Research Square

Preprints are preliminary reports that have not undergone peer review.
They should not be considered conclusive, used to inform clinical practice,
or referenced by the media as validated information.

Traditional Knowledge and Processing of Ayib (Cottage cheese) in Ethiopia: An Ethnographic Study

Lammifyad Chimde

lammifyad0912@gmail.com

Bule Hora University

Mitiku Eshetu

Haramaya University

Takele Wolkaro

Haramaya University

Kefelegn Kebede

Haramaya University

Tesfemariam Berhe

Bio and Emerging Technology Institute

Ulfina Galmessa

Ethiopian Agricultural Research Institute

Research Article

Keywords: Ayib, Baadu, traditional knowledge, rubbing, preservation practices, Ethiopian cottage cheese, traditional dairy products, ethnographic

Posted Date: December 17th, 2025

DOI: https://doi.org/10.21203/rs.3.rs-8369140/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License. Read Full License

Additional Declarations: The authors declare no competing interests.

Abstract

Background *Ayib is a cottage-type cheese produced through acid-heat coagulation principles. The processing, handling, and preservation of Ayib are highly integrated with traditional knowledge and practices. It plays a crucial role in the social, cultural and economic development of rural communities.*

Methods *A cross-sectional study design and random sampling techniques were employed. Data was collected from 210 households using* semi-structured interviews and from 4 focus groups*. Household observation was also utilized to collect data. The collected data were analyzed using the SAS JMP18 Pro software. Inductive coding and theme categorization was also performed to analyze the qualitative data derived from interviews and focus group discussion.*

Result *The study revealed that* 91.43% of the respondents believed women were more empowered in Ayib processing. Approximately 75.71% of smallholder farmers in the study areas produced Ayib primarily for home consumption. Moreover, 96.7%, 89%, and 77.6% recognized Ayib's importance in daily meals, cultural events, and traditional marriage and social gatherings, respectively. *Various local tree leaves were identified for container cleaning, with* 59.18% using *Ejersa* (*Olea Africana) for fumigation.*

Conclusions The research highlighted Ayib's significant roles in household food security, preserving bio-cultural heritage, and women's empowerment, suggesting the importance of integrating traditional knowledge of Ayib processing into academic and policy agendas to advance the field

1. Introduction

The Convention on Biological Diversity defines traditional knowledge as the innovations and practices of indigenous communities (Nigussie et al., 2020) that have been essential to the preservation and expansion of biological diversity over many centuries, as well as in identifying beneficial uses of genetic resources. Traditional knowledge is an invaluable and intangible asset, passed down through generations via research and practical experimentation (Chala and Tizazu, 2019).

Worldwide, dairy products hold a significant place in the human diet due to their high nutritional value. They serve as sources of proteins, fats, carbohydrates, and amino acids for consumers (Benyahia et al., 2025). In developing countries, these dairy products are traditionally produced using spontaneous fermentation with indigenous microflora and age-old techniques (Asresie *et al.*, 2018; Dereje et al., 2022). This process involves natural lactic acid bacteria, which are most commonly occur in unhygienic environments. The temperature and duration of incubation vary depending on environmental conditions (Kedir and Mohammed, 2024). The fermentation process begins with the initial microbiota multiplying (Tiruha et al., 2024) and is used to improve shelf-life, sensory quality, preservation, and detoxification properties (Chelule et al., 2010; Berhe, 2017; Tiruha et al., 2024), as well as provide probiotic benefits to consumers (Hasan et al., 2014).

Among dairy products, traditional cheeses serve as both a cultural and economic resource (Nyamakwere et al., 2021). Like many other countries, Ethiopia produces various dairy products such as yogurt, butter,

ghee, buttermilk and cottage cheeses (Berhe et al., 2017). Ayib, an Ethiopian cottage cheese, is a staple food with significant cultural and social value. Consumed year-round, it is cherished for its nutritional content and adaptability in regional cooking (Zerihun et al., 2025). Ethiopian culture deeply values Ayib consumption, linked to rituals and traditions, symbolizing hospitality, abundance, and popular social events (Fisahaye, 2016; Asresie et al., 2018). Ayib is consumed by all people, regardless of gender as a side dish at the household level to ensure food security (Dereje et al., 2022; Zerihun et al., 2025), but surplus is shared during special occasions and sold for smallholder income (Tadesse et al., 2017).

Tiruha et al. (2024) and Zerihun et al. (2025) discuss the unique process of making Ethiopian Ayib, a cheese made from *Arera*/buttermilk, a naturally fermented, unpasteurized milk byproduct of butter-making. The process involves churning spontaneously fermented milk, heating buttermilk, cooling, and straining the curd. Other traditional cheeses, such as braided cheese (Nyamakwere et al., 2022), *wagashi* (Essodolom et al., 2025), and *Wagassirou* (Hounsoun et al., 2022), use different raw materials and processing methods distinct from Ethiopian Ayib.

Ethiopian dairy product production is predominantly managed by women, who process and sell Ayib and butter (Tamirat, 2021). Women are typically responsible for daily home milk processing, turning it into cheese and butter, as well as handling labor-intensive tasks such as milking and feeding (Food and Agricultural Organization, 2017; Danayit and Neima, 2025). Dairy product production benefits women as it provides them with a reliable source of income, ensures food security, and grants them social and economic empowerment (Gallina, 2016).

Globally, dairy safety concerns are increasing due to foodborne diseases. Artisanal cheese processing can introduce various sources of microbial contamination to foods due to personal hygiene and processing conditions (Nyamakwere et al., 2021). Kedir and Mohammed (2024) found high levels of yeast and mold, total bacterial count and coliform count in Ayib, surpassing microbial quality and safety standards. This highlights the need for implementing hygienic practices to minimize contamination (Abera, 2023).

In rural regions of Ethiopia, farmers use indigenous knowledge and practices to preserve Ayib, including smoking, cleaning containers with plant species (Lemma *et al*., 2024), and seasoning with traditional herbs and spices (Eyassu, 2023). Although traditional methods of dairy product processing, handling, and preservation integrated with cultural norms of the local communities are common practices in the West Shewa zone, there is a lack of integrated studies by NGOs, the government, and researchers that combine technical, socio-cultural, and gender perspectives. Therefore, this study aims to document traditional Ayib production practices and analyzing their relationship to cultural norms of the local communities. The study further elucidates the key processing steps and evaluates the hygienic and preservation practices, explores the linkage of Ayib to local economy, and examines gender roles in Ayib processing.

2. Materials and Methods

2.1. Description of the study areas and period

The survey was conducted in four districts (Toke-Kutaye, Ambo, Dandi, and Ejersa-Lafo) in the West Shewa Zone of the Oromia regional state, Ethiopia, from December 2023 to November 2024. These study sites are located in Western Addis Ababa, the capital city of the country. Each of the study areas receives different annual rainfall and means daily temperatures. The agricultural system practiced in the area is a mixed crop-livestock farming system, with a primary focus on crop production. Livestock production in the study districts is primarily extensive, with animals grazing on pastureland; however, there are also some intensive and semi-intensive livestock production systems.

2.2. Study design and sampling framework

The study used cross-sectional and qualitative participatory research methods. Prior to the main survey, a preliminary survey was carried out to identify potential areas for *Ayib* production. The study was structured in three stages. Firstly, four districts were chosen to represent the zone based on criteria such as livestock and human population, milk and *Ayib* production levels, marketing channels, and accessibility to smallholder producers. Secondly, eight kebeles were chosen based on the same criteria used for district selection, with two kebeles selected from each district to cluster the large-sized districts into smaller administrative units Lastly, participants with experience in Ayib production, having a dairy cow, and willingness to take part in survey were randomly selected from each kebele to gather relevant information for the study. The research data were also designed through the use of immersive participant observation, focus group discussions, and ethnographic interviews.

2.3. Sampling strategy and sample size

A random sampling strategy was employed to ensure that informants represented a wide range of roles within Ayib processing practices. This approach aimed to capture the perspectives of individuals directly involved in processing, handling, and preserving Ayib. The sampling process accounted for demographic diversity, including age, gender, and socioeconomic status, to ensure that the findings reflected the varied experiences within the community. For this study, the sample size was determined using the Yamane (1967) formula among the identified producers and was proportionally allocated across each study district, with a confidence level set at 95%, as shown in Figure 1

$$n = \frac{N}{1+N(e)2} = \frac{444}{1+444(0.05)2} = 210.43 = \sim \mathbf{210}$$

Where;

n= designates sample size, N= the total population, e= Margin of error =5% (0.05), and

1=unite (a constant value

2.4. Data source and collection methods

Both primary and secondary data sources were utilized for this study. Primary data sources included women's empowerment such as economic, social, and cultural empowerment in Ayib processing; the

socioeconomic contribution of Ayib; knowledge transmission mechanisms; the cultural significance of Ayib including identity shaping, social bonding and group practices, and historical reflection; fermentation parameters, such as temperatures and seasonal variations; the steps involved in *Ayib* production; hygienic practices; preservation methods; and the materials used for storage and processing of Ayib in the respective districts. Secondary data consisted of written documents providing information about the study areas including altitudes, mean annual rainfall, mean annual temperature, farming systems, and potential districts were obtained from the respective districts and zonal agricultural offices.

In this study, various qualitative participatory data collection methodologies where utilized, including individual semi-structured in-depth interviews, focus group discussions (FGD), and direct observations were used. Respondents were interviewed individually using a pre-tested semi-structured question guide. Additionally, household observations were conducted over eight days using a house-to-house approach to verify the traditional equipment used, traditional hygienic practices, and Ayib's socio-cultural contributions. Four FGDs, one in each district, were conducted with six to eight participants in each. Data collection was categorized based on technical and socio-cultural aspects of food safety research. Information collected on Ayib processing, handling, and preservation was categorized under technical aspects, while information on the economic significance of Ayib, gender labor division, mechanisms of knowledge transfer, and cultural value of Ayib was classified under socio-cultural aspects. Each informant was asked a combination of closed-and open-ended questions.

