform in Karamoja. Hence, the inhabitants of Karamoja subregion mostly rely on traditional processing methods because modern methods appear not affordable. Therefore, National Agriculture Policy (2013) and the Uganda Nutrition Action Plan (2011–2016) encouraged the documentation, promotion, and improvement of traditional food processing methods in homes to avoid loss of this knowledge (Ministry of Agriculture, Animal Industries and Fisheries, 2013; Government of Uganda, 2011). However, traditional food preservation techniques have been abandoned (Asogwa 2017) because it is considered inferior and old-fashioned, resulting in a decrease in their effectiveness in improving food security.

We acknowledge that there is noticeable practice of milk processing by traditional methods in East Africa (Hawaz et al., 2025; Nuwemuhwezi and Ssemakula, 2017). Particularly, Mattiello et al. (2017) documented a traditional milk preservation method among the Sebei tribe of Eastern Uganda. The Sebei and Pokot tribes of Uganda and Kenya belong to the Kalenjin ethnic group, and in Uganda, the Pokot reside in Amudat and Nakapiripirit districts (Kolaczinski et al., 2008; Olobo-Okao and Sagaki, 2014). The fermented milk (*mursik)* processed by Kalenjin is slightly different from the one (*lolon)* processed by the Pokot community in Uganda. For instance, according to Digo (Digo, 2015), *mursik* is traditionally prepared from unpasteurized whole cow's milk that is spontaneously fermented in smoke treated gourds (*sotet*) for about 3–5 days. However, Nduko et al. (2017) reported that *mursik* is prepared by process steps similar to, *lolon* involving use of boiled milk followed by spontaneous fermentation. Nieminen et al. (2013) reported that the gourd used for *mursik* is internally smoked using charcoal from a burnt and dried branch of the Ite tree (*Senna didymobotrya*), which is repeatedly burned and rubbed onto the inner surface of the calabash to improve flavour and reduce porosity. In comparison, *lolon* calabashes are treated with an indigenous tree species locally called *cromwo* (*Ozoroa insignis*). In addition, Nieminen et al. (2013) noted that in some cases bovine blood may be added during *mursik* preparation. There is inadequate literature regarding specifically how the Pokot community of the Karamoja sub-region process fermented milk known as *lolon*.

The current study provides an in-depth evidence-based information insightful for understanding the nexus between traditional milk processing methods and food systems in guaranteeing food and nutrition security in the Karamoja sub-region. The study adds to existing knowledge about various traditional methods of milk processing in pastoral settings and provides an understanding of the potential of the product for economic development. In addition, the finding can provide a basis for other researchers to identify gaps and design further studies in related areas to milk processing by traditional methods.

2. Methodology

The methodology followed a consolidated criteria for reporting qualitative research (Tong, Sainsbury, and Graig, 2007) aligned to the key domains.

2.1. Research team and reflexivity

The principal investigator has experience in nutrition implementation and has been actively practicing nutrition through the implementation of various nutrition projects in northern and north-eastern Uganda since 2011.

The study was conducted with the help of two research assistants because they were familiar with the local setting, culture, and traditions. The principal investigator moderated the interviews and discussions while the research assistants complemented documentation of the information by taking notes, photos and observations.

2.2. Study design

A cross sectional study underpinned by qualitative techniques was used to document the traditional milk processing method.

2.3. Study area and setting

The study was conducted in Nakapiripirit district, located in the Karamoja sub-region of Uganda. The district is referenced at $01^{\circ}55^{1}$N$34^{\circ}40^{1}$E and is bordered in the north by Moroto district, in the east by Amudat district, in the west by Katakwi, and Kumi, Sironko, and Kapchorwa in the south (Fig. 1). The district is approximately 148 kilometers (by road) from Mbale, the nearest city, and approximately 79 kilometers (by road) south of Moroto Town, which is a more developed town in the sub-region.

Nakapiripirit comprises two (2) counties (Thekwii West and Thekwii East), four (4) sub-counties (Namalu, Kakamongole, Loregai, and Moruita), and one (1) Town Council (TC) (Nakapiripirit TC). The area of the study (Moruita sub-county) is occupied by the Pokot ethnic group, whose cultural practices are similar to those in Amudat district in Uganda and the Kalenjin ethnic group of West Pokot county in Kenya, (United Nations Development Programme (UNDP) and Government of Uganda (GoU), 2014).

The study adopted a community-based approach, at homes practicing traditional preservation of milk and "village meeting points" such as tree shades, since the communities were more comfortable in such settings. The six villages were Lemuswii. Chepkararat, Narionomor, Akokor, Alapat, and Cheptumot.

