Preparation and Consumption of *Shameta*: An Indigenous Cereal-based Fermented Porridge in Western Ethiopia

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Abstract

Background: *Shameta* is a traditionally fermented porridge consumed by lactating mothers in Wollega Zones, western Ethiopia. However, so far, there have been no scientific data describing the ingredients used, the processing techniques applied, and the specific use of the food.

Objective: The objective of this study was to assess the production and utilization practices of traditionally produced *Shameta* as food for lactating mothers.

Materials and Methods: A community-based cross-sectional study was conducted to collect data from 150 lactating mothers using a semi-structured questionnaire. The data were analyzed employing descriptive statistics by using the IBM Statistical Package for the Social Sciences (SPSS) version 20 for Windows.

Results: The results of the study showed that 37.3% of respondents prepare *Shameta* from a combination of barley (95%) and maize (5%), followed by maize alone (33.3%) as primary ingredients. Almost all the respondents (93.3%) used rapeseed as a source of oil for making of the food. The preparation process included cleaning, milling the grains, and roasting the spices before grinding, and fermenting the product in two phases: The flours are mixed into the dough and fermented for a period of one to five days. The fermented dough is cooked into a porridge followed by the second phase of fermentation for 14 to 30 days. The fermented product is consumed either as the main dish or as a side dish. From the food safety point of view, most of the respondents (88.7%) had the opinion that there is no health problem associated with the consumption of the product.

Conclusion: *Shameta* is a fermented porridge made mainly from the combination of maize and barley, oilseeds, spices, and herbs to stimulate breast milk production and enhance recovery among lactating mothers. A combined effect of fermentation and cooking could contribute to better physicochemical properties, nutritional compositions, and product safety. Therefore, the information generated in this study will help to characterize the product and optimize ingredients and processing conditions to produce a better quality product for better milk production, rapid postpartum recovery, and strength of lactating mothers.

Keywords: Fermentation; Ingredients; Lactating mothers; Porridge; Postpartum recovery

1. Introduction

Fermented foods have been widely produced and consumed since prehistoric times as a traditional part of the human diet (Kabak and Dobson, 2011). Fermentation of foods can play a significant role in ensuring food and nutrition security for millions of people globally, particularly among marginalized and vulnerable groups (FAO, 2012). Traditional fermentation enhances flavour, increases taste and consumption, preserves food by enhancing shelf life, and improves nutritional and nutraceutical values (Satish *et al.,* 2013).

In Ethiopia, traditional fermented food products are usually produced from locally available ingredients, applying indigenous knowledge that varies from region to region according to the variation in climate, social patterns, and consumption practices (Kebede Abegaz *et al*., 2002; Belay Binitu *et al*., 2015). In many parts of Africa, rural residents produce and consume fermented food products from combinations of cereals such as maize, sorghum, millet, wheat, and barley (Mogessie Ashenafi and Tetemke Mehari, 1995). The fermenting microorganisms come from the raw materials, utensils used, or a previous batch of the fermented product through back slopping (Mogessie Ashenafi and Tetemke Mehari, 1995; Ketema Bacha, 1997). The process commonly occurs under uncontrolled conditions, which may result in inconsistency in the quality and safety of products (Kebede Abegaz *et al*., 2002). In addition,

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traditional fermentation is time-consuming, tedious, and complex with the production of a small volume of the final product (Belay Binitu *et al.*, 2015).

In most African countries, cereal-based fermented foods are consumed for breakfast, snacks, or as complete meals for all age groups (Blandino *et al.*, 2003; Ojo and Enujiugha, 2018). In Ethiopia, *Cheka,* and *Borde* are among the most popular traditional low alcoholic fermented beverages frequently prepared and consumed in central and southern parts of the country. Those who could not afford full meals (Mogessie Ashenafi and Tetemke Mehari, 1995, Kebede Abegaz *et al.*, 2002, Belay Binitu *et al.*, 2015) mainly consume these two products as meal replacements. However, *Shameta* is a locally consumed cereal-based fermented product exclusively prepared for lactating mothers in Wollega Zones. It is different from other related fermented products in terms of the composition of ingredients, method of preparation, fermentation time, purpose, and utilization.

Several studies have assessed and documented the ingredients, processing techniques, and purpose of production of different fermented foods in Ethiopia, such as *Borde* (Ketema Bacha *et al.*, 1998), *Checka* (Belay Binitu *et al.*, 2015), *Keribo* (Rashid Abafita, 2013), *Korefe* (Getnet Belay and Berhanu Andualem, 2016) and *Azo* (Letay Gebrelibanos, 2015). Even though *Shameta* porridge is a traditional food that has been used in the study area for a long time, the ingredients used, preparation techniques, and magnitude of utilization have not been scientifically studied and documented. To this effect, this work attempted to understand and document the existing practice to be used as a benchmark for subsequent actions. Furthermore, it could give pertinent information for researchers who want to make in-depth study about *Shameta* especially on the characterization of the food in terms of its physicochemical properties, microbial dynamics, and significances of optimizing ingredients formulation and processes conditions on safety and nutritional quality of the final product. In addition, this work revealed that consumption of "*Shameta*" with other common foods at different mealtimes would enhance postpartum recovery, strength and milk production of lactating mothers. Therefore, the objective of this study was to identify the type of ingredients used, preparation methods applied, and consumption of *Shameta* in the study area.