Questionnaire Translation Validation was conducted to ensure that the translation from English into the local language *Afaan Oromoo* accurately reflected the meaning and intent of the original. This process included back translation from *Afaan Oromo* into English by an independent forward translator. Any difference between the translated instruments and the original were identified and revised by a bilingual translator. Visual ethnography was also used to document traditional Ayib processing and storage utensils, and hygienic practices, complementing oral narratives with photographic data. Statistical data validation using Cronbach's alpha was also employed. Pre-testing of the questionnaire aimed to identify uncover potential flaws in terms of clarity, understandability, relevance, and completeness. Any wordings or structural elements that could lead to biased answers were assessed and revised to enhance the validity and reliability of the instrument.

2.5. Data quality control

The research questionnaire was translated into *Afaan Oromo* and English to ensure accuracy and validity. Data collectors received instructions, and the questionnaires were pre-tested. The researchers closely monitored the data collection process, double-checking for completeness and errors during field work. Corrective measures were taken as necessary to ensure the validity of the original version.

2.6. Recall bias control

Descriptions of traditional practices provided by respondents were relied highly on memory, making them subject to recall bias. To minimize this bias, strategies such as providing clear instructions on how to

respond to questions, using open-ended questions, and allowing ample time between questions were implemented.

2.7. Variable definitions

"Ayib" refers to a cottage-type cheese, which is a traditional Ethiopian dairy product made from *baadu* or buttermilk. "*Baadu"* refers to the byproduct of butter making and is used in the processing of Ayib. "*Kebele"* refers to the smallest administrative division in Ethiopia.

2.8. Comparative analysis framework

The comparative analysis of the current finding was structured as follows: Initially, published and unpublished literature focusing on traditional dairy product processing and handling, gender roles in dairy product processing, the socioeconomic contribution of dairy products, and traditional preservation methods were identified and collected from various sources. Next, among the identified literature, more recent (2017-2025), Scopus indexed, and literature in similar contexts focusing on ethno-dairy processing specifically cheese processing was prioritized and screened from Ethiopia and other countries. Finally, the results of the finding were compared with recent literature primarily from Ethiopia, followed by literature from other countries. The differences and the similarities of the findings were also analyzed.

2.9. Methods of data analysis

The gathered data were subjected to appropriate statistical analysis. The collected data were analyzed using SAS JMP 18 Pro (2023) software. The results of the survey data were summarized using key statistical measures, including means and percentages. The Pearson chi-square test was applied to evaluate significant differences among categorical variables, while significant differences were analyzed using the Tukey test for quantitative variables. Qualitative data was analyzed through thematic categorization, with themes derived from interviews and FGDs using inductive coding. The process of thematic coding involved familiarizing with the data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and writing the report. Themes were identified by compiling the results of the coding process, creating themes that connect the identified codes into groups based on their subject matter. Multiple coders, all familiar with the research topic, contributed theme development.

3. Results and Discussion

3.1. Demography of the respondents

The demographic characteristics of the research areas are presented by respondents in Figure 2, including age (a), religion (b), and educational status (c). The age distribution of the respondents shows that 51% were between 31and 45 years, 46% were 46 and older, and 3% were 18 to 30 years. This indicates a predominance of individuals in working ages, essential for dairy tasks. Regarding educational status, 51.43% of the respondents were literate (attained formal or informal education), which could positively

impact dairy transformation and quality production. Nearly 62.68% of the respondents identified as Orthodox Christians, which influences demand for dairy products, particularly during fasting periods. During fasting periods, Orthodox Christian followers refrain themselves from consumption of milk and milk products, which causes a swings in demand for dairy-sourced food. These factors may lead to seasonal variations in dairy consumption and production, affecting smallholder producers socially and economically.

3.2. Gender division of labor and socioeconomic contribution of Ayib

Table 1 displays the gender division of labor, socioeconomic contributions and methods of knowledge transmission of Ayib manufacturing in the study areas. The values of the chi-square test on the survey results indicated that gender division of labor in Ayib processing, knowledge transfer mechanisms in Ayib processing, local economy linkages of Ayib, and reasons for not selling Ayib were significantly different ($P < 0.001$) among the study areas. The study revealed that all respondents participated in Ayib processing, with women holding more authority than other family members in these activities. It was also noted that other family members, such as daughters, assisted their mothers with Ayib processing tasks. Survey respondents indicated that women have more control over Ayib processing activities compared to other family members, likely due to gender divisions of labor in family and household structures. The existing cultural norms and social perceptions empower women in dairy product processing and handling, which are their primary roles. Respondents noted that in households without male partner due to death, disability, or divorce, females took on the role of head of households and engaged in dairy processing and related activities. Additionally, focus group discussions indicated that cultural systems, including family rituals and religion, empower women in handling and processing of Ayib. Women's empowerments enhance household income and boosts financial autonomy and bargaining power within the household. This finding is consistent with the research of Danayit and Neima (2025), ILRI (2015), and Ulfina et al. (2019), who found that women were empowered to perform tasks such as milking, processing, marketing, and managing dairy in various rural areas of Ethiopia. Additionally, FAO (2017) noted that women contribute most of the labor in dairy production under the traditional production system in Kenya. Furthermore, Ayinde et al. (2022) reported that cheese production was mainly practiced by women in Ogun State, Nigeria.

A majority (75.71%) of the respondents reported that Ayib produced by smallholder farmers in the study areas was primarily used for family consumption. The remaining participants indicated that Ayib was utilized both for home consumption and sold at local markets and eateries, in addition to being shared among neighbors, family, and relatives who lacked their own dairy cows for production. They explained that Ayib was sold when there were surpluses beyond family needs to meet basic household expenses. This finding suggests that Ayib production holds both social and economic significance for smallholder producers and plays a crucial role in household food security insurance in rural areas. In the study areas, many respondents (80.48%) reported that Ayib was not produced for sale due to cultural taboos against it and other dairy products. Reports indicated that selling Ayib and other dairy products has been viewed as taboos; however, some respondents noted that the sale of Ayib is also limited by its low production output during processing. This study aligns with Tegegne et al. (2022), who found that a high percentage (78.08%) of dairy producer households were food secure in the Central Gondar Zone. Similarly, Nyamakwere et al. (2021) also reported that artisanal cheese in East and Northern Africa is predominantly used for household

food security. In contrast, Asresie *et al*. (2018) reported that most farmers sold *Ayib* varieties in the Eastern Gojjam zone, Ethiopia.

In the study areas, 76.67% of respondents indicated that knowledge of Ayib processing was primarily transferred through parental inheritance via observation, with oral traditions, apprenticeship, and a combination of inheritance and oral traditions also contributing (Table 1). Participants stated that daughters learn Ayib processing activities by observing and emulating their mothers as they perform the tasks. However, traditional knowledge is being eroded over time as younger generations pursue alternative livelihoods and as technological shifts outplace traditional learning. Maintaining the transfer of knowledge is crucial to ensure children and their descendants understand and sustainably traditional knowledge practice. Study is in consistent with the findings of Nigussie et al. (2020), who reported that traditional knowledge in Ethiopia developed through experience, observation, and practice. Additionally, Nyamakwere et al. (2021) noted that traditional cheese processing techniques and recipes are passed down from generation to generation through practical experience and observation. The following quotes are taken from participants to illustrate this result.

“We inherited Ayib and others dairy product processing from our mothers, older sister(s), or neighbor by observing while they performed the task “(ID 28, 46 years old, respondent).

Table 1: Gender division of labor, Socio-economic contribution and mechanisms of knowledge transfer in Ayib processing

Variables	Category (%)	Districts					X^2- value
		T/Kutaye (n=48)	Ambo (n=52)	Dandi (n=57)	E/Lafo (n=53)	Overall (n=210)	
Do you process Ayib?	Yes	100	100	100	100	100	-
	No	0.00	0.00	0.00	0.00	0.00	
Gender division of labor	Women	93.75	92.31	89.47	90.57	91.43	137.62**
	Men	0.00	0.00	0.00	0.00	0.00	
	Other	6.25	7.69	10.53	9.43	8.57	
Knowledge transfer mechanisms	Parental inheritance	77.08	71.15	80.70	77.36	76.67	302.8**
	Oral traditions	16.67	11.54	10.53	11.32	12.83	
	Parental inheritance and oral traditions	4.17	11.54	7.02	9.43	8.10	
	Apprenticeship	2.08	5.77	1.75	1.89	2.86	
Local economy linkages	Only consumed at home	79.17	73.08	78.95	71.70	75.71	170.6**
	Consumed and sold	8.33	19.23	14.04	16.98	14.76	
	Shared among communities	12.50	7.69	7.02	11.32	9.52	
	Only sold	0.00	0.00	0.00	0.00	0.00	
Reasons for not selling Ayib	Cultural restriction	83.33	76.92	82.46	79.25	80.48	78.019**
	Low Ayib production	8.33	3.85	3.51	7.55	5.71	

**=significant at P<0.001, X^2= chi-square

3.3. Traditional and semi-modern utensils and their uses

Figure 3 illustrates the processing steps of Ayib and the various traditional and semi-modern tools used. Majority of the respondents identified traditional utensils for Ayib processing and storage equipment, while few respondents used both traditional and semi-modern equipment simultaneously. Traditional equipment included wooden and thatch-made utensils locally known as *Okolee* (Fig. 3a) for milking, a clay pot locally named *Okkotee* (Fig. 3b) for milk and *Ayib* storage, churning, and buttermilk cooking, a gourd locally named