2.4. Data collection

Data were collected using Key Informant Interviews (KIIs) and Focused Group Discussions. The participants were women because they are usually responsible for traditional milk processing and preservation. The number of participants for KIIs was consistent with a study by Tanyanyiwa and Chikwanha (2019). Accordingly, five women were purposively selected for Key Informant Interviews. For FGD, a minimum of six-eight participants from each of the six villages were enrolled. None of the participants contacted declined to take part in the discussions, thus, a total of 46 women participated in the FGDs. Moruita Sub-county was purposively selected because its villages are located at the foot of Mt. Kadam where there is predominance of milk processors by traditional methods especially the yoghurt.

Data were collected using the local language (*Pokot*) with the help of the research assistants who received prior training on research ethics and research protocol. Face-to-face interviews were conducted using a question guide. Prior to data collection, the question guide was pretested among three Key Informants (KIs) and with one FGD session for the purpose of ensuring quality of data. The KIIs and FGDs were conducted for 45–60 min and 2–2.5 h, respectively. Although six FGDs were planned, only five sessions were conducted having attained saturation. The key informant interviews were held at the homes of each of the

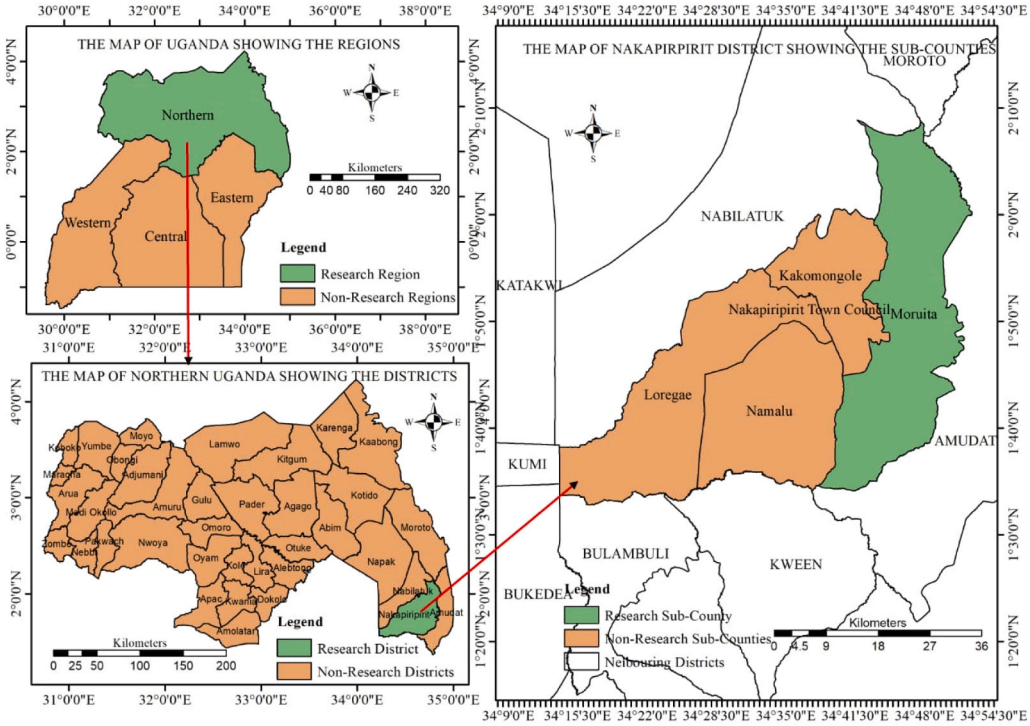

Fig. 1. Map indicating the study area in Uganda and Karamoja subregion.

women, in a family setting, while, FGDs took place at "village meeting points" such as tree shades, since the communities were more comfortable in such settings. The responses were captured through written field notes, audio recordings, observation of the entire processing (from in five homes), and photographs with permission from the participants. The information collected was verified and validated together with the participants before proceeding to the next participant or group.

2.5. Data analysis

Content analysis was carried out manually with the aid of Microsoft Word 2010. An inductive approach where major and minor themes emerged from the raw data were used since little was known about the subject under study, while participants' the quotations were used to illustrate the themes. The information was summarized in the table. Quotations used were tracked to the participants through names reassigned against the participants' real identities that were only known to the researcher.