2. Materials and Methods

2.1. Description of the Study Area

The study was conducted in East Wollega Zone, western Ethiopia, located about 242 km from Addis Ababa. The Zone was selected based upon its widespread use of *Shameta* compared to other zones. According to CSA (2016) data, the Zone has 17 districts and a total population of 1,213,503, of whom 606,379 are men and 607,124 are women, with an area of 12,579.77 square kilometers (Figure 1). The geographic coordinate of the study sites falls within the latitudinal range of 8° 42' 0" N–9°24'N and longitude of 36°36'E–37° 52`E (Table 1). Some of the major crops grown in the Zone are teff, barley, wheat, faba bean, sesame, groundnut, field pea, maize, sorghum, finger millet, potato, tomato, and hot-pepper (Kifle Degefa *et al.*, 2020). A preliminary survey was conducted to ensure the availability of lactating mothers who produce and consume *Shameta*. Accordingly, three kebeles from Guto Gida district (Darge, Chalalaki, and Ukke), Jimma Arjo district (Bedasa Didesa, Hine, and 02 kebele of Jimma Arjo town), and Sibu Sire district (Bikila, 01 and 02 kebeles of Sibu Sire town) were purposefully selected, based on the availability of a sufficient number of lactating mothers in those areas (Figure 1).

Table 1. Description of the study area (district geographical location and meteorological information).

Location/ district	Latitude	Longitude	Average altitude (m a.s.l.)	Average temperature (^{o}C)	Mean rainfall (mm)
Guto Gidda	09° 07` N	37° 52'E	1900	27.5	1475
Sibu Sire	9°24'N	36°36'E	1918	20.7	1295
Jimma Arjo	8° 42' 0" N	36° 38' 57" E	2279	20.0	1500

2.2. Study Design

A community-based cross-sectional study was conducted in East Wollega Zone, Oromia Regional State, Ethiopia, from November 2019-February to 2020.

2.3. Study Population

Participants in this study were lactating mothers from the East Wollega Zone who delivered in 2019 (EWZHO, 2019). The list of lactating mothers in the year was considered a population frame to pick mothers randomly from selected districts and kebeles.

2.4. Sample Size Determination, Sampling Technique, and Data Collection

The sample size was determined according to Yamane's formula (Yemane, 1967) with a 90% confidence interval and an 8% margin of error. The total number of lactating mothers who gave birth in the Guto Gida, Sibu Sire, and Jimma Arjo districts was 3,661, of which 150 lactating mothers were recruited for the study.

$$\frac{N}{1+Nx(e)^2}=\frac{3661}{1+3661x(0.08)^2}=149.85\sim150$$

The lists of lactating mothers were taken from the districts' health offices. The mothers who delivered in 2019 were taken as the study population. Using the proportional sampling method, 150 households of lactating mothers were randomly selected from three districts. A semi-structured questionnaire was used to collect data related to the demography of the respondents, purpose of preparation, preparation and utilization practices, and safety issues of the product. The questionnaire was first translated to Afan Oromo language (widely spoken language in the study area), pre-tested, modified, and used. Data collectors were well acquainted with the questionnaire and data collection ethics. Four focus group discussions, each group possessing at least six members were conducted with experienced mothers, to triangulate information from the interview.

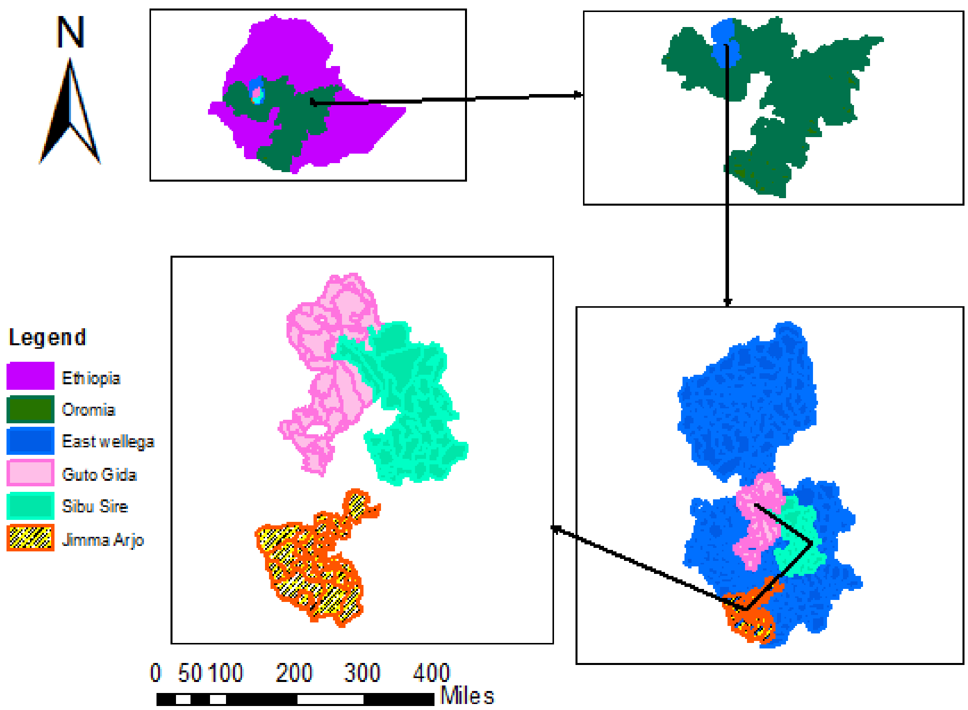

Figure 1. Map of the study areas showing selected districts, and a Zone in Oromia Regional State, Ethiopia

2.5. Data Analysis

The data were analyzed using simple descriptive statistics (including frequency, mean, and percentage) with the IBM Statistical Package for the Social Sciences (SPSS) version 20 for Windows. The processes of qualitative data analysis were followed according to Marshall and Rossman (2006). The content analysis was used for the qualitative analysis of the translated transcripts which were reviewed by researchers repeatedly. The condensed meaning units were identified and labeled with codes which helped to identify and formulate themes and sub-themes. Finally, the discordant views were included to highlight differing experiences or perceptions of the individuals and groups.