Qabee (Fig. 3c) for storage and churning, and a wooden bowl locally known as *Gabatee* (Fig. 3d) for *Ayib* storage. This indicates that the majority of smallholder farmers are not adapted to the use of advanced processing and storage devices, which may be due to cultural perceptions towards the use of modern equipment and the unavailability of modern devices from local markets. This finding align with Gonfa *et al*. (2001), who mentioned *Okole* for milking and Qabee/kussa for milk storage in Wollega. Befekadu et al. (2019) also reported *Okole* for milking in the Borena Zone. Furthermore, Seifu and Tassew (2024) discussed the use of gourds and plastic containers for milking, and clay pots and gourds for churning in Northwestern Ethiopia. Similarly, Hounsoun *et al.* (2022) reported the use of bowls, plastic boxes, and plastic colanders for *waragashi* storage in Benin. The similarity in containers reported may be attributed to factors such as social relationships, regional cohesion, and material availability. However, Gabriele et al. (2025) reported the use of traditional wooden equipment such as *tina*, *rotula*, *cisca*, *mastredda*, and *piddiaturi* for cheese processing and storage in Southern Italy. Guetouache and Guessas (2020), on the other hand, reported that *Klila*, an Algerian traditional cheese, is kept in glass jars and tulle bags, contradicting the current study.

In addition to traditional equipment, semi-modern tools such as plastic buckets locally called '*Baldi* (Fig. 3e) were used for milking, milk storage, and *Ayib* marketing. Milk cans were used for milk storage, a semi-modern churner (Fig. 3g) for churning, an iron pot locally called *Biret-dist* for buttermilk cooking, and a plastic or metal sieve locally called *Gingilcha* (Fig.3f) for curd separation were also identified. These findings align with Berhe *et al*. (2017) and Seifu and Tassew (2024), who reported the use of plastic containers for milking and milk product storage in different regions of the country. Additionally, Tseday et al.(2024) reported that smallholders in Southern Ethiopia performing cash crop based production systems are using modern devices for milking, storage and transportation. The similarities between the current study and the cited previous findings may be due to cultural similarities, availability, or changes in practices over time. Notably, traditional containers are highly worn and are gradually being replaced by modern equipment in the study areas.

Figure 3: Ayib processing steps with different visual aids.

3.4. Cultural value of Ayib

The assessed cultural value of Ayib is presented in Table 2. The study discovered that the connection of Ayib with family and community culture was an essential part of day-to-day living in the study areas. A majority of the surveyed families (96.7%) include Ayib in their daily meals, which is crucial for preserving cultural identity and familial ties. The interviewees also revealed that traditional values and cultural knowledge were passed down through families' use of Ayib. They emphasized that preparing and consuming Ayib helps to maintain culinary traditions and improve family relationships. 89% of the respondents mentioned that Ayib was shared throughout communities on special events, including festivals, cultural food showcases/exhibitions, religious beliefs, and holidays like the Ethiopian New Year and Christmas. As noted by respondents, through these cultural events, communities can exchange traditional knowledge on how to handle and prepare Ayib. Additionally, 77.6% and 79.5% of the respondents understand that Ayib also has significant symbolic significance in traditional marriage and social

gatherings, respectively. The interviewees claimed that Ayib was served as a side dish with various stews during traditional marriages and social gatherings in the research areas. In traditional marriage, Ayib is highly valued. Interviews also revealed that 59% of respondents understand the regional identity of Ayib, while 38.1% did not understand the regional symbolism of Ayib. This highlights the significance of Ayib for social cohesion, cultural representation, and nutritional benefit. However, 89.41% of the survey respondents were unaware of the connection of Ayib with cultural ceremonies such as death. The communities in the study area consider traditional Ayib to hold great importance within their customary and cultural systems. The present study is in line with a study by Nigussie et al. (2020) that found traditional foods are associated with celebrations like holidays, festivals, social gatherings, funerals, and special occasions in Ethiopia. Additionally, Chukwurah et al. (2024) emphasize the significance of traditional food in maintaining cultural identity, social cohesion, and cultural heritage in the Nigerian state of Enugu, and Kadir et al. (2025) found that Jaji cheese is one of the traditional foods linked with Turkish cultural heritage.

Table 2: Cultural values of Ayib in the study areas

Cultural value of Ayib	Participant response (%)		
	Understand	Hesitate	Not understand
Is Ayib included in the household's daily meals?	96.7	3.30	0.00
Is Ayib shared during special events?	89.00	11.00	0.00
Does the community use of Ayib in traditional ceremonies, like as for a traditional marriage?	77.60	8.10	14.30
Is Ayib used in social gathering within the community?	79.50	2.90	17.6
Does Ayib represent regional identity?	59.00	2.90	38.10
Knowing the use of Ayib in other cultures, such as death ceremonies	10.59	0.00	89.41

3.5. Principles of Ayib (Ethiopian Cottage Cheese) processing

3.5.1. Milk souring and Fermentation

Table 3 shows the numbers of days required for milk fermentation to prepare *ergo (*yogurt*),* which is a raw material used in dairy product processing. The results indicate significant differences ($p<0.05$) in the number of days required for milk fermentation among the study districts. The reported overall average fermentation time was 3.9 days in the study area. In comparison, the highest (4.1 ±0.105) milk fermentation days were observed in the Ejersa-Lafo district, while the Dandi district had the lowest (3.6 ±0.102) fermentation days. The variations in fermentation days among the study districts can be attributed to factors, such as ambient temperature (higher temperatures generally accelerate fermentation by promoting microbial activity, while lower temperatures slow it down), hygienic conditions (cleanliness during milking and handling impacts microbial contamination, which can either speed up or slow down

fermentation depending on the types of microbes introduced), container type and material (traditional containers, such as those made of clay or wood, may carry beneficial microbes that influence fermentation rates, while modern, sterile containers might yield different rates due to less microbial diversity), storage conditions (placement of the container in warm or cool environments, or exposing it to sunlight or shade, can impact fermentation times by maintaining the viability and activity of starter cultures), and the presence of additives (in traditional practices, herbs or other additives are sometimes added to influence taste, aroma, or microbial balance, which can also impact fermentation speed). Next, the spontaneously fermented milk was churned using traditional and/or modern utensils such as clay pots or semi-modern churners to obtain *baadu*/buttermilk, the initial substrate for Ayib processing. The results are consistent with the findings of Seifu and Tassew (2024), who indicated that milk fermentation lasts for 3.8 days in northwestern Ethiopia. This is also supported by a previous study by Gonfa *et al*.(2001), who reported a fermentation period of 2-4 days in Ethiopia. In contrast, Yilma *et al*. (2007) found that milk fermentation lasts for 6 days in Holetta. Nyamakwere *et al*. (2021), however, reported a fermentation period of 1-3 days in Zimbabwe. The study also contradicts Bytyqi et al. (2017) and Gagara et al. (2019), who stated that milk fermentation lasts for 24-48 hours in Kosovo and overnight in Niger, respectively. The difference between the present and referenced findings is likely due to storage temperature, container type, and hygienic practices.

3.5.2. Estimating the volume of baadu/buttermilk needed to produce one kilogram of Ayib

The average volume of *baadu*/buttermilk required to produce one kilogram of Ayib varied significantly ($p<0.05$) among the study areas, as shown in Table 3. The overall volume of *baadu* utilized to produce one kilogram of Ayib in the study area was 8.5L. In Toke-Kutaye, the estimated average volume of *baadu* heated at a time per household to produce one kilogram of *Ayib* was 8.7L, while in Ambo it was 7.0L, in Dandi it was 9.3L, and in Ejersa-Lafo it was 8.9L. Dandi district reported a higher volume of *baadu*/buttermilk, whereas a lower volume was recorded in Ambo to produce one kilogram of *Ayib*. These differences among the study districts may be attributed to factors such as the breeds of animals providing milk, seasons and feeds, stage of lactation, and processing experience (including cooling time, heating duration, and filtration methods). The average volume of buttermilk reported in this study aligns with the values reported by Abebe *et al*. (2014), who described 9L. This study is also supported by the results reported by Seifu and Tassew (2024), who stated that 8.9L of buttermilk were used to produce one kilogram of Ayib. In addition, Gonfa *et al*. (2001) reported 8L of buttermilk in Ethiopia, which is consistent with the current result. The similarity between the current and referenced findings is likely due to the protein content of milk and breeds. However, Derese *et al*. (2016) reported a higher value (13.63L of buttermilk) than the current finding to produce a kilogram of Ayib in the West Shewa zone.