3. Results

3.1. Characteristics of respondents

Majority of the Key Informants (KIs) (80) were 30–39 years, while 87% of the FGD participants were 19–39 years. KIs (100%) and FGD participants (87%) did not attain any formal education. In terms of marital status, most of the participants were married, accounting for 80 among KIs and 97.8% among the FGD participants. Majority of the KIs participants (80%) and 97.8% of the FGD participants were from households that were male-headed, while the families mostly had 7–10 members. Regarding livestock ownership, 80of the KIs participants owned cattle and goats while 96% and 100% of the FGD participants owned goats and cows, respectively (Table 1).

Table 1
Socio-demographic characteristics of respondents during FGDs and Key informant interviews.

	Key informants		FGD participants		
Characteristics	***N***	***Percentage***	***Characteristics***	***N***	***Percentage***
Education level			**Education level**		
No formal education	5	100	No formal education	40	87
Age			Primary (Grade 7)	5	10.9
30–39	4	80	Secondary (O-Level or A-Level)	1	2.2
60 +	1	20	**Age group**		
Marital status			19–29	12	26.1
Married	4	80	30–39	28	60.9
Widowed	1	20	40–49	5	10.9
Head of Household			50–59	1	2.2
Father	4	80	**Marital status**		
Mother	1	20	Married	45	97.8
Size of Household			Widowed	1	2.2
0–6	2	40	**Head of Household**		
7–10	3	60	Father	45	97.8
Livestock ownership			Mother	1	2.2
Cattle	4	80	**Size of Household**		
Goats	4	80	0–6	16	34.8
			7–10	27	58.7
			> 10	3	6.5
			Livestock ownership		
			Cattle	46	100
			Goats	44	96
			Poultry	10	22
			Sheep	10	22

3.2. Traditional method of milk processing by Pokot community

Processing *lolon,* a traditionally fermented milk, follows seven steps (Fig. 2). It was noted that women were taught by their mothers on how

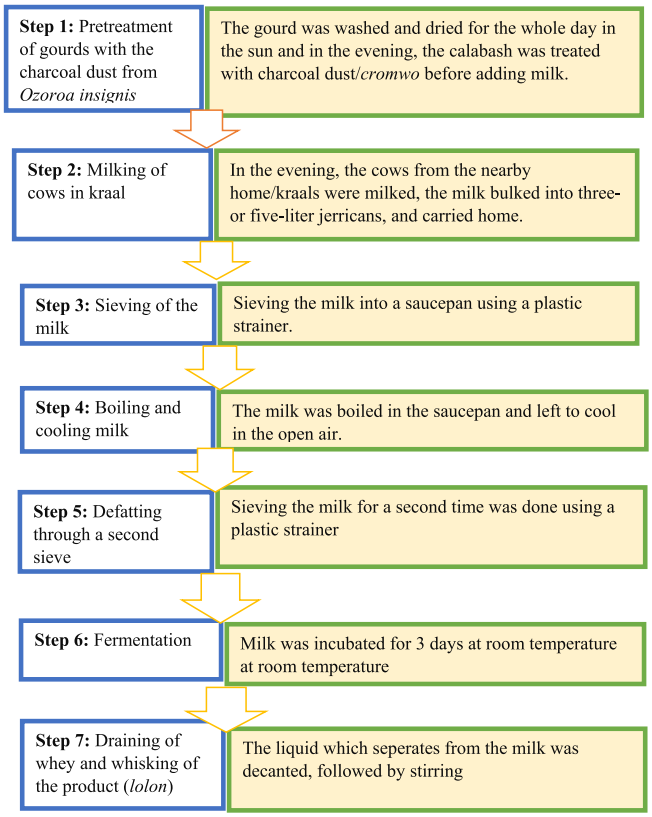

Fig. 2. The steps in processing fermented milk (*lolon*).

to prepare *lolon* when they were young.

"…by the time I got married, I started to ferment the milk, and I was initiated by my mother……." (A 31-year old respondent at Chepkararat village, Katabok parish).

Step 1: Pre-treatment of gourds (calabash) with the charcoal dust/*cromwo*.

The process starts with the cleaning and treatment of the calabash. In the morning, the calabash is prepared by scrubbing inside with a stick locally known as a *socion*, followed by rinsing with clean water, and hanging upside down (Fig. 3) to dry in the sun for the whole day or for up to two days in the rainy season.

In the evening, the gourds are treated with charcoal dust from burning the dried branch of *Ozoroa insignis* (locally known as *cromwo*) which was reported to serve the purpose of imparting flavor and disinfecting the gourd.

"….to get good quality lolon, I clean the gourd in the morning and dry it the whole day" (A 25 years old respondent at Narionomor village, Alapat parish)

"……. *In the past, my parents could only use cow urine to wash the gourds, but for me, I use clean water to wash the calabashes……."* (A 41 year old respondent at Narionomor village, Alapat parish).