3. Results and Discussion

3.1. Socio-demographic Characteristics of the Study Population

In the present study, 98.7% of the participants were married and aged between 26 to 40 years (66.7%). The majority (90%) of the respondents were literate, while slightly more than one quarter (27%) had at least a college diploma (Table 2.). The majority (73%) of the respondents had three to five children, and 52% were employed and are working at different institutions and organizations. Almost half (45%) of the respondents reported earning an average monthly income of 2000 ETB (69 USD, at the exchange rate of the study period). About 90% of the respondents were Christians, and 83.3% were from the Oromo ethnic group. The higher number of Christians and ethnic Oromo in the study site is mainly because of the wide settlement of followers of the specified religion and ethnic group in the study area. In addition, *Shameta* has been exclusively produced by the same social groups for consumption by lactating mothers.

Table 2. Socio-demographic characteristics of lactating mothers involved in the study in western Ethiopia.

Variable	Category	Frequency (n =150)	Percentage (%)
Age group (year)	<25	27	18
	26–40	100	66.7
	>40	23	15.3
Education level	Illiterate	15	10
	Write and read-only	53	35.33
	High school	42	28
	Diploma and above	40	26.67
Marital status	Married	148	98.7
	Widow	2	1.3
Family size	≤2	24	16
	3–5	110	73.3
	>5	16	10.7
Occupational status	Employed	38	52
	Unemployed	78	25.33
	Business	28	18.67
	Housewife	6	4
Monthly income	>2000 ETB	67	44.67
	1999–1000 ETB	27	18
	999–500 ETB	50	33.33
	<500 ETB	6	4
Religion background	Coptic Orthodox Christian	42	28
	Protestant Christian	91	60.7
	Catholic	4	2.7
	Muslim	11	7.3
	Wakefata	2	1.3
Ethnic background	Oromo	125	83.3
	Amhara	12	8
	Gurage	8	5.3
	Tigre	5	3.3

Note: *1USD = 29 ETB at the time of the study; Wakefata = Oromo indigenous religion.*

3.2. Purpose of *Shameta* Preparation

In the present study, most respondents (87.3%) prepared *Shameta* during childbirth. Almost all the lactating mothers (99.3%) have been preparing and consuming *Shameta* as a cultural food with the assumption that the product contributes to the rapid postpartum recovery and strength of lactating mothers and enhances breast milk production for the newborn (Table 3).

Table 3. Variables and their frequencies characterizing the production and use of *Shameta* in western Ethiopia.

Variable	Category	Frequency (n = 150)	Percentage (%)
The specific time of *Shameta* preparation	During childbirth only	131	87.3
	During childbirth and fasting time of Coptic orthodox followers	11	7.3
	During childbirth and any other time	8	5.3
Purpose of preparing *Shameta*	Consumption at home	149	99.33
	Marketing	1	0.67
Experience of *Shameta* preparation	One time experience	13	8.7
	Two-time experience	46	30.7
	More than two times	91	60.7
Frequency of *Shameta* preparation during the lactating period	Once	129	86
	Twice	18	12
	More than two times	3	2
The volume of *Shameta* that can be consumed per day (L)	1	50	33.33
	1.5	100	66.67
Specific time to consume S*hameta*	After breakfast	78	52
	After lunch	3	2
	Before dinner	70	46
The consumption of *Shameta* increase the breast milk of the lactating mother	Yes	150	100
	No	0	–
The consumption of *Shameta* increases body strength and rapid recovery of lactating mothers	Yes	150	100
	No	0	–

Majority (86%) of the participants responded that they prepared *Shameta* only once during the lactation period. All respondents believed that the consumption of *Shameta* increases the production of breast milk and enhances the mother's body weight and leads to a fast postpartum recovery. Similarly, studies showed that other fermented beverages like *Borde and Cheka* are believed to enhance lactation (Kebede Abegaz *et al.*, 2002; Belay Binitu *et al.*, 2015). However, *Borde* has been used as a meal replacement among low-income people living in Ethiopia's central and southern parts (Ketema Bacha, 1997). In the current study area, the majority (66.67%) of lactating mothers consumed 1.5 L of *Shameta* per day, and slightly more than half (52%) consumed it during or after breakfast (Table 3).

3.3. Ingredients Used During *Shameta* Preparation

The ingredients being used for *Shameta* preparation are as shown in Table 4. Although Maize (*Zea mays*) and barley (*Hordeum vulgare*) were the main ingredients, the proportion of ingredients varies from district to district. For example, in Guto Gida district, *Shameta* is made either entirely from maize, or in combination with other ingredients [Maize (95%) + Barely (5%), or Maize (95%) + Faba bean (5%)], while in Jimma Arjo and Sibu Sire districts, *Shameta* is made by mixing Barley (95%) + Maize (5%), Barley (85%) + Maize (5%) + Wheat (5%) + Sorghum (5%), and Barley (85%) + Maize (5%) + Wheat (5%) + Faba bean (5%).