3.5.3. Heating period and processing techniques of Ayib

Significant differences ($p<0.05$) in *Baadu* (buttermilk) heating periods were reported among the study areas (Table 3). The overall heating period for *baadu* to produce Ayib in the study areas was 30.2 minutes. In detail, in Toke-Kutaye, Ambo, Dandi, and Ejersa-lafo district, the average heating period for *baadu*/buttermilk were 31.9, 32.6, 26.8, and 29.4 minutes, respectively. The longest *baadu* heating periods

was recorded in Ambo district, while the shortest was reported in Dandi. The variations in cooking times observed among the study districts may be attributed to differences in containers, fire intensity, and cultural practices. As reported, Ayib processing was initially started by slowly cooking *baadu* over a slow intensity fire in a clay pot. The cooked *baadu* was then removed from the heat source and left in lidded clay pots to cool overnight at room temperature. Respondents mentioned that the lids allow vapor circulation inside the container, which facilitates the maturity of the curds. Curd maturity was determined by finger touch, as firmness indicates maturity according to their reports. Once maturity was reached, the respondents separated the curds and whey using a sieve. They emphasized that curd separation in hot conditions should be avoided, as it can reduce yield by removing curds with the whey. These findings align with Seifu and Tassew (2024), who also reported 30 minutes of heating time. However, the cultural processing techniques of Ethiopian Ayib are compared with those of other countries. Guetouache and Guessas (2020) reported that *klila*, the Algerian traditional cheese, is produced by curdling milk and pressing the curd. Benyahia et al. (2025) reported that *Djeben*, the Moroccan traditional cheese, involves curdling raw milk with rennet and whey from the previous production batch, draining and shaping the curd into small rounds. Setiarto et al. (2025) described the production of *Dangke*, the Indonesian traditional cheese, which includes heating milk, adding papaya sap, stirring, separating the whey, leaving the curd overnight, and wrapping it with banana leaves for ripening. Furthermore, the traditional manufacturing techniques of *Wagassirou* cheese in Benin (Guetouache and Guessas et al., 2020; Nyamakwere et al.,2021), *Kariesh, Ras* and *Domiati* in Egypt (Adlo et al.,2013; Nyamakwere et al.,2021), *Gibna bayda* in Sudan (Osman and Omer,2007), *Wagashi* in Togo, Mali, Niger, Burkina Faso, Ghana (Nyamakwere et al.,2021), *Wara* and country cheese in Nigeria, and *Huguenot* in South Africa (Nyamakwere et al.,2021), *Halloumi* and *Baladay* in Lebanon, and *Jebna haloum* and *Jebna Arabia* in Syria (Marina et al.,2022) are outlined, showing differences from Ethiopian Ayib. The traditional cheese processing techniques vary from country to country possibly due to the adoption of indigenous knowledge, social and cultural traits, and sources of raw materials.

On the other hand, this study compared Ayib processing techniques with other traditional Ethiopian dairy products. Accordingly, Alganesh and Yetenayet (2017) reported on the processing techniques of butter and ghee, while Beshir (2020) discussed the processing techniques of *Ititu* (Yogurt) in the Borena zone, which differ from Ayib processing techniques.

In a focus group discussion (FGD), an *Ayib*-making method without using heat was mentioned. Respondents explained that they let *Baadu* sit in the container for a few days without applying any external force. In this case, the curd and whey separated naturally. They described two methods for curd separation: using a ladle to scoop the curds or filtering the whey through a small hole between the container and its lid. They noted that curds made using this method were softer, which could be a drawback. However, this processing approach preserves the product's chemical composition, giving it an advantage over *Ayib* processed with heat.

Table 3: Fermentation length, heating times and volume of buttermilk required to produce a kg of *Ayib* (Mean ±SE)

Variables category	Districts					p
	T/Kutaye (n=48)	Ambo (n=52)	Dandi (n=57)	E/Lafo (n=53)	Overall (n=210)	
Fermentation length in days	3.8^{ab}±0.111	3.9^{ab} ±0.106	3.6^{b}±0.102	4.1^{a}±0.105	3.9±0.106	0.022
Heating times in minutes	31.9^{a} ±1.269	32.6^{a}±1.219	26.8^{b}±1.164	29.4^{ab}±1.207	30.2±1.215	0.028
Volume of buttermilk in liters	8.7^{a}±0.322	7.0^{b}±0.310	9.3^{a}±0.296	8.9^{a}±0.307	8.5±0.309	0.009

T/Kutaye= Toke-Kutaye, E/Lafo= Ejersa-Lafo; Values in the table are least square mean ± standard error. Mean with different superscript letters within the same row shows significant difference ($p<0.05$).

3.6. Indigenous hygienic practices during *Ayib* processing

3.6.1. Personal hygiene

Table 4 presents the personal hygiene practices of the sample respondents in the study areas. All respondents practiced personal hygiene, with the study revealing significant differences in hygienic practices ($P<0.001$). 70.95% of respondents maintained personal hygiene by washing their hands, while 29.05% washed their hands and covered their hair. Respondents reported either washing their hands with water and soap (70.95%) or with water alone (29.05%). Variations in personal hygiene practices across the study areas may be attributed to limited awareness of the importance of hygiene, economic disparities, and lack of access to clean water. Personal hygiene practices, including hand washing and covering hair during Ayib processing, are implemented to control disease transmission and protect consumer health. Hand washing and hair cover hold cultural significance, deeply rooted in the community and considered beliefs. The results indicated that personal hygienic practices were observed for ritual and symbolic reasons during religious ceremonies and in particular everyday situations, as supported by focus group discussions. These results are consistent with Abera (2023) and Shewangzaw *et al*. (2016), who emphasize hand washing as a crucial step in dairy processing in various regions of Ethiopia. In contrast, Ramon et al. (2017) reported that dairy product handlers in the Salta region of Argentina did not cover or tie back their hair. This difference may arise due to differences in awareness and cultural norms that could account for discrepancies.

There were significant differences ($P<0.001$) in water sources for personal hygiene across the study districts (Table 4). The majority of the respondents used river water, followed by tap, bore well, and spring water to carry out their personal hygiene during Ayib processing. Differences in water sources among study areas may stem from variation in environmental conditions. This contrasts Asresie et al. (2018)

report of borehole and tap water as primary sources for hand and container cleaning. Variances in agro-ecological conditions, infrastructure availability and water preferences likely explain differences between current and previous findings.

Table 4: Personal hygienic practices during *Ayib* processing in the study areas

Variables	Category (%)	Districts					X^2-value
		T/Kutaye (n=48)	Ambo (n=52)	Dandi (n=57)	E/Lafo (n=53)	Overall (n=210)	
Hygienic practices	Yes	100	100	100	100	100	-
	No	0.00	0.00	0.00	0.00	0.00	
Personal hygiene practices	Only hand wash	60.42	65.38	71.93	84.91	70.95	1950.9**
	Hand wash and hair cover	39.58	34.62	28.07	15.09	29.05	
Methods of hand wash	Water alone	7.55	17.31	68.42	18.75	29.05	35.219**
	Water and soap	92.45	82.69	31.58	81.25	70.95	
Sources of water	River	68.75	80.77	82.46	83.02	79.05	338.76**
	Tap	16.67	11.54	12.28	11.32	12.86	
	Spring	2.08	1.92	0.00	3.77	1.90	
	Bore-well	12.50	5.77	5.26	0.00	6.19	

**=significant at P<0.001, X^2= chi-square

3.6.2. Equipment hygienic practices and indigenous plants used

Cleaning: In the research areas, smallholder farmers have a long-standing custom of cleaning Ayib storage and processing equipment with various plant leaves. The respondents cleaned the Ayib processing and storage equipment using different methods, which varied significantly (p<0.001) among districts (Table 5). 85.095% used hot water and soap, while 11.414% opted for cold water and soap. The study revealed that *Kusaye* (29.50%), *Koshoneta* (17.60%), *Tosign* (17.60%), *Oloto (*3.30%), and a combination of *Tosign* and *Koshoneta* (31.90%) were leaves from local trees traditionally used to clean Ayib processing utensils with water. *Oloto* was the only plant leaf reported from Ejersa-Lafo district, while *Kusaye* and *Tosign* were frequently reported in Toke-Kutaye and Ambo districts for cleaning utensils. Using natural plant materials for cleaning Ayib processing equipment demonstrates indigenous knowledge systems that leverage local resources. Traditional practices include cleaning utensils with specific plant leaves and using hot/cold water with soap before and after processing were applied to prevent contamination, remove

residues, extend fermentation time, and enhance product scent and flavor. These traditional hygienic practices are deep-rooted within the community. Cultural practices, agro-ecology, and plant preferences likely explain the variation among study areas. These findings align with Derese et al.'s (2016) use of herbal plants for utensil cleaning in the West Shewa zone, but differ from Tewodros and Muluken's (2018) emphasis on *chifirig*, *Amija*, and *Embacho,* locally grown plants for utensil cleaning in the South Wollo Zone, Tsedey et al. (2024) who studied in Southern Ethiopia and identified *nech bahirzaf* (Eucalyptus globulus Labill.), *koseret* (Lippiaabyssinica), and *tenadam* (Ruta chalepensis) as the main plant used. Abdela et al.(2024) also mentioned Eucalyptus globulus and Ruta chalepensis for milk container cleaning, while Asresie et al. **(**2018**)** described soap use with cold and hot water for Ayib container cleaning in Eastern Gojjam.

Drying: Overall, 31.9% of respondents in the study areas reported that after cleaning, the equipment was dried, which was statistically significant difference among the study districts ($p<0.001$), as shown in Table 5. However, 68.1% of the surveyed respondents did not dry their Ayib processing and storage equipment. Cultural practices and lack of awareness may be the reasons for the differing results among the research areas. According to the respondents, containers were dried by being placed upside down to allow for adequate drainage of any remaining water droplets (Table 5). The current study closely matched the findings of Shewangzaw et al. (2016), who found that all respondents in Gondar town dried their containers after cleaning. Similarly, Abera (2023) stated that to reduce microbial contamination, milk and milk product storage equipment must be properly cleaned and dried in an upside-down position before use. Cultural practices and social trends are presumably the basis of agreement between the present and the referred findings.