It was observed that the charcoal dust/*cromwo* was applied in two ways; i) the charcoal dust/*cromwo* was applied to the gourds directly with a smoldering piece of *cromwo* picked from the fire, followed by scrubbing the inner walls with the hot tip of the burning branch in a circular motion, producing smoke and fragments of charcoal in the process. The excess charcoal particles were poured out and a scrubbing stick (*socion*) was used to uniformly spread the charcoal in the gourd. ii) the charoal dust/*cromwo* was prepared beforehand by burning a dry piece of branch from the tree to obtain charcoal, which was ground into a fine powder. In this case, the gourd was treated by scooping the desired

Fig. 3. The gourds hanged upside down to dry before being treated.

amount of charcoal dust, adding it to the gourd, and applying it to the inner walls of the gourd (Fig. 4A-C).

"…the old gourd, which spoils the lolon, to make it good, the fresh bark of cromwo is crushed, mixed with water, and the gourd soaked with the mixture…." (A 26 year old respondent at Alapat village, Katabok parish).

Step 2: Milking of cows in kraal

In the evening, the cows from the nearby home/kraals are milked (Fig. 5). The milk is bulked into three or five-liter jerry cans, and carried home. The respondents reported using cows' milk as the raw material since it is easy to get the amount required for the process compared to goats' milk.

"*…the goats' milk is little, but the cows' milk is a lot, and it is easy to get the quantity I require to make lolon……."* (A 32 year old respondent at Narionomor village, Alapat parish)

"…. *In the evening, I milk the cows using clean containers…….*"(A 25 years old respondent at Narionomor village, Alapat parish).

"…these days we ferment and sell some of the cow milk, while some is left for consumption at home……." (A 39 year old respondent at Kadekele village, Katabok parish).

"……here we use cows milk…." (a 27 year old respondent from Lemuswii Village)

"……Goats milk is good, it has bad smell…." (a 32 year old respondent from Kadekele Village)

"….sometimes we make lolon from goats milk and give it to children…." (a 29 year old respondent from Cheptumot Village).

Step 3: Sieving

This is the first step at the homestead, where the rest of the processes take place. The sieving is done as a hygienic measure to remove any foreign materials, including hairs, which could have fallen into the milk during the milking process. A plastic strainer is used for sieving the milk directly into a sauce pan, before heating. Various hygienic measures have been adopted during the processing, and they include; heating, sieving, second sieving, cleaning and drying of gourds and jugs or jerricans, and hand washing.

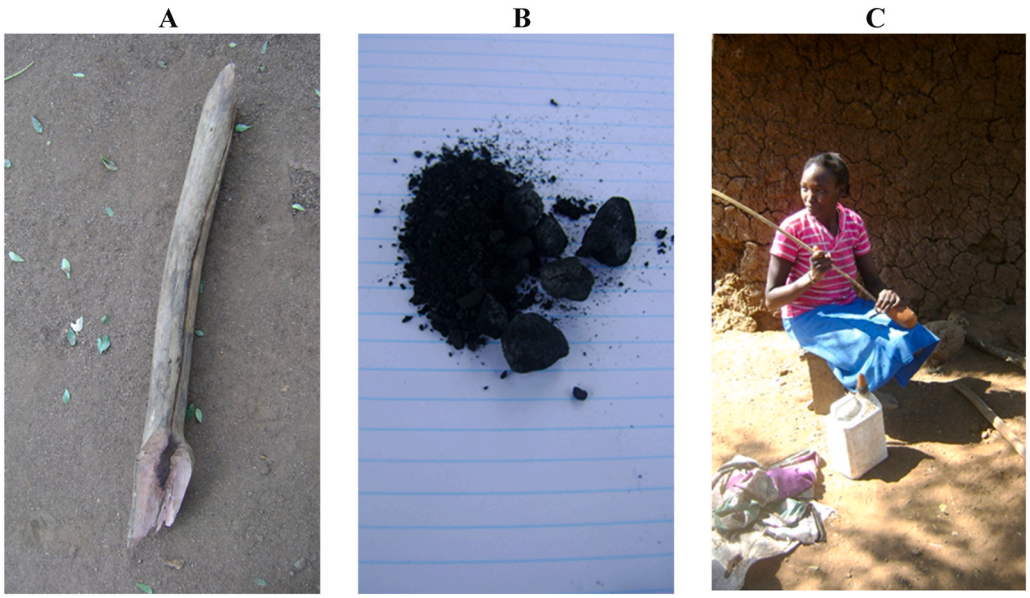

Fig. 4. (A): A dried branch of *cromwo*; (B): charcoal dust from burning the *cromwo* (C): A woman scrubbing *cromwo* into the gourd walls.