"*Shameta is made up of maize (95%) as a major ingredient with others such as barley (5%) or faba bean (5%)*." (A participant from group 1)

"*Shameta is made up of maize alone as major ingredient.*" (A participant from group 2)

"*The major ingredient of Shameta is barley (95%) with the addition of maize (5%) for only coloring purpose.*" (A participant from group 3)

"*The major ingredients during Shameta preparation is barley (90 or 85%) with the addition of maize (5%), wheat (5%), sorghum (5%) or faba bean (5%)*." (A participant from group 4)

Globally, many fermented foods are made of different cereal grains based on the availability of cereal grains and the existing practice. For example, *Akamu* and *Ogi* in Nigeria are made from maize, sorghum, and millet (Nwokoro *et al.*, 2012; Afolabi *et al.*, 2018). Indian *Ragi* is made from millet (Padmaharish *et al.*, 2018), Sudan's *Medida* is made from rice (Kabeir *et al.*, 2004), Kenyan

Kirario is made from green maize and millet (Nkirote, 2006), and *Motoho* in South Africa is made from red sorghum (Moodley, 2015). *Borde*, and *Cheka* are also cereal-based fermented beverages in Ethiopia (Kebede Abegaz *et al*., 2002; Belay Binitu *et al*., 2015).

Table 4. Ingredients and their proportion used during preparation of *Shameta* in western Ethiopia.

Variable	Ingredients used and their proportion	Frequency (N = 150)	Percentage (%)
Cereals as major ingredients (Faba bean as a minor ingredient)	Maize	50	33.3
	Maize (95%) + Barely (5%)	24	16
	Maize (95%) + Faba bean (5%)	7	4.7
	Barley (95%) + Maize (5%)	56	37.3
	Barley (85%) + Maize (5%) + Wheat (5%) + Sorghum (5%)	5	3.3
	Barley (85%) + Maize (5%) + Wheat (5%) + Faba bean (5%)	8	5.3
Oil sources as minor ingredients	Rapeseed	149	99.33
	Niger seed	1	0.67
Spices are used as minor ingredients	Ginger, garlic, fenugreek, black cardamom, and white cumin	55	36.7
	Ginger, garlic, fenugreek, black cumin, and black cardamom	75	50
	Garlic, black cumin, white cumin, and black cardamom	20	13.3
Herbs are used as minor ingredients	Rue leaves only	37	24.7
	Rue + Basil leaves	113	75.3

In this study, almost all (99.33%) respondents reported that they used rapeseed (*Brassica napus*), while less than 1% of the respondents reported using niger seed (*Guizoti abyssinica*) as a source of oil (Table 4). Half (50%) of the respondents indicated that they used a combination of different spices to enhance the taste and flavour of the product and their use as preservatives. Furthermore, majority of the respondents (75.3%) also reported using rue (*Ruta graveolens*) and basil leaves (*Ocimum basilicum*) for the same purposes. The types of spices and herbs used and the stage at which they are added slightly vary among households. Different authors also report the use of spices and herbs for flavour enhancement and preservation (Letay Gebralibanos, 2015), as potential antimicrobial agents in addition to their flavour-enhancing capacity in different traditional fermented foods (Zainab, 2008; Olaniran *et al*., 2020).

3.4. Production Practices of *Shameta*

3.4.1. Raw materials preparation

Maize (*Zea mays*), barley (*Hordeum vulgare*), wheat (*Triticum sativum*), sorghum (*Sorghum bicolor*), and faba bean (*Viciafaba L.*) are sorted and cleaned before grinding them into flours (Table 5). First, barley is dehulled with the help of a wooden mortar and pestle (Figure 2a) with the addition of little water to soften both hull and bran for easy removal and then sun-dried. Spices such as fenugreek, black cumin seed, black cardamom, and white cumin seed are roasted separately on a metal or clay griddle. The roasted spices are mixed and ground using either a spice grinding machine, traditional grinding stone, or mortar and pestle. The majority (60.67%) of the respondents indicated that producers pulverize ginger and garlic together. With regard to the use of different types of traditional utensils to prepare ingredients, more or less similar utensils and trends being used for the production of fermented products in other parts of the world have been used for *Shameta* production. For instance, *Borde*, *Cheka*, and *Keribo* producers use almost similar locally available utensils (Kebede Abegaz *et al*., 2002; Rashid Abafita, 2013; Belay Binitu *et al*., 2015).

Rapeseed is the primary oil source in *Shameta* production. The size of the seeds is reduced using traditional grinding stone and repeatedly milled until crude oil is visible in the mortar (Table 5). Before transferring the ground rapeseed to the clay pot (approximately 4-10 L holding capacity), the pot is thoroughly washed and smoked by glowing dried stem splinters of *Weira* (*Olea Africana)* to add flavour to the crude rapeseed oil. Then, approximately 3 L of hot water is added to 1 kg of ground rapeseed and left aside for one to five days of incubation to enhance oil extraction from the crude. After the incubation period, additional hot water is added (approximately 1.5 L/kg of ground rapeseed) to finalize the extraction process. Then the oil is separated from the cake by pressing using fabric like cheesecloth. However, few respondents (6.67%) indicated that they directly filtered the rapeseed oil by adding hot water without further incubation.