Fumigation (*Qoraasuu*): All respondents reported that fumigation of containers was a common hygienic practice in the studied areas, with significant differences ($P<0.001$) in the types of plants used across locations (Table 5). In Dandi and Ejersa-Lafo districts, *Ejersa* (*Olea Africana*) was commonly used, while in Ambo and Toke-Kutaye districts, both *Ejersa* (*Olea Africana*) and *Qadiidaa* (*Rhamnus Staddo*) were reported. The fumigation method varied based on equipment material. For example, calabash and plastic-made equipment were easily burned by fire flames. Therefore, they should be fumigated by placing the container in an upside-down position on the chips of the smoke plant, while the clay pot could be fumigated by putting the chips of the smoke plant in the container, followed by capping it to allow the circulation of smoke throughout the container. Agro-ecological differences and the availability of plants might be causes of the variation in smoking plant preference among the study areas. Many studies have also reported *Ejersa* (*Olea Africana*) as a major plant used for fumigating Ayib processing and storage utensils (Tseday et al., 2024; Lemma et al., 2024; Befekadu et al., 2019; Tewodros and Muluken, 2018). Derese et al. (2016) also identified *Qadiidaa* (*Rhamnus Staddo*) and *Ejersa* (*Olea Africana*) for equipment fumigation plant in West Shewa zone. The survey indicated that farmers utilized fumigation of milk and milk product as a ritual and cultural practices to disinfect the vessels, extend fermentation times, and enhance the sensory and microbial quality of the product. This finding aligns with Alemu and Girma (2018b), who noted that plant-based fumigation can extend fermentation times. Similarly, Alganesh and Tola (2017), and Lemma et al. (2024) observed that fumigation with plant parts imparts a special flavor and odor to dairy products. The similarity of the smoking plants between the current and previous findings

is probably due to agro-ecological similarities and users' preferences. In contrast, Fisahaye (2016, unpublished) reported using *Hasiti* (*Erica arborea*), roots of *am-ae* (*Urticasimensis*), and *chili-aen* (*cadiapurpurea*) to smoke milk processing utensils in the highland, midland, and lowland of Endamohoni district of Tigray region.

Rubbing (*Foksuu*): Overall, 86.2% respondents reported that following fumigation, the inner surface of the container were rubbed or scrubbed with leaves from plant species, including *Lantana trifolia* and *Lippia adoensis*, prior to incorporating processed *Ayib* into the container (Table 5). The respondents rubbed the containers to eliminate charcoal residues from fumigation and to enhance the flavor of the final product. The technique of application and plant used to rub the milk and milk product container was similar to the findings concluded by Gonfa *et al*.(2001), Abebe et al. (2013), and Lemma et al. (2024) in different parts of Ethiopia. The similarity between the present and cited study might be attributed to the availability and preferences of plants, experience, cultural trends, and awareness about the advantages of container rubbing. On the other hand, the study reported by Ivayo (2022) indicated that *Lantana trifolia* had antimicrobial effects against the growth of *Mycobacterium fortuitum* and gram-positive bacteria, while Yared et al. (2014) reported that *Lippia adoensis* leaves had significant antibacterial activity against *S.aureus, P.aeruginosa, E.coli, and S.typhi*.

Table 5: Equipment hygienic practices and plant used in the study areas

Variables	Category (%)	Districts					X^2-value
		T/Kutaye (n=48)	Ambo (n=52)	Dandi (n=57)	E/Lafo (n=53)	Overall (n=210)	
Do you clean equipment	Yes	100	100	100	100	100	
	No	0.00	0.00	0.00	0.00	0.00	-
Equipment cleaning methods	Hot water and soap	87.50	78.85	85.96	88.07	85.095	417.77**
	Cold water and soap	9.125	16.061	11.04	9.43	11.414	
	Only cold water	1.201	0.00	3.00	0.00	1.050	
	Only hot water	2.174	5.089	0.00	2.50	2.441	
Equipment cleaning plants	*Only Kusaye*	58.33	61.54	1.75	1.87	29.50	54.762**
	Only Tosign	16.67	13.21	21.05	18.87	17.60	
	Only Koshoneta	29.92	9.62	21.05	16.98	17.60	
	Oloto	0.00	0.00	0.00	13.21	3.30	
	Tosign and *Koshoneta*	2.08	15.83	56.14	49.06	31.90	
Do you dry equipment	Yes	35.42	19.23	42.11	30.19	31.90	67**
	No	64.58	80.77	57.89	69.81	68.10	
Position of equipment placement to dry	Upside down	35.42	19.23	42.11	30.19	31.90	-
	Upside up	0.00	0.00	0.00	0.00	0.00	
Do you fumigate equipment	Yes	100	100	100	100	100	-
	No	0.00	0.00	0.00	0.00	0.00	
Equipment fumigation plants	Only *Ejersa*	39.58	13.46	91.23	92.45	59.18	84.686**
	Only *Qadida*	4.12	5.77	8.77	0.00	4.66	
	Ejersa and Qadida	58.33	80.77	3.51	7.55	36.16	
Do you rub	Yes	85.42	88.46	91.23	81.13	86.20	182**

equipment							
	No	14.58	11.54	8.77	8.87	13.30	
Equipment rubbing plant	Only *Lantana trifolia*	14.58	11.54	17.54	11.32	13.30	90.886**
	Only *Lippia adoensis*	8.33	34.62	8.77	20.75	18.10	
	Lantana trifolia and *Lippia adoensis*	62.50	42.30	64.91	49.06	54.80	

**=significant at P<0.001, X^2= chi-square

3.7. Traditional preservation methods and shelf life of Ayib

Figure 4 displays *Ayib* preservation methods in the study areas. Approximately 86.67% of respondents stored the processed *Ayib* at room temperature without any additional preservation methods. In contrast, 3.81% of respondents submerged it in cold water, and 2.38% of them kept the curds together with the whey by regularly replacing the old whey with fresh while maintaining room temperature. Additionally, 7.14% of respondents indicated that they preserved the processed *Ayib* in a refrigerator. The choice of different preservation methods is likely influenced by indigenous knowledge, cultural practices, availability of infrastructure and technology, efficiency of the methods, and amounts of the produced product. The reasons behind the use of preservation are to improve the keeping quality of the products, such as shelf life and sensory properties. This research aligns with the findings of Hounsou et al. (2021) and Philippe *et al.*(2013), who documented that *Wagassirou* was preserved in Benin by soaking it in whey, untreated water, and colored water. However, the study contradicts the findings of Shewangzaw *et al.* (2016), who reported using a refrigerator to preserve dairy products in Gondar, Ethiopia. On the other hand, Hounsou *et al.*(2022), and Philippe *et al.* (2013), described the traditional preserving of waragashi in Benin, including daily boiling, chilling, grilling, frying, sun drying, smoking, and soaking in water extract of sorghum panicle. Methods, experience, social and cultural trends, and technology availability are likely the reasons for the discrepancy between the present and referenced findings.

Ayib storage periods reported across the study districts is presented in Figure 4. Most respondents (86.86%) indicated that *Ayib* had a shelf life of 2 to 3 days when stored at room temperature. Conversely, respondents noted that additional treatments, such as storing the curd in cold water, whey, or a refrigerator, could extend its shelf life to 4 days or even more than a week. The nature of the produced product (hard or soft *Ayib*), storage containers, temperature, and preservative methods may be the reasons for storage period similarities across the study areas. The current study's findings are consistent with those of Berhe et al. (2017), who reported a 2-3 day shelf life at high ambient temperatures and a 7-day storage period at 4°C. Additionally, Nyamakwere *et al.* (2021) reported that *Ras* cheese from Egypt had a 2-3 or 4-5 day shelf life when stored in cooled water, *Wagashi* from Mali, Niger, Burkina Faso, Ghana, and Mauritania had a 3-day shelf life without brine, West African's traditional cheese, *wara,* had a 2-3 day shelf life at room

temperature, Southern Algeria's *Aoules*, Madagascar's *Fromage blanc*, Sudan's Gibna, and *Mashanza* from the Democratic Republic of the Congo had a shelf life of less than seven day. The similarity of the result between the current and referred findings is due to preservation and processing technology, hygienic practices, and the nature of the product. In contrast, Makhal and Kanawjia (2022) reported that commercial cottage cheese has a shelf-life of 7–15 days (approximately 2 weeks). Additionally, Nyamakwere *et al*. (2021) found that Northern Benin's *wagassirou* has a one-month shelf life, while Karish from Egypt has a 7–11 day shelf life when submerged in whey. The dissimilarities of the current and cited findings on the shelf life of the product are probably due to the scope of production (commercial vs. home consumption) and preservation methods.

4. Conclusion

This study concludes that traditional knowledge and processing techniques of Ayib (cottage cheese), in accordance with an ethnographic viewpoint, are widely practiced in the West Shewa zone of Oromia, Ethiopia. Despite the availability of advanced food processing and preservation technology, farmers in the study areas continue to rely on traditional knowledge and techniques to process, handle and preserve Ayib. There is a gender division scenario in Ayib production that empowers women to ensure household food security. Additionally, Ayib production plays a crucial role in developing social ties, identity, and cultural sharing among the community. Traditional preservation techniques such as storing the product in whey and cold water are documented. Plant-based hygienic practices are the primary option in the study areas. In addition, personal hygiene practices are undertaken to ensure the quality of the product. However, even with these traditional quality improvement measures, the product's quality may still substandard and unsafe for consumption. In general, the study provides insightful information about the documentation of traditional knowledge and Ayib processing techniques, its cultural significance, gender roles in processing, quality improvement through traditional methods, and the role of Ayib in household food security and local economic development. This information is valuable for researchers, policy makers, dairy technologists and producers.

Therefore, further studies on ethnographic dairy practices, commercialization of the product by changing cultural taboos over time through training, phytochemical composition and the microbiological effect of plants traditional used for quality improvement, microbial content of the product, and improvement of processing, handling, and preservation practices of Ayib are necessary to plan a sustainable dairy development program at a smallholder level. This can be achieved through collaboration with stakeholders and dairy technologists.