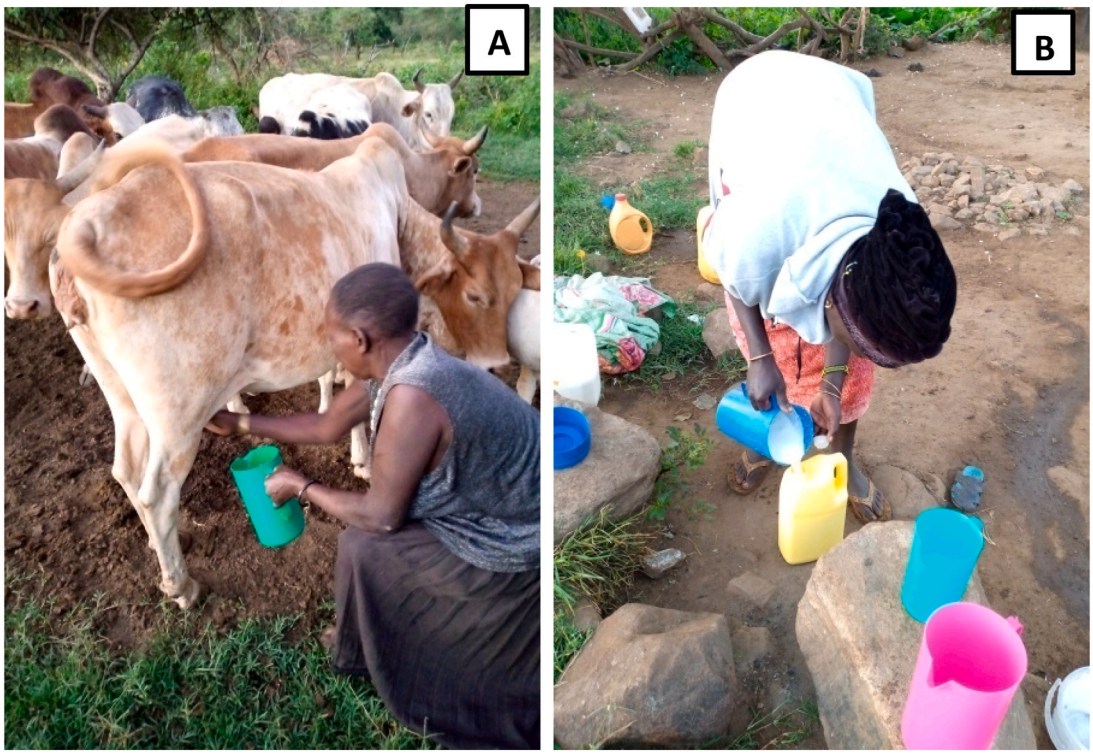

Fig. 5. Milking of cows by women (A) and bulking milk into plastic jerrycans (B).

"…the processing of the lolon by my mother is different because for me I sieve and heat the milk"……. (A 41 year old respondent at Narionomor village, Alapat parish)

"*….after I get the milk from the cow, I sieve, boil, wait for it to cool and sieve again……"* (A 25 years old respondent at Narionomor village, Alapat parish).

"*…in the past, I would put the milk just like that, but now days I boil and sieve the milk because I have learnt more……*" (A 24-year old respondent at Alapat village, Katabok parish).

Step 4: Boiling and cooling

The milk was heated in a metallic saucepan over an open fire, the heating was stopped when the milk starts boiling. This was followed by cooling in the open air to room temperature.

"…after sieving into the saucepan, I boil the milk and leave it to cool for two hours……." (A 35year old respondent at Cheptumot village, Katabok parish**).**

Step 5: Defatting through a second sieving

On cooling, the milk was sieved for the second time and poured directly into the calabash, which is treated with charcoal dust/*cromwo.*

"…After boiling, I sieve the milk again and put in the guards……." (A 45 year old respondent at Alapat village, Katabok parish).

"……when the milk is sieved again some particles are removed…., they remain in the sieve and the clean one is poured in the gourd……"(A 37-year old respondent at Kadekele village, Katabok parish)

Step 6: Fermentation

The most commonly used container for fermenting cow milk is the calabash. The respondents reported that they use the calabash for fermenting milk (Fig. 6), although the trend of using plastic containers for fermentation is emerging.

"…now days, people can ferment milk in clean jerry cans even if there are no gourds……" (A 24 years old respondent at Narionomor village, Alapat parish).