"*I have a long experience in the preparation of Shameta. After the ground rapeseed was ready, I wash the pot thoroughly and smoke by glowing dried stem splinters of Weira (Olea spp.) for flavour enrichment to the crude rapeseed oil. Then after I transfer the ground rapeseed to a pot and add approximately 2.5 L of hot water to 1 kg of ground rapeseed and then incubate for five days. On the fifth day, I add around 1.5 L of hot water to crude oil to finalize the extraction process.*" (A participant from group 1)

"*Incubation of ground rapeseed for two to five days increase the oil extraction and productivity*" (A participant from group 1)

"*Some Shameta producers extract rapeseed oil directly by adding hot water without further incubation. This is due to two reasons: first, some of them prepare Shameta as soon as possible after pregnant women give birth before the right time such as premature birth and the second is producers by themselves didn't know the importance of incubation of ground rapeseed for some times.*" (A participant from group 3)

Similar to this finding, during the fermentation process of *Borde*, *the clay pot* (*earthenware pot*) is cleaned with *grawa* (*Vernonia amygdalina*) leaves and smoked with glowing splinters of *Olea africana* to reduce microbial loads and improve flavour of the product (Kebede Abegaz *et al.*, 2002).

Table 5. Processing practices and corresponding utensils used during *Shameta* preparation.

Practices	Equipment
Cleaning of grains and rapeseed	Sefed (a circular flat tray made of grass)
Drying of grains and rapeseed	Sefed, mats, and blanket
Milling of grains	Hammer mill
Dehulling of faba bean	Grinding stone
Size reduction of rapeseed	Grinding stone
Grinding of rapeseed	Mortar and pestle
Removing skin or seed coat from barley, faba bean, and rapeseed	Sefed
Removing skin from cereal flour	Sieve
Roasting spices	Mitad (griddle made of clay or a thick iron sheet)
Milling spices	Grinding stone or mortar and pestle
Filtration of rapeseed oil	Cloth or sieve
Fermentation vessel of dough	Pot (made up of clay)
Cooking of porridge	Clay saucepan or metal saucepan
Fermentation vessel of porridge	Plastic jar or earthenware pot

3.4.2. *Shameta* Production Process

As indicated in Figure 5, when maize is used alone or in combination with other ingredients, the dough is subjected to the first phase of fermentation, which is not common in the case of barely-based *Shameta*. However, according to respondents, the whole *Shameta* production process can be sub-grouped into three major phases. Details of production steps and ingredient types used are as indicated in Figure 5.

Phase I (First stage fermentation of the dough): In the first phase, the maize-based dough is subjected to first stage fermentation for two to five days depending upon ambient temperature and the interest of producers to produce a more or less fermented product.

Fermentation is done in a clay saucepan (approximately 10 to 20 L holding capacity) with the wrapping of the lead with an available cloth or plastic sheet. Respondents indicated that the first stage of fermentation is considered a means to enhance the flavour and nutrient contents of the final product. They also believe that the first stage fermentation enhances the solubility and integration of macromolecules, assisting the cooking phase and the cooked products are more suitable for consumption. Different studies confirmed an increase in the solubility of maize flour during fermentation (Hayta *et al.,* 2001; Zeng *et al.,* 2011; Murekatete *et al.,* 2012). This fermentation stage is skipped when *Shameta* is made exclusively from barley or barley mixed with other ingredients. Respondents had the opinion that the solubility of the barely-based dough is better than that of maize-based dough during cooking. This may be due to a high amount of water-soluble protein and β-glucan in barley flour (Gajdosova *et al.,* 2007; Hozová *et al.,* 2007; Lee *et al.,* 2017) as compared to maize.

Phase II (Cooking the fermented dough to make porridge): This phase makes *the Shameta* preparation process unique as compared with other processing methods of cereal-based fermented products. Fermented dough from phase one is then cooked in an open fire until the porridge gets the desired cooking maturity and texture (Figure 2b). However, to minimize the impact of excessive heat while cooking in a metal saucepan, the metal girdle is placed between the fire and the metal saucepan. Warm water is added while cooking (reduced heat condition) to compensate for moisture loss due to evaporation. The product is simmered to attain the desired taste and texture. According to the respondents, cooking could take up to 90 minutes due to the slow cooking process. Low temperature, longer time cooking could improve the taste and flavour of the porridge. Fermentation of dough following cooking to porridge texture is a peculiar practice in the community compared with practices in other parts of the country (Zewdie Tilahun *et al.*, 2021). It is believed that both first phase fermentation and cooking might significantly alter the microbial, sensorial, functional, nutritional, and anti-nutritional properties before the second phase of fermentation. The lesser health risk of the product as indicated by the majority of the respondents might be associated with the introduction of intermediate cooking apart from fermentation processes. Cooking improves cereal grains' sensory and functional properties while reducing the concentration of anti-nutritional factors (Lapveteläinen and Rannikko, 2000; Samtiya *et al.*, 2020). Heat treatment could also inactivate pathogenic and spoilage microorganisms that originated from ingredients, and the first phase of fermentation helps to produce a relatively safe product (James *et al.*, 2021).

Figure 2. Part of the traditional processing steps during the preparation of *Shameta:* Seed coat removal (dehulling) from barley (a) and making of porridge from barely flour (b).

Figure 3. Overnight cooled porridge from maize (95%) and faba bean (5%) at ambient temperature.

