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Production practice, microbial quality and consumer acceptability test of traditionally produced butter in North Shoa Zone, Oromia Regional State, Ethiopia

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ABSTRACT

'The study was conducted to evaluate the production practices and microbial quality of butter produced in North Shoa Zone, Oromia Regional State, Ethiopia. The result of the study revealed that the educational status of households in the study area was 53.3% illiterate, 33.9% in elementary school, and 12.8% in high school. In the study area, 76.7% of the farmers dip their fingers into the milk during milking. Butter was taken to market by packing with plant leaves (30.6%), plastic sheet (11.1%), or plant and plastic sheet alternatively (58.3%). About 12.2% of the farmers do not treat the water. The practise of treating underground water with chlorine accounts for 82.9% of the study area. A total of 180 respondents were randomly selected for the survey from six purposefully selected kebeles in the Wachale district. A total of 34 butter samples (thirty from three open markets, equally ten from each, two butter samples from cooperatives, and two laboratory made butter samples) were collected and analyzed. The aerobic mesophilic bacteria count was significantly ($P < 0.05$) higher (6.48 log cfu/g) in butter samples from Muke Turi than Wabari (6.36 log cfu/g). The coliform count was significantly ($P < 0.05$) lower in laboratory made butter (2.96 log cfu/g) than others. The *Escherichia coli* count was significantly ($P < 0.05$) higher in butter sample collected from Muke Turi (3.46 log cfu/g) than Wabari (3.29 log cfu/g). *Staphylococcus aureus* was significantly ($P < 0.05$) higher in Gimbichu butter (5.46 log cfu/g) samples. Listeria monocytogenes was significantly ($P < 0.05$) higher in Gimbichu butter, whereas no count of this colony was found in the cooperative and prototype butter samples. The color and aroma of butter made in laboratory have a significantly ($P < 0.05$) higher score than butter collected from open market. The microbial qualities of butter from three open markets except Gimbichu were substandard. The butter sample from the prototype was relatively compliant with the microbial quality standard, an indication of possibilities for improvement.

1. Introduction

Ethiopia is believed to have the largest livestock population in Africa. This sector contributes significantly to the country's economy. According to the Central Statistical Agency (CSA's) [1] estimate, the country is home to 59.5 million cattle, 30.7 million sheep, 30.2 million goats, and 56.53 million poultry. Ethiopia has huge potential to be one of the key countries in dairy production for

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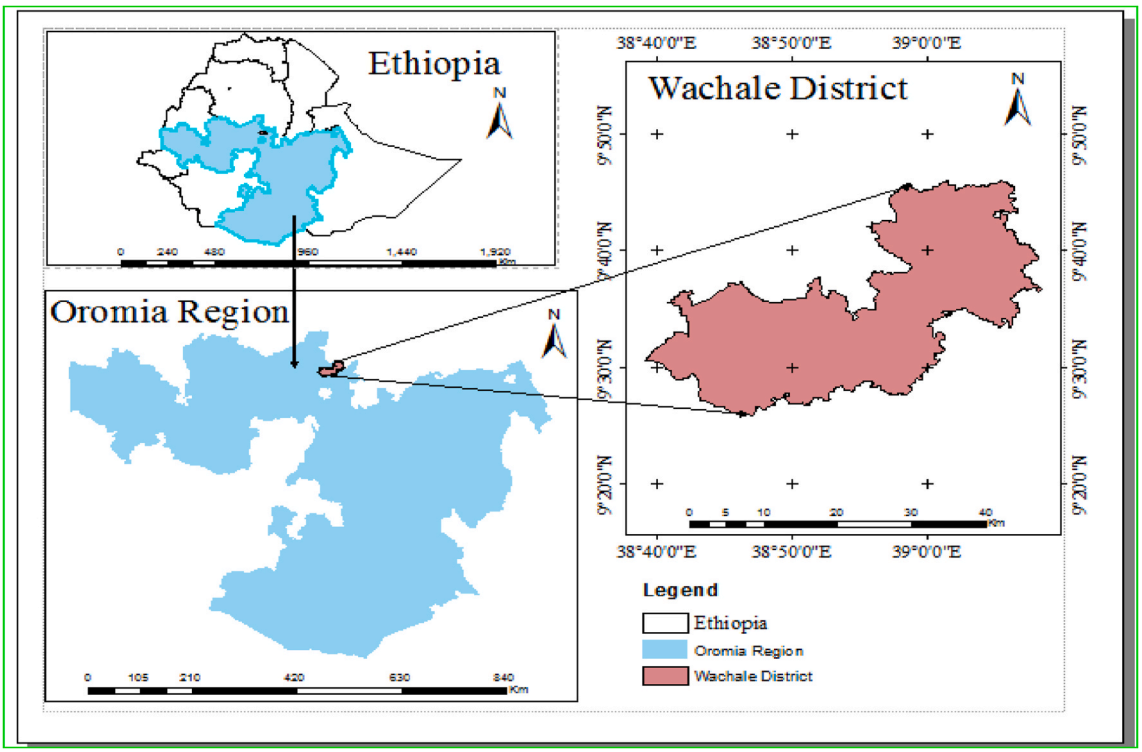

Fig. 1. Satellite map of Wachale district.

various reasons [2]. These include a large population of milking cows in the country and a conducive and relatively disease-free agro-ecology; particularly, the mixed crop–livestock systems in the Highlands can support crossbred and pure dairy breeds of cows [3].