The gourd is kept in the kitchen in a specially made basket (*asacha*) for three to six days (Fig. 5), depending on the season. During the dry season, incubation of milk takes 3 days in their rooms.

" ……. I fill the gourd and keep in a warm place for three days…." (A 25 years old respondent at Narionomor village, Alapat parish).

"…lolon takes three days to be ready for consumption and the good gourds take a short time to ferment the milk……." (A 19-year respondent at Narionomor village, Alapat parish).

To know whether the fermented milk/*lolon* is ready for consumption, the respondents stated that the reduction in volume of the fermented milk/*lolon* in the gourds and water on the top of the fermented milk was an indicator. The end point of fermentation was also noted after three days by the separation of whey, the presence of cream and a change in thickness of milk, and shininess of the gourd.

"…the milk takes three days to get ready. The fermented milk/lolon is checked using a scrubbing stick, if there is water, it shows that it is ready" (A 22 years old respondent at Cheptumot village, Katabok parish).

Step 7: Draining and stirring

Once it has been determined that fermented milk/*lolon* is ready for consumption, some of the (whey is poured off and the remaining products in the calabash is mixed using a local whisk (*agwech*) to obtain a uniform thick consistency. The respondents reported a strong desire for the fermented milk/*lolon* with a thick consistency. In general terms, the respondents, stated that good taste, good smell, no bubbles, and thickness were qualities of a good traditional fermented milk/*lolon*.

The quality of the traditional fermented milk/*lolon* is graded according to its sensory and physical attributes. Most of the respondents regarded smell as the most desirable sensory attribute of a good traditional fermented milk/*lolon*, while a few of the participants mentioned taste.

"…I open the gourd, use a spoon to remove the top layer to check the lolon, then remove some water, shake, and use a local whisk (agwech) to stir……." (A 54 years old respondent at Alapat village, Katabok parish).

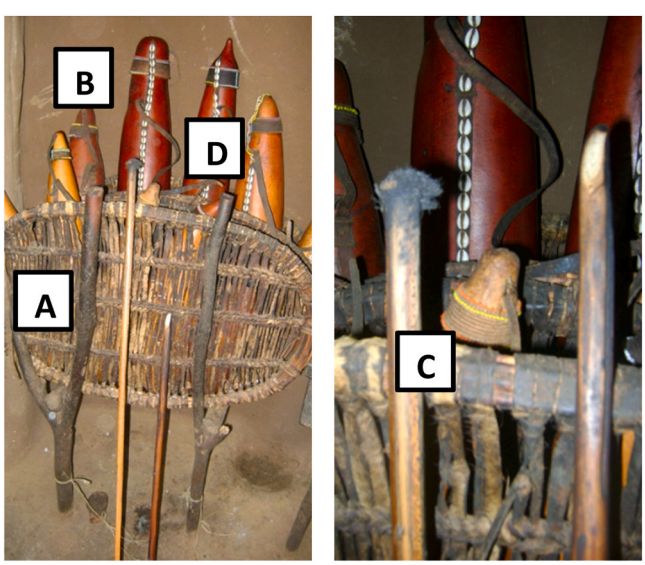

Fig. 6. (A): An *asacha* for holding gourds; (B): A calabash for fermenting *lolon*; (C): A scrubbing stick for cleaning the calabash; (D): A larger calabash used for bulking up milk curd/ *soyo*.

4. Discussion

Milk is fermented for both consumption and income generation. The finding is consistent with Azeze et al., 2016 study that established milk as vital for improving the nutrition status of individuals as well as enhancing household food security and income. The use of bovine milk to process sour milk is similar and has been observed for various traditionally fermented milk products such as *Kivuguto* in Rwanda (Karenzi et al., 2013), *Ergo* in Ethiopia (Berhe et al., 2017), and *nunu* from Ghana (Akabanda, 2010). In contrast *audai* from southern Namibia (Jane et al., 2017) and *Suusac* from Kenya (Lore at al., 2005) are made from goats' and camels' milk, respectively. However, in the current study, the respondents portrayed a dislike for goats' milk and the *lolon* made from it on account of un appealing organoleptic properties. Limited use of goat's milk could also be attributed to low yield compared to bovine milk. This makes sense especially from the perspective of attaining adequate quantity of the fermented milk for household's meals.