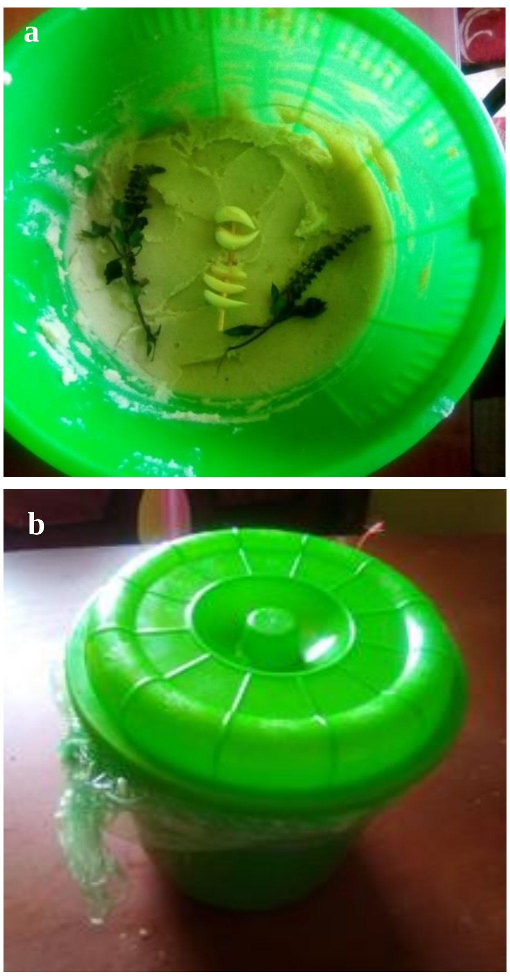

Figure 4. Garlic bulb hanging on the stick and basil branches placed at different layers of the porridge in plastic jar (a) and the plastic jar air tightly covered with plastic sheet before covered by its own lid (b).

Respondents also indicated that poorly cooked porridge could lead to diarrhea in consumers of the product. Pre-prepared powders of spices (fenugreek, black cumin, black cardamom, white cumin seed, and pulverized garlic and ginger) are added after the porridge is well cooked. However, few *Shameta* producers usually add those spices after the porridge is cooled overnight. According to the respondents, spices are added to improve the product's flavor and aroma and as a preservative. The texture and color of porridge cooled overnight at ambient temperature before the second phase of fermentation is indicated in Figure 3.

Phase III (Second stage fermentation of porridge): Once the porridge cools to ambient temperature and is equilibrated overnight, it will be transferred to a plastic bucket for the second phase of fermentation (Figure 4). According to the assessment, 98% of the respondents use a similar container for second-stage fermentation, staying from 14–30 days. The use of plastic containers is a recent practice with its easy availability on market replacing the traditional clay earthenware, which is only used by 2% of the respondents. Studies show that communities in different parts of the country use the same containers to ferment different types of cereal-based fermented products (Kebede Abegaz *et al.*, 2002; Rashid Abafita, 2013; Belay Binitu *et al.*, 2015; Letay Gebralibanos, 2015).

During the transfer of cooled porridge to the fermentation vessel, garlic bulbs (12–20 bulbs), rue, and basil leaves (6–12 branches) are placed across different strata of the cooked porridge (Figure 4a). Similar to the previously added spices, these ingredients could also contribute to the improvement in the flavour of the fermented product with some preservative effects. The duration of fermentation of maize-based *Shameta* ranges from three to four weeks depending on the ambient temperature and types and proportion of cereals used other than maize. However, barley-based *Shameta* is left to ferment for two to three weeks, depending on ambient temperature. When only barley is used as an ingredient, fermentation lasts only two weeks.