Wide varieties of products are manufactured by processing raw milk into dairy products. Among them, butter is one of the primary fat sources and an important source of dietary energy. It has been produced since ancient times and was an internationally traded commodity as early as the 14th century [4].

Although the Ethiopian Standard Authority has set standards for indigenous and imported dairy products, the standards have not been enforced to control and assure the safety and quality of dairy products. Hence, there are no strict regulations and quality assurance techniques on production, processing, packaging, transportation, and marketing of dairy products in the country [5]. Furthermore, research conducted during the last half century has focused on increasing milk production without giving much emphasis to the safety and quality of dairy products. Consequently, only fragmented research was undertaken on this aspect [5]. There was a lack of information on the quality of local butter produced in the study area. In the earlier studies, pathogenic bacteria, including *Staphylococcus aureus*, *Escherichia coli*, and Listeria monocytogenes, were not considered, while the production practice is presumed to be a predisposing factor. Hence, the aim of this study was to analyze the microbial quality and consumer acceptability test of traditionally produced butter from cow's milk in the Wachale district. In addition, this study also attempted to locate the source of contamination in butter through an assessment of milking practices and the manufacturing and handling processes of butter by farmers in the study area. Therefore, this work was aimed at achieving the general objective of tracking production practices, microbial quality status, and consumer acceptability levels of traditionally produced butter in the Wachale district.

2. Materials and methods

2.1. Sample collection method

In this study, a total of 34 samples were analyzed, of which 30 were traditional butter made from cow's milk purchased randomly from a local market in the district. Two butter samples that were produced by cooperatives and two prototypes (laboratory-made samples) that were prepared under controlled conditions by the researcher were also considered for comparison.

All samples were transported to the Holeta dairy technology laboratory using an ice chain, in cold condition within 5 to 8 h.

2.2. Design of the study

The study has both survey and laboratory experiment parts. Peri-urban kebeles adjacent to Muke Turi town that are no more than 5 km from Muke Turi town, as well as other rural kebeles in Wachale district, were purposefully chosen for the survey study. The survey

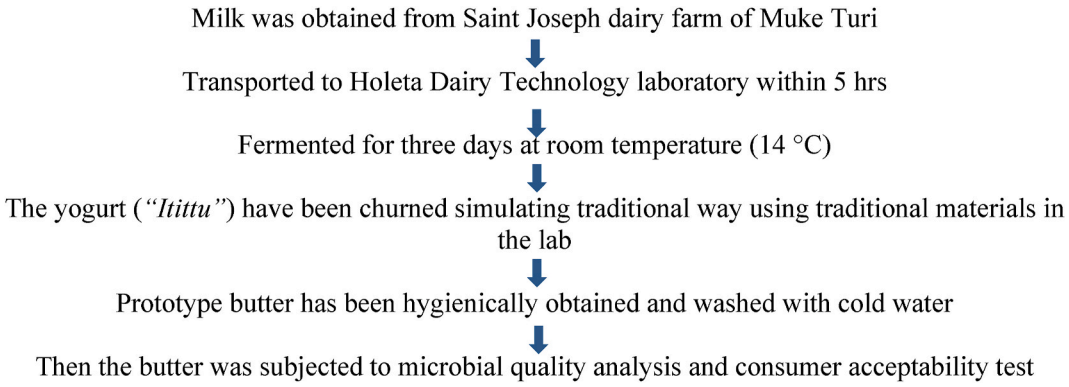

Fig. 2. Flow chart of prototype/control butter production.

study focused on butter production and handling practices. Production systems in rural and peri-urban areas were the basis for comparison in the survey results. The survey was conducted from September to November 2017.

The butter samples were collected from three open markets in the district and analyzed following standard laboratory procedures [6]. In the microbiology section, the district was the source of variation, with Muke Turi representing the peri-urban and Gimbichu areas and Wabari representing the rural area market.

2.3. Survey study

The kebeles were selected purposefully from rural and peri-urban areas of the district (Fig. 1). Accordingly, three kebeles from rural and three kebeles from peri-urban areas of the district were identified based on accessibility and the practice of butter production. Then 30 respondents from each kebele were selected randomly, and in total 180 respondents were interviewed for the survey.