Various traditional milk preservation methods such as boiling, fermentation, smoking, and use of additives have been extensively documented with an interest in microbial properties, and as such, literature is abundant with the effects of fermentation of milk on the microbial properties of the milk ((Agyei et al., 2019; Mourad and Bettache, 2020; Setta et al., 2020; Owusu-Kwarteng et al., 2017). The treatment of fermentation gourds similar to that in the current study (Fig. 2; Fig. 4) has been documented in previous studies conducted in Africa (Nduko et al., 2017; Jane et al., 2017; Behre et al., 2017).Several studies done in Africa reported fermentation involving additives like roots (Jane et al., 2017), which are put directly into milk or the treatment of fermentation vessels with locally available substances like burnt twigs of acacia tree (Nduko et al., 2017), hot smoke from grass (poaceae) (Karenzi et al., 2013), and smoke from the African olive tree (Olea africana) (Behre et al., 2017). The practice of treating the fermentation vessels is expected to prolong the shelf life and impart flavor to the traditional sour milk products (Nakavuma and Nasinyama, 2012; Seifu and Tassew, 2014). Similarly, the current study (Fig. 2) identified one common method for processing *lolon* (traditional fermented milk) that involved pre-treatment of fermentation calabashes with charcoal dust from the dried branch of *Ozoroa insignis*, locally known as *cromwo* (Fig. 4). Since these technologies are readily available, the local people can easily access and afford them for milk preservation purposes. However, the effect treating fermentation vessels on self-life these authors still remain a claim and requires an empirical study. Our study was also not able to investigate the mechanism of the preservation due to the treatment of fermentation vessels with charcoal dust. We therefore suggest further studies by future scholars/researchers to ascertain the effect of this charcoal dust on shelf-life.

Milking is done at home, mostly by women (Fig. 5). In regard to processing the bovine milk at home, freshly collected milk in many pastoralist communities in Africa may be sieved or filtered before being processed into yoghurts to eliminate animal hair and other debris that may have contaminated the milk during collection and handling on the farm (Agyei et al., 2019). Plastic tea strainers are the popularly used for

sieving because it is inexpensive and widely available in most local markets (Moonga et al., 2019). The practice of sieving milk before heating was observed in the current study (Fig. 2) and was one of the hygienic measures adopted by the communities.

The sieving process is a good practice in ensuring that physical contaminants do not end up in the milk, which could undermine the hygiene of the final product. According to Majalija, Tumwine, Kiguli, et al. (2020), unhygienic milk handling practices compromise the quality of raw milk. The boiling of milk observed in the current study (Fig. 2) is similar to that reported during the making of *mursik*, a traditional fermented milk in Kenya (Nduko et al., 2017), *zabady* a traditional fermented milk in Egypt (El-baradei et al., 2008), and *amabere* by the Kisii community in Kenya (Nyambane et al., 2014).

Thermal treatment of raw milk is one of the most important processes because of its effect on eliminating both infectious & spoilage bacteria from the milk, ensuring that it is safe and also has a long storage life (Kshirod et al., 2022). Boiling and a longer fermentation time are both associated with a safer product as in both cases, the bacteria counts are reduced by heat (Kshirod et al., 2022) and low pH. (Hawaz et al., 2025). This implies that boiling of milk is a good practice which should always be encouraged to ensure safety of the *lolon and assure public health*.

On the other hand, un-boiled milk is used to prepare *nunu* from west Africa (Akabanda, 2010), *suusac* from Kenya (Lore et al., 2005), and *Kivuguto* from Rwanda (Karenzi et al., 2013). This is because it is believed that boiling imparts a cooked flavor to the milk, which affects the smell and preference of the fermented milk product (Ainsworth, 1996), which could explain why some communities do not boil raw milk intended for the fermentation process. Moreso, on the contrary (Moonga et al., 2019) reported that boiling of milk destroys the initial microorganisms, hence, fermentation takes a longer time than expected (Moonga et al., 2019).

Similar to the current study (Fig. 6; Fig. 3), previous studies in African countries have reported the use of wooden jars or hollowed wood vessels, pot vessels or clay pots, calabash, woven grass, skins of animals, rubber buckets, clay pots, and stone jars to make fermented milk products (Bille et al., 2007; Nduko et al., 2017; Jane et al., 2017). For instance, in the making of *Kivuguto* in Rwanda, a wooden jar called *icyansi* was used to ferment milk, while a calabash was used to churn the resultant curd (Karenzi et al., 2013). Interestingly, the use of fermentation gourds over time has been cited as an important factor responsible for the desired organoleptic properties of traditional fermented milk over similar modern products (Beukes et al., 2001), which could explain the preference of calabashes in the present study over other options such as plastic containers. Thus, in the current study, the quality of the gourd was important in producing quality fermented milk products, and if the quality of the gourd deteriorates such that the final product is not desirable, fermentation vessels are rested for them to regain their good qualities, similar to findings by Seifu and Tassew (Seifu and Tassew, 2014). Future studies need to determine the effect of using plastic containers not only on the microbial properties but also organoleptic and physiochemical properties of the sour milk.