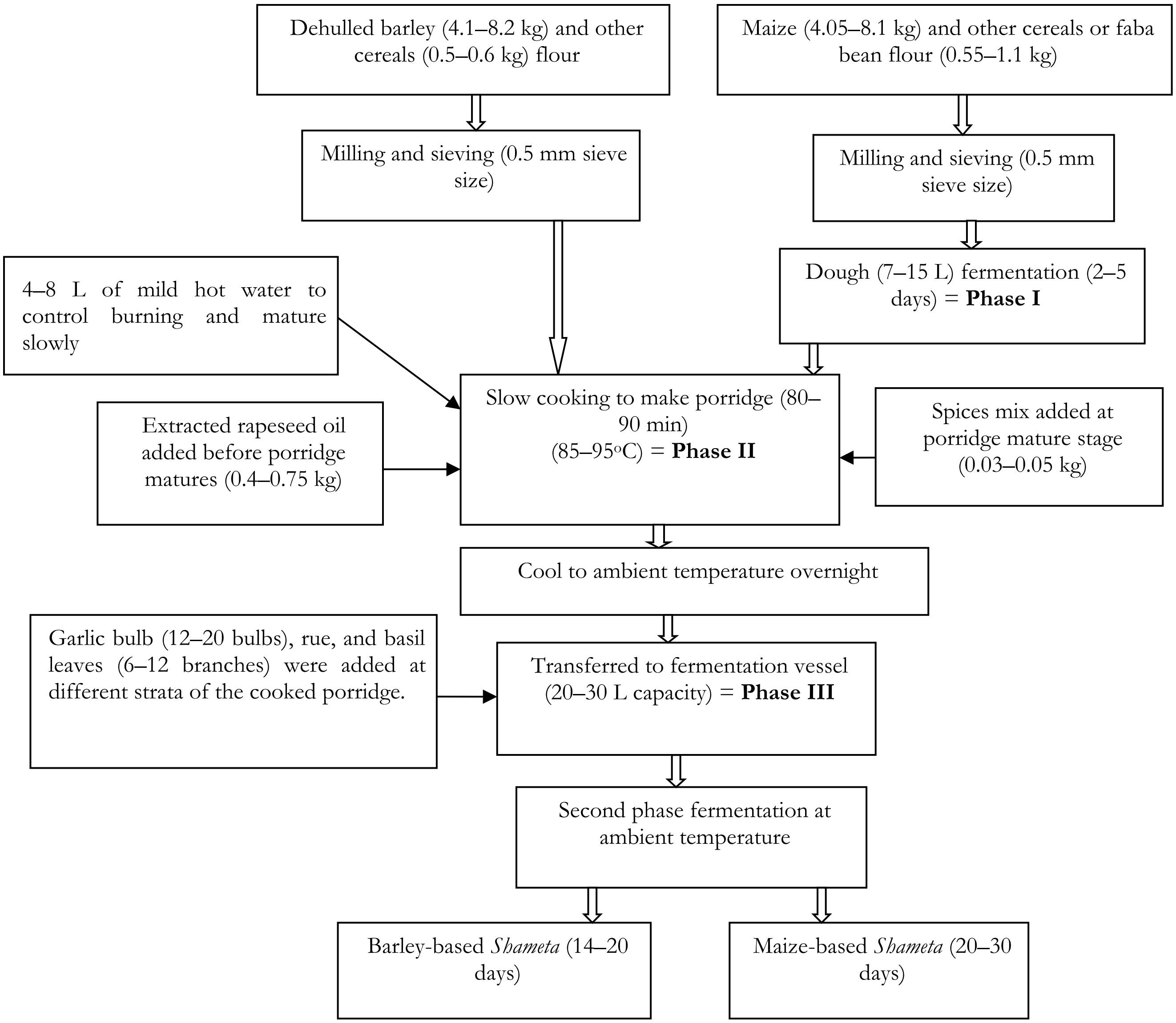

Figure 5. Follow diagram of traditional *Shameta* production processes.

"During Shameta preparation, the addition of faba bean reduces the fermentation time from thirty days to twenty days. When Shameta is prepared from maize and faba bean, and fermented for up to thirty days, it becomes less acceptable due to its burning sensation to consumers." (A participant from group 1)

"During Shameta preparation, the combination of barley with wheat or sorghum increases the fermentation time by more than 20 days." (A participant from group 4)

"Most of the time, when Shameta is made up of barley alone and fermenting for more than fourteen days, it shows syneresis. Therefore, its volume and acceptability decreased." (A participant from group 3)

Respondents also indicated that faba bean flour reduces the fermentation time of maize-based *Shameta* to 20 days, while the combination of barley with wheat or sorghum could increase the fermentation time by more than 20 days. The fermentation time of maize-based *Shameta* in this study is similar to that of '*Azo* and *Cheka*,' a condiment and low alcoholic beverage in Ethiopia, respectively, which is close to 30 days (Belay Binitu *et al.*, 2015; Letay Gebralibanos, 2015). However, the duration of fermentation of *Shameta* is comparatively longer than other fermented products such as *Keribo* which is fermented for 24 hrs (Kumela Dibaba *et al.*, 2018) and one to four days for *Borde* (Ketema Bacha *et al.*, 1998) in Ethiopia, two days for *Kirario* (Nkirote, 2006) in Kenya, two to four days for *Malwa* (Muyanja *et al.*, 2010) in

Uganda, and four to six days for *Kenkey* (Nout *et al.*, 1996) in Ghana.

The duration of fermentation determines the sensorial properties of the product at the end of fermentation. Respondents reflected that the aroma and flavour of the fermented product are indicators of the degree of maturity of *Shameta*. Matured *Shameta* gives a strong cheesy or spicy aroma, while *Shameta* from immature fermentation has a poor flavour with a minor degree of acceptability and a possibility of causing flatulence to consumers. Gas production and accumulation in the large intestine could result from resistant starch left unbroken during a short fermentation period (Zhao *et al.*, 2011). On the contrary, over fermentation makes *Shameta* sour due to excess acid production, which might be due to the accumulation of lactic acid as a secondary metabolite of lactic acid bacteria (Nsofor *et al.*, 2014). Over fermented product results in a burning sensation in the stomach and other discomforts to consumers. According to the respondents, *Shameta,* made from barley only and fermented for more than two weeks, shows syneresis, resulting in poor quality and less production volume. *Shameta* drawn from fermentation vessels should be either semi-liquid or semi-solid based upon ingredient composition. Respondents also indicated that the maize-based *Shameta* has a relatively long shelf life (safe for a month) than the barley-based *Shameta,* which stays safe for only two weeks.

"When a mature Shameta open, it gives cheesy or spicy flavour, and the flavour disperse to all rooms in the house." (A participant from group 1)

"When somebody opens Shameta without telling me, I feel by its flavour." (A participant from group 3)

"The flavour of mature Shameta attracts the consumers to eat a lot, while immature Shameta doesn't give any sense." (A participant from group 2).

3.5. Sensory Properties, Utilization, and Safety of *Shameta*

The type of cereals and spices used and the duration of the fermentation period determine the quality and sensory properties of the final product. For example, the color of *Shameta* varies from bright white to light grey color, depending on the type of ingredients used. *Shameta* made exclusively of maize tends to be whitish, while exclusively barley-based *Shameta* tends to be white grey. The color of barley-based *Shameta* in the present study looks like other fermented products such as *Boza* (Blandino *et al.,* 2003) in Turkey, *Motoho* (Moodley, 2015) in South Africa, and *Burukutu* (Atter *et al.,* 2017) in Ghana. However, unlike the sour tastes of *Mahewu*, *Motoho,* and *Doklu* (Assohoun *et al.,* 2013; Moodley, 2015; Idowu *et al.,* 2016), *Shameta is spicier*. The aroma of *Shameta* ranges between cheesy to spicy based on the spices and herbs used. When garlic and basil are used in high proportion, the aroma is cheesy, but a spicy aroma is developed when enriched with black cardamom, black cumin, and rue.