2.4. Control sample preparation

In this study, a prototype butter sample has been developed in the laboratory by simulating the traditional method used by farmers in the study area. However, during the preparation of this sample, standard handling methods were applied to produce the prototype in a safe and hygienic way for comparison purposes. There was no starter culture added, and the milk was not treated in any way. Finally, a microbiological quality analysis and consumer acceptability test were performed (Fig. 2).

2.5. Butter prepared at cooperative

The cooperatives collect milk from producers and send this milk to the central market (Addis Ababa). That milk, which could not be accepted because it could not pass the quality limit, will be processed into butter and other milk products. The cooperative's butter preparation method included separating the cream with a cream separator, producing butter with a rotating manual churner, and then storing the butter at 4 °C until it was sold to consumers.

2.6. Microbiological analysis

2.6.1. Aerobic mesophilic bacteria count

The total bacterial count was determined using the procedure described by International Organization for Standard (ISO) [7]. A homogenized butter sample of 1 g was added to each duplicate Petri dish and poured onto plate count agar. The plates were incubated at 35 °C for 48 h and 2 h, and colonies were counted using a colony counter.

2.6.2. Coliform count

The total coliform count was determined using sterile violate red bile agar (VRBA) [8]. Following thorough mixing, 1 g of butter was poured onto sterile VRBA containing Petri dish and incubated for 24 h within 35 ± 2 °C °C. The count was prepared from serial dilutions of 10^{-2} and 10^{-3}. Then the corresponding colonies were counted on duplicate plates.

2.6.3. Yeast and mold count

The yeast and mold count was performed using the procedure indicated by Andrew [9] One gram of appropriate dilutions of the butter sample was plated by the pour plate technique in duplicate using potato dextrose agar (PDA) supplemented with streptomycin. Colonies were counted after incubating the plate at 25 °C for five days.

2.6.4. Staphylococcus aureus

An aseptically weighed 50 g sample of butter was put into the sterile blender jar with 450 ml of diluent (1:10) and homogenized for 2 min at high speed (16000–18000 rpm). Then it was pipetted: 1 ml of the homogenate into 9 ml of diluent to make a 1:100 dilution. It was mixed very well using a vortex mixer. The prepared dilution was inoculated into each of three tubes of tryptose soy broth (with 10% sodium chloride and 1% sodium pyruvate) with 1 ml of butter homogenate. Then it was incubated at 35 °C for 48 h. A serial dilution of one ml of the sample was spread on the surface of a dry Baird-Parker agar medium plate using a sterile bent glass road and incubated at 37 °C for 24–36 h. White yellow colonies surrounded by clear haloes were considered *Staphylococcus aureus* [9], and total *Staphylococcus aureus* colonies from two consecutive plates of each sample were converted into colony-forming units per gramme (cfu/g) using a formula given by Public Health England (PHE) [10].

2.6.5. Escherichia coli

Each sample was enriched in peptone water and had been incubated at 37 °C for 24 h. Each inoculum was streaked on MacConkey Lactose Agar, a differential medium, and colonies that appeared pink after 24 h of incubation at 37 °C were identified as *Escherichia coli* [9].

2.6.6. Listeria monocytogenes

Twenty-five gram of a well-mixed butter sample was put for enrichment into stomacher bag and use 225 ml of half Frazer broth [11].

⬇

Then the sample stomached for 2 min.

⬇

The contents was poured aseptically in to a wide mouth bottle and incubated at 30 °C for 24±2 h

⬇

One ml of the above culture was transferred to 9 ml of Frazer broth

⬇

The inoculated tube was incubated for 48± 2 h at 35–37 °C

⬇

From 24 h culture of half Frazer broth and 48 h Frazer broth streaked out culture on Modified Oxford Agar and PALCAM agar so that well separated colonies are obtained [8].

⬇

The plates were inverted and incubated at 37 °C for 24 h.

⬇

The plates was examined for colonies presumed to be Listeria monocytogenes small colonies (1 mm) greyish surrounded by a black halo and turn darker with a possible green luster After 48 h the colonies and are about 2 mm in diameter are considered to be Listeria monocytogenes. After all other results are available; the serotyping of Listeria isolates becomes meaningful after a biochemical test has been done [9].

2.7. Consumer acceptability test

Butter samples were subjected to a consumer acceptability test using the seven-point hedonic scale, where 7 = very much like, 6 = like a lot, 5 = like, 4 = slight like, 3 = dislike, 2 = much dislike, and 1 = very much dislike. Twenty adult consumers accustomed to butter consumption were used to evaluate the acceptability of the butter samples produced by farmers and cooperatives as well as the butter made in the laboratory. One day of training was given to these individuals on how to evaluate the acceptability of butter using hedonic scales. They have evaluated the acceptability of butter samples for colour, texture, smell, and overall acceptability [12]. Each