Furthermore, it is worth noting that the end point of fermentation depends on temperature (season), altitude, the amount of background bacteria in the gourd, and sensory preference (Bille et al., 2007). Similar to the current study, most pastoralist communities ferment the milk for two to three days at ambient temperature with no back sloping (Karenzi et al., 2013) which differs from communities in highland areas which take three to five days due to low temperatures (Berhe et al., 2017). Akabanda (2010) pointed out the effect of temperature (season) in determining the duration of fermentation as it varied from 12 to 24 h at 35 °C and 48 h at 15–17 °C.

Rapid fermentation, which occurs during the hot season, leads to deterioration in the texture and appearance of the final product, and as such, some communities leave the fermentation gourds in a water bath to control temperatures during the hot season (Moonga et al., 2019). According to Ashenafi (1996), lower incubation temperatures (around 20 “C) may favour the proliferation of lactic acid bacteria and thus guarantee a desirable fermentation.

In contrast, fermented traditional beverages from Namibia such as *Omashikwa*, *Mashini*, and *Mabisi* were reported to take a longer time than the typical time under ambient temperatures, i.e. 3–4 days, 4–5 days, and 4 days, respectively, which is linked to the preference in taste as a longer fermentation time is associated with a more acidic taste and thus safety (Jane et al., 2017). This confirms that variations in the duration of fermentation of milk by traditional methods is driven by the intended product characteristics.

The practice of whisking the final product before consumption was also observed in the current study. The water that separates after the fermentation is undesirable as it makes the fermented milk watery and as such, the whey is drained off before whisking to ensure that the product maintains a good thickness and homogeneity (Agyei et al., 2019; Moonga et al., 2019). Hence the thickness of the *lolon* is perceived to impart satiety, which is one of the reasons the locals prefer a thick *lolon.*

5. Conclusion and recommendations

We documented the traditional method for processing bovine milk as practiced by the Pokot pastoralist community of the Karamoja subregion. Our study demonstrates that milk processing by traditional methods by the Pokot ethnic community is culturally entrenched, initiated when the women are at a young age. There is emergence of use plastic containers besides calabash in fermentation of milk is likely to affect preservation of cultural heritage among the Pokot community. Milk processing by traditional methods among the Pokot ethnic community follows seven critical steps and includes use of charcoal and gourds.

The documentation of the processing method provides opportunities to the local authorities for improvement and development of a standard and guidelines for processing *lolon* based on the traditional method with special emphasis on hygiene practices. Cultural identity associated with the milk processing among the Pokot reinforces food systems, therefore, the need to harness this potential to improve food security and nutrition among the Pokot community in Karamoja subregion.

CRediT authorship contribution statement

Okello Uma-Ipolto: Writing – review & editing, Supervision, Conceptualization. **Christopher Muggaga:** Writing – review & editing, Writing – original draft, Supervision, Conceptualization. **Enos Kitambo:** Writing – review & editing, Data curation, Conceptualization. **Doreen Chemutai:** Writing – review & editing, Methodology, Formal analysis. **Emmanuel Owiny:** Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Ethics approval and consent to participate

Ethical clearance was issued by Gulu University Research Ethics Committee (GUREC) (No. GUREC 089–20). GUREC was officially recognized with full accreditation bestowed by the Uganda National Council for Science and Technology (UNCST) in 2015. Furthermore, the committee earned accreditation from the Office for Human Research Protections (OHRP) in the United States, with the designation IRB No. IRB00010381.

Administrative permission obtained from the Chief Administrative Officer (CAO) of Nakapiripirit District. Further, informed verbal consent was also obtained from the participants before enrolment in to the study. Written consent was signed by the participants before taking photos and videos.

Declaration of Generative AI and AI-assisted technologies in the writing process

Authors declare that there was no use of generative AI or AI assisted tools in the generation of figures and images

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Muggaga Christopher reports was provided by Gulu University Faculty of Agriculture and Environment. Muggaga Christopher reports a relationship with Gulu University Faculty of Agriculture and Environment that includes: employment. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

The authors express sincere gratitude to the caregivers and household heads from the study districts for their time, cooperation, and willingness to participate in this research. We also appreciate the support provided by local leaders, district agricultural officers, and Village Health Teams, whose facilitation and guidance were invaluable in accessing the communities and conducting data collection effectively.

Data availability

Data will be made available on request.

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