Declarations

Ethics approval and consent to participate

Prior to the start of the survey, smallholder farmers were informed about the purpose of the study. The study respondents were informed about the importance of the information they would provide, assured of the confidentiality of their responses, and clearly told about their freedom to decline participation or

withdraw from the research at any time. The farmers were reassured that there was no risk in participating in the study and were specifically informed about the anonymous handling of individual replies. Additionally, the study received ethical approval from Haramaya University, School of Animal and Range Sciences (SARS).

Consent for Publication

Not applicable

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflict of Interest

Authors declare no conflict of interest

Acknowledgments

The authors are thankful to all the enumerators involved in survey data collection. The financial (salary) support (grant no.11/1-12022/1089/35) of Bule Hora University for the 1st author is also highly appreciated.

Funding statement

This research did not receive external funds, but it was performed as part of the employment of Bule Hora University

Author contributions

The corresponding author was responsible for title selection, proposal development, data collection, date entry and analysis, and writing the draft of the manuscript; whereas all co-authors were responsible for title approval, supervision and drafted manuscript edition.

References

1. Abebe, B., Mohammed, Y., Zelalem Y.(2014) Handling, Processing and Utilization of Milk and Milk products in Ethiopia. World Journal of Dairy and Food Scienc 9(2):105-112.
2. Abebe, B., Zelalem, Y., Ajebu, N. (2013) Handling, processing and utilization of milk and milk products in Ezha district of the Gurage zone, Southern Ethiopia. Journal of Agricultural Biotechnology and Sustainable Development 5(6): 91-98.
3. Abera,T. A. (2023) Review on Handling, Hygienic Practices and Microbial Quality of Raw Milk in Ethiopia. International Journal of Agriculture and Nutrition 6 (1): 08-12.

4. Abdela, E., Tesfaye, A., Alemayehu, A., Yadeta, N., Sisay, I. (2024) Effect of Cleaning Milk Equipment with Plant Material on Microbial load, Quality and Organolwtic Character of Milk. Frontiers in Environmental Microbiology 10(4), 84-88.
5. Adlo,T., Fady, A., Ola, A.H.O. (2013). History, Processing and Quality Enhancement of Traditional Egyptian Kariesh Cheese: A Review. Food Science and Technology 1(1): 1-6.
6. Alemu, T., Girma, M. (2018b) Preservative Plants and Preservation methods of milk and milk Products in south Wollo Zone, Amhara region, Ethiopia. Abyssinia Journal of Science and Technology 3(2):13–18.
7. Alganesh, T., Tola, Y. (2017) Traditional butter and ghee production, processing and handling in Ethiopia: A re-view. African Journal of Food Scie11 (4): 95–105.
8. Alganesh, T., Yetenayet, B. (2017) Traditional butter and ghee production, processing and handling in Ethiopia: A review. African Journal of Food Science 11(4): 95-105.
9. Asresie, A., Yilma, Z., Seifu, E., Lemma, Z., Mitiku, E., Mohammed, Y.K.. (2018) Handling, Processing, Utilization and Marketing of Ayib (Ethiopian Traditional Cottage Cheese) Varieties Produced in Selected Areas of Eastern Gojjam, Northwestern Highlands of Ethiopia. Open Journal of Animal Science 8: 51–73.
10. Ayinde, I. A., Olanite, J. A., Akerele, A., Odedoyin, M. O. (2022) Economics of Cheese Production among Nomadic Households in Ogun State, Nigeria.
11. Befekadu, T., Misganaw, W., Enidegena, A., Genene, T. (2019) Traditional Knowledge of Milk Production, Processing and Utilization in Borena Zone, Ethiopia. World Journal of Dairy and Food Science 14 (2): 210-221.
12. Benyahia, A. F., Bouali, A. Meghzili, B. Foufou, Saadi, E. S., EL-Mechta, L., Zitoun, O.A. (2025) Review of the Main Traditional Cheese-making in the Mediterranean Basin. Journal of Ethics Foods 12-31.
13. Beshir, H. (2020) Production Practices of *Ititu* (Traditionally Fermented Cow Milk) in Selected District of Borena Zone, Oromia Regional State, Ethiopia. Science Research 8(2): 52-58.
14. Berhe, T., Finn, K. V., Richard, I., Seifu, E., Kurtu, M.Y., Hansen, E.B. (2017) Traditional Fermented Dairy Products of Ethiopia: A Review. East African Journal of Science 11(2):73–80.
15. Bytyqi, H., Berisha, K.., Hamidi, A., Sylejmani, D., Thaqi, M. (2017) A Survey on Traditional Cheese Production and Diversity in Kosovo. Bulgarian Journal of Agricultural Science 23 (1): 42–48.
16. Chala, G. K., Tizazu, Y. B. (2019) Review on Contribution of Indigenous Food Preparation and Preservation Techniques to Attainment of Food Security in Ethiopia. Food Science and Nutrition 8:3-15.
17. Chelule, P.K.., Mokoena, M.P., Gqaleni, N. (2010) Advantages of Traditional lactic Acid Bacteria Fermentation of Food in Africa. Current Research, Technology and Education Topics in Applied Microbiology and Microbial Biotechnology. 1159-1167.
18. Chukwurah, O.G., Okeke, O. F., Isimah, O. M., Enoguanbhor, E. Ch., Awe, F.Ch., N-Okeke, Sh.Guo, R.Ch., Nwafor, I.V., Okweke, Ch. A.(2024) Cultural Influence of Local Food Heritage on Sustainable Development. World 6(10): 1-27.

19. Danayit, A., Neima, A. (2025) The Role of Gender Norms in Transforming Dairy Farming and Empowering Women in Ethiopia: A Review. Asian Journal of Research in Biology 8(1): 34-41.
20. Dereje, D., Sintayehu, Y., Yetenayet, B.T., Taye,T. (2022) Contribution of Dairy Products to Farm Household Nutrition in Addis Ababa and Hawassa-Dilla milk sheds in Ethiopia. East African Journal of Science 16(1): 31-46.
21. Derese D B, Wari L F, Gemechu A T. (2016) Assessment of Traditional Butter Production and Preservation Techniques in West Shewa Zone, Oromia Regional State, Ethiopia. Journal of Biolology, Agriculture and Health 6(23): 6–21.
22. Essodolom, T., Batcha, O., Kadanga,K..K.. Souho, T., Amouzou, K.E., Tchabi, A. (2025) Microbiological Quality and Food Poisoning Risks of Artisanal Dairy Products from the Cantons of Pya and Yadè, Togo. African Journal of Food Science 19(7): 98-106.
23. Eyassu, S. (2023) Chemical Composition and Microbiological Quality of Metata Ayib : A Traditional Ethiopian Fermented Cottage Cheese. International Food Research Journal 20(1): 93–97.
24. FAO (Food and Agricultural Organization of the United Nations). (2017) Gender assessment of dairy value chains: evidence from Kenya. Rome, Italy.
25. Gabriele, B., Lucal, S., Raimondo, G. (2025) Gastronomic Treasures of Southern Italy: The role of wooden equipment and heritage cheeses. International Journal of Gastronomy and Food Science 40(2025): 101179.
26. Gagara, H. M., Sessou, Ph., Dossa, F., **Ahounou, S.**, Azokpota, P., Youssao, I., Gouro, A., Farougou, S.S. (2019) A Study on the Indigenous Methods of Processing Milk in Niger. Current Agricultural Research Journal 7(2): 213-223.
27. Gallina, A. (2016) Gender Dynamics in Dairy Production in Kenya: A literature review. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Copenhagen, Denmark.
28. Gonfa, A., H. A. Foster, W. H. Holzapfel. (2001) Field survey and literature review on traditional fermented milk products of Ethiopia. International Journal of Food Microbiology 68(2001):173–186.
29. Guetouache, M., Guessas, B. (2020) Various Traditional Dairy products in Africa and Algeria. Journal of Nutrition and Food Security 5(4): 400-408.
30. Hasan, M. N., M. Z. Sultan, Mar-E-Um, M. (2014) Significance of Fermented Food in Nutrition and Food Science. Journal of Scientific Research 6 (2): 373-386.
31. Housoun, M., Dabade. D.S., Gotz, B. Hounhouigan, M. H. Honfo G.F., Albrecht A., Kreyenschmidt, J., Hounhouigan, D. J. (2022) Handling Practices, Quality and Loss Estimation along the Value Chain of Waraashi, a Soft Cheese from Benin. African Journal of Food, Agriculture, Nutrition and Development 22 (7): 20774-20792.
32. ILRI. (2015) Ethiopia livestock master plan. International Livestock Research Institute, Addis Ababa, Ethiopia.
33. Ivayo, R. M. (2022) Antimicrobial activity, Toxicity and Phytochemical screening of Lantana trifilia leaf extracts. MSc thesis, University of Nairobi, Nairobi, Kenya.
34. SASJMP Pro. (2023).SAS Institute Inc. https://www.jmp.com