"When I prepare Shameta, I add a high proportion of garlic and basil, because I prefer cheesy aroma Shameta than spicy aroma Shameta." (A participant from group 1)

"During Shameta preparation, we add rue leaves instead of basil leaves due to its availability in our garden." (A participant from group 2)

"When garlic and basil are used in high proportion, the aroma of Shameta is cheesy, but a spicy aroma is developed when enriched with black cardamom, black cumin, and rue." (A participant from group 3)

"Most consumers prefer Shameta with cheesy aroma than Shameta having spicy aroma." (A participant from group 4).

The texture of *Shameta* is semi-liquid to semi-solid depending on the ingredients and amount of water added during preparation. For example, maize-based *Shameta* has a semi-solid consistency, while barley-based *Shameta* has a semi-liquid consistency. Maize-based *Shameta* is thicker than barley-based, associated with relatively more starch in maize than barely. A similar texture was reported in other products such as *Akamu*, *Ogi,* and *Kirario* (Nkirote, 2006, Nwokoro *et al.,* 2012; Afolabi *et al.,* 2018). From a utilization point of view, serving *Shameta* to the lactating mother by experienced women is recommended to minimize the risk of cross-contamination. A portion of the product is scooped using a dedicated spoon or ladle and then served after re-prepared in different forms, as indicated in Figure 6. Before serving, fresh *Shameta* should be diluted using warm water on a sieve (0.5 mm) to give uniform consistency and a smooth product. To allow *Shameta* to pass through the sieve, mixing and pressing hot water with fresh *Shameta* using a large spoon takes place simultaneously. Sieving also helps to remove rue and basil leaves and garlic bulbs. Reduction of the viscosity of fresh *Shameta* facilitates consumption of the product with fresh porridge, *injera*, or drinkable as gruel. Different types of spices can also be served as a side dish along with fresh *Shameta* as an appetizer to encourage more consumption. Even if the product is mainly produced for lactating mothers, it can also be consumed by other family members.

From the food safety point of view, most of the respondents (88.7%) indicated that they had not experienced health-related problems associated with the consumption of *Shameta*. However, 11.3% of the respondents indicated that they experienced diarrhea or stomach discomfort after consuming the product. Different authors also indicated the possible outbreak of foodborne illnesses such as diarrhea and vomiting following consumption of different fermented foods (Adams & Mitchell, 2002; Capozzi *et al.,* 2017). This could be accounted to inappropriate fermentation and post-process that could cause cross-contamination due to a lack of awareness and good hygienic practices (Gadaga *et al*., 2004). Once ready for serving and opening the fermentation vessel for service, the product can stay for about 7 to 30 days under proper handling practices. The product's shelf life depends on good practices such as using a dedicated ladle or spoon, excluding ambient air contamination by covering the vessel with airproof material, and serving it by an experienced woman.

Figure 6. Serving types of *Shameta*: *Shameta* with fresh porridge (commonly served type) (a and b), and gruel form (c and d) used along with different types of spices (hot pepper powder, green pepper pure), ghee, and salt.

The food industries utilize Lactic acid bacteria to produce fermented products with their antibacterial effects as bio-preservative agents during the storage period (Parada *et al.,* 2007; Ozogul and Hamed, 2018). In addition to this, different works indicated that essential oils in spices and their components from spices and herbs added at different stages of preparation could inactivate microorganisms through different mechanisms (Benchaar *et al*., 2008; Solorzano-Santos and Miranda-Novales, 2012). Respondents also indicated that their elders practiced storing *Shameta* underground in a narrow-mouthed clay pot while leaving the mouthpart above the ground. This could help to cool the product by the lowering ground temperature compared to the ambient temperature. This practice could slow down the further fermentation process for constant flavour and taste of the product under an extended storage time.

4. Conclusion

The results of this study have revealed demonstrated that traditionally prepared and consumed *Shameta* can be broadly categorized as maize-based and barley-based. Maize-based *Shameta* is prepared from maize (95%) with barley or faba bean (5%). However, barley-based *Shameta* is prepared from barley (85 or 95%) and other grains such as maize (5%), wheat (5%), sorghum (5%), or faba bean (5%). The majority (87.3%) of respondents indicated that the product is mainly prepared for lactating mothers but can also be consumed by other family members. From a processing point of view, *Shameta* preparation involves three different phases, two phases of fermentation with intermediate cooking. This makes the product processing method different from other cereal-based products. Double fermentation with the heat treatment could modify physicochemical properties, functional properties, nutritional compositions, anti-nutritional factors, and sensorial properties of the product apart from its microbial safety. Rapeseed oil, spices, and herbs as components of the product could improve the product's flavor, texture, and shelf life. The product can be served in the form of fermented porridge or gruel with different spices as a side dish. It is believed that the product helps to restore the strength and postpartum recovery of lactating mothers. Its consumption is also presumed to promote the volume of breast milk for the newborn. Therefore, in order to generate more comprehensive scientific information, further studies need to be conducted to address the nutritional compositions and other health benefits of the product. In addition, further studies should be conducted to optimize ingredients composition and processing methods for better nutrition of the product as an alternative locally available and affordable nutritious food for lactating mothers and newborns.

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