35. Kadir C, C. Merve, G. Ilhan. (2025) From traditional knowledge to gastronomic heritage: cultural value and chemical properties of Jaji cheese. International Journal of Gastronomy and Food Science 4(2025):1-9.
36. Kedir, A. A, A. A. Mohammed. (2024) Review on quality attributes of milk and commonly produced dairy products in Ethiopia. Heliyon 10(2024) e40089.
37. Lemma, H., Lechisa, A., Tibesso, G., Demissie, F., Loka, B., Dhengesu, D., Kumela, G., Kerbana, G., Daba Ch. (2024) Indigenous Knowledge on the Practice of Milk Container Fumigation and its Effect on Microbial Safety of Milk among Pastoral Communities in West Guji zone, Southern Ethiopia. Heliyon10(4): 1-9.
38. Makhal, S., S. K. Kanawjia. (2022) Effectiveness of thymol in extending keeping quality of cottage cheese. Journal of Food Science and Technology 51(9): 2022–2029.
39. Marina, M., M.D. Amira, M. Priti, M. Sajid, B. Fatma. (2022) Traditional Fermented Dairy Products in Southern Mediterranean Countries: From Traditional to Innovation. *Fermentation* 2022(8):743.
40. Nigussie, S. T., F. B. Girum, B. H. Tesfaye, A. H. Ashenafı. (2020). Traditional Foods and Beverage in Eastern Tigray of Ethiopia. Journal of Ethnic Foods 2020: 7-16.
41. Nyamakwere, F., G. Esposito, K. Dzama, E. Raffrenato. (2021) A Review of artisanal cheese making: An African perspective. South Africa Journal of Animal Science 51(3): 296-309.
42. Osman, A.O.E.O, I. A.H. Omer. (2007) Production of White Cheese (Gibna bayda) in Zalingei Area West Darfur (Sudan). Australian Journal of Basic Applied Science 1(4): 75.
43. Philippe, S., F. Sousaibou, A. Paulin, I.Y.A. Karim. (2013) Endogenous methods of preservation of wagashi, a Beninese traditional cheese. African Journal of Agricultural Research 8(3): 4254-4261.
44. Ramon, N. A., D.M.S. Vega, C.E. Ferrrer, A.P.C.Bruneri. (2017) Training Small Producers in Good Manufacturing Practices for Development of Goat Milk Cheese. Food Science and Technology 38(1): 134-141.
45. Seifu, E., A.Tassew.(2024) Small-Scale milk production, Utilization and Marketing of Traditional Dairy Products in Bahir Dar Zuria and Mecha Districts, Northwestern Ethiopia. Journal of Food Technology Research 1(2): 122–132.
46. Setiarto, B. H. R., N. Nur, A. Romulo, T. V. Herlina. (2025) Dangke: unveiling Indonesian Traditional fermented cheese from Enrekang, South Sulawesi. Journal of Ethnic Foods 2025: 12-16.
47. Shewangzaw, A., M. Ahmed, H. Nunu. (2016) Handling, Processing and Utilization of Milk and its products in Gondar Town, Ethiopia. Journal of Life Science and Biomedicine 6(6):120-126.
48. Tadesse, M., M.Fentahun, G.Tadesse.(2017) Dairy farming and its economic importance in Ethiopia:Review. W. World Journal of Dairy and Food Science 12(1):42-51.
49. Tamirat, K. (2021) Ethiopian Gender Dynamics in Dairy Production along the Climate Smart Dairy Value Chain. Journal of Veterinary Medicine and Animal Science 4(2):1082.
50. Tegegne, D., D. Chalachewu, Ch. Essa, A. Marelign. (2022) Impact of dairy production on smallholder Houselods Food Security in Central Gondar Zone Ethiopia. International Journal of Rural Management 1-20.

51. Tewodros, A., G. Muluken. (2018) Preservative Plants and Preservation Methods of Milk and Milk Products in South Wollo Zone, Amhara Region, Ethiopia. Abyssinia Journal of Science and Technology 3(2):13-18.
52. Tiruha, H. K., B. K. Jamal, Semedo-L. Teresa, K. M. Jovin. (2024) Insights on the microbiology of Ethiopian fermented milk products: A review. Food science and Nutrition 12: 6990–7003.
53. Tsedey, A., E. Mitiku, Y. Zelalem, B. Tesfemariam. (2024) The value of traditional milk products among smallholder farmers ofSouthern Ethiopia: handling, consumption and making of butter. Cogent food and Agriculture 10(1): 2378557.
54. Ulfina, G., K. Meseret, B. Amanuel, F. Lemma. (2019) Gender Roles in Dairy Cattle Production, Processing and Marketing in Two Selected Districts of West Shoa Zone of Oromia Regional State, Ethiopia. EC Agric 5.12 (2019): 01-14.
55. Yared, W., A. Tesfalem, A. Solomon. (2014) Evaluation of Antibacterial Activity and Phytochemical Constituents of Leaf Extract of Lippia adoensis. Asia Pacific Journal of Energy and Environment 1(1): 45-53.
56. Yilma, Z., G. Loiseau, B. Faye.(2007) Manufacturing efficiencies and microbial properties of butter and Ayib-Ethiopian cottage cheese. Livestock Research and Rural Development 19(7): 1-12.
57. Zerihu, A., T. Anteneh, D.Asnake, D. Tadesse, H. Tsion. (2025) Formulation and Evaluation of Probiotic Starter Cuture; Impact on Ethiopian Cottage Cheese'Ayib'Safety, Stability, Sensory Acceptability and Antiodidant Potential. One Health Outlook 2025: 7-17.

Figures

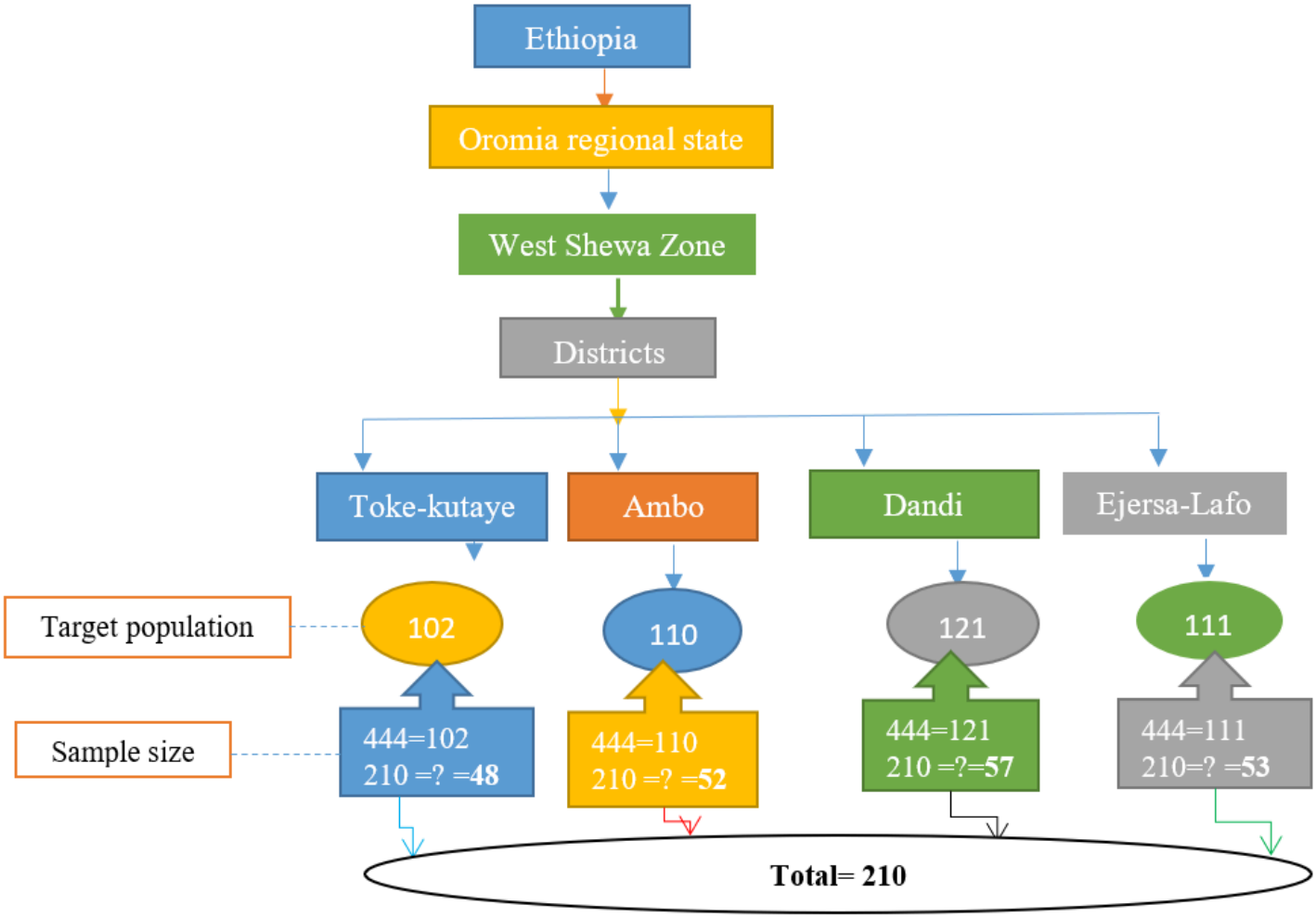


Figure 1

Proportionally determined sample size

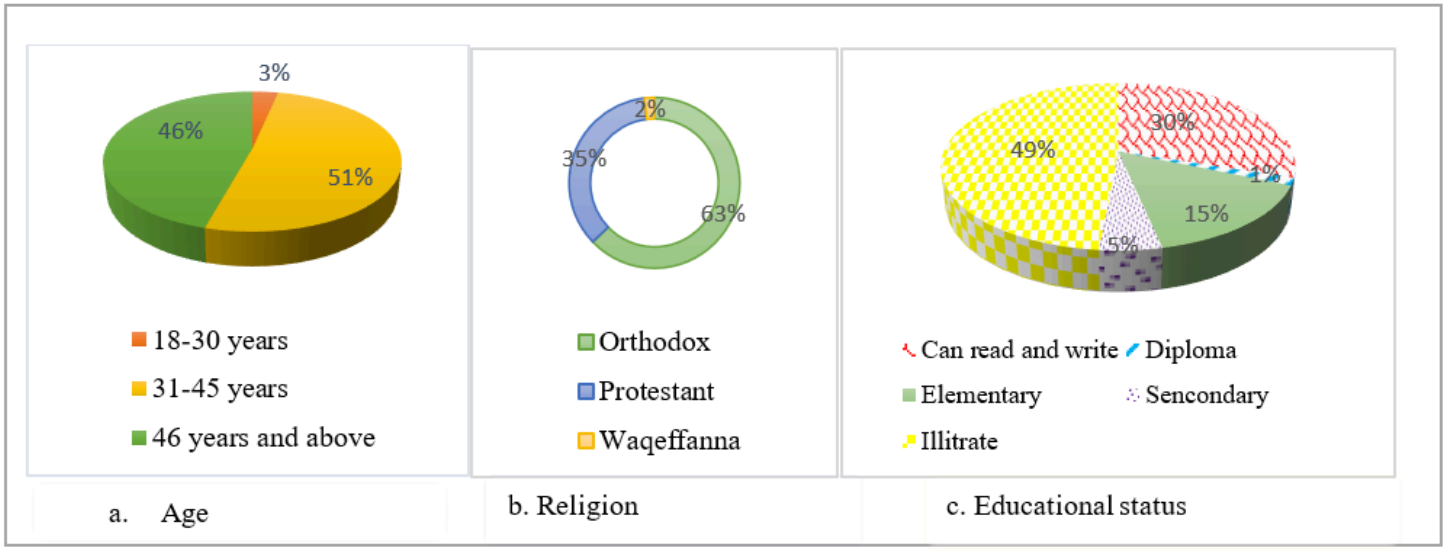


Figure 2

Demographic characteristics of the respondents

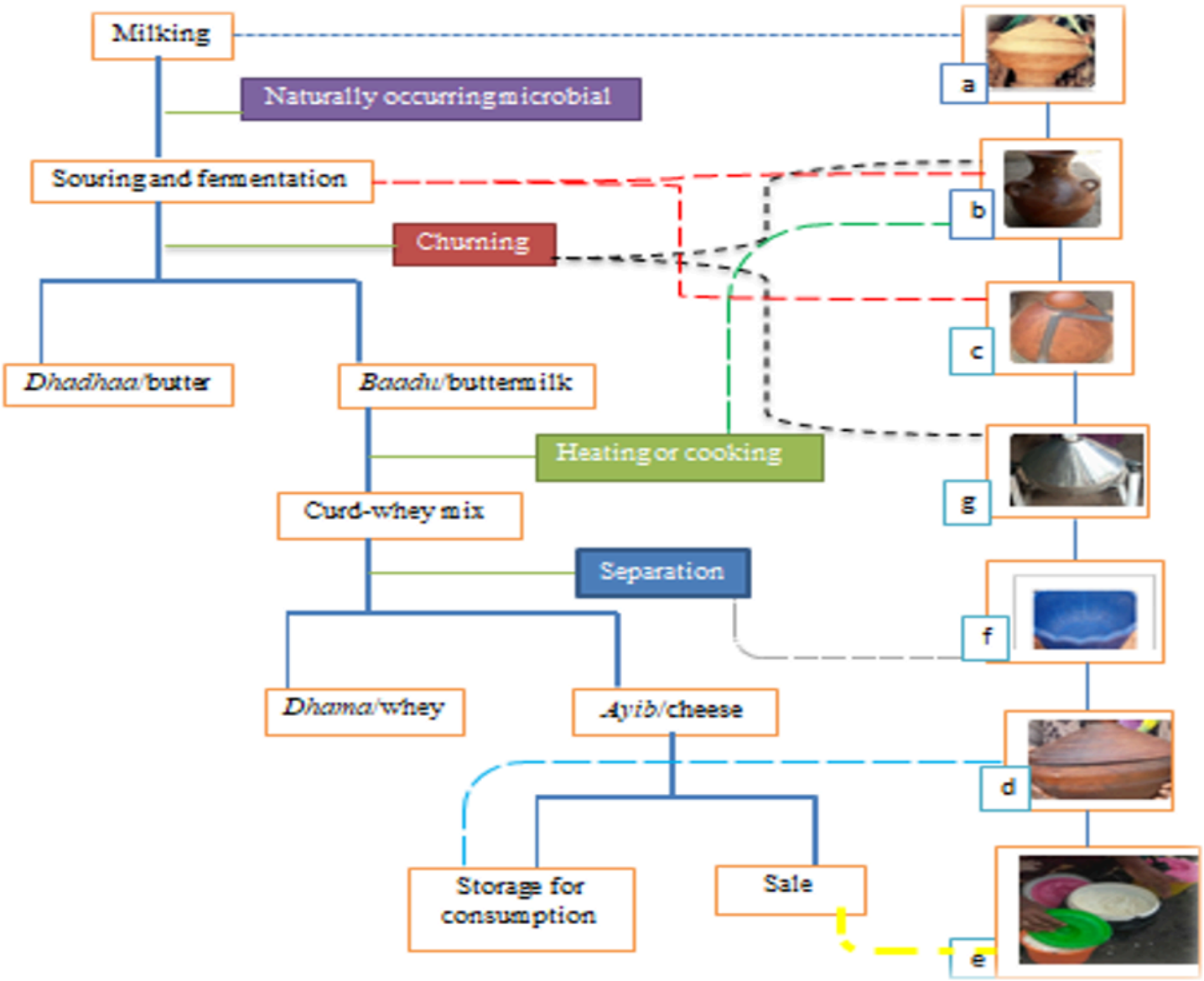


Figure 3

Ayib processing steps with different visual aids

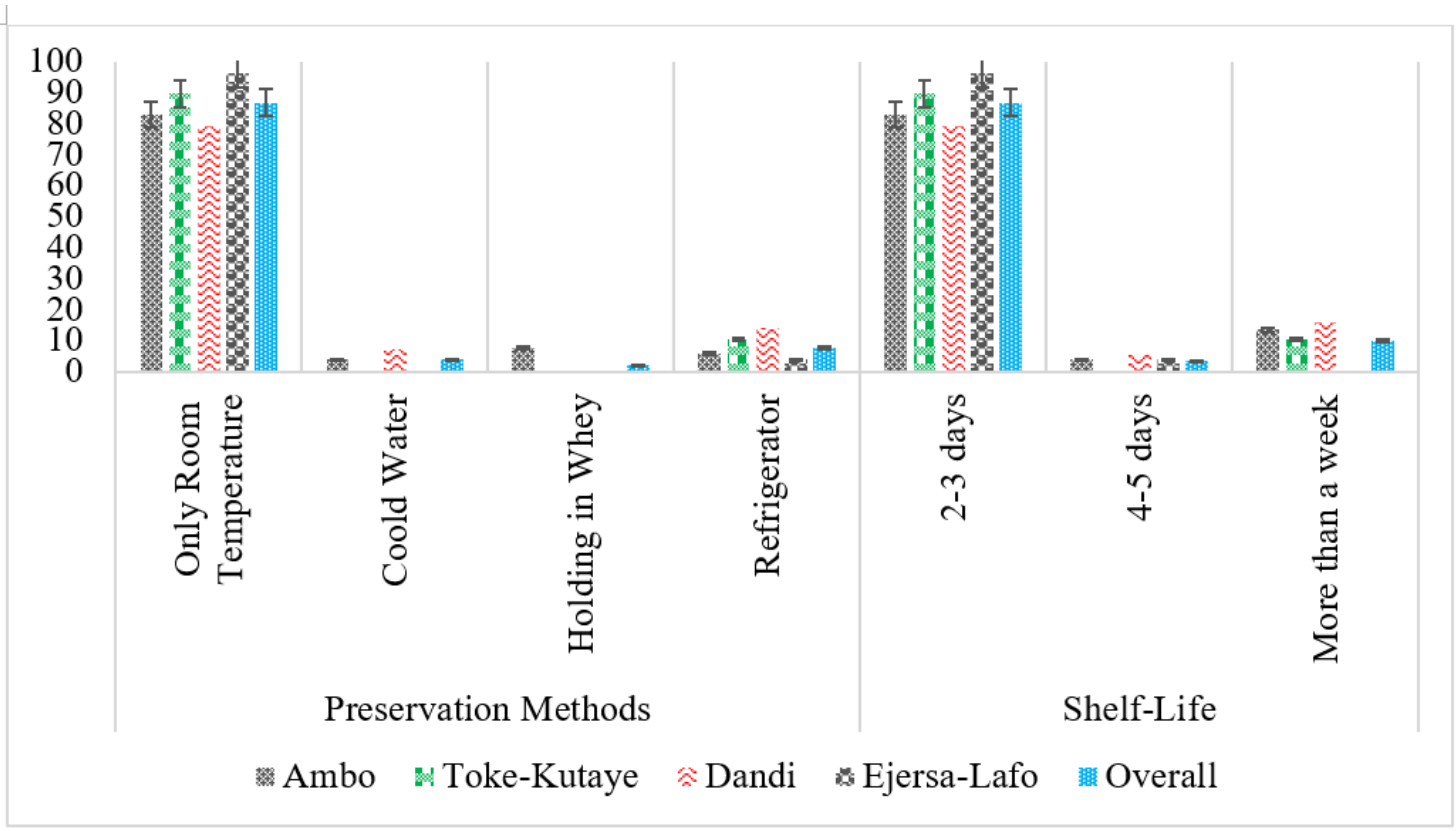


Figure 4

Indigenous *Ayib* preservation methods and shelf life of Ayib in the study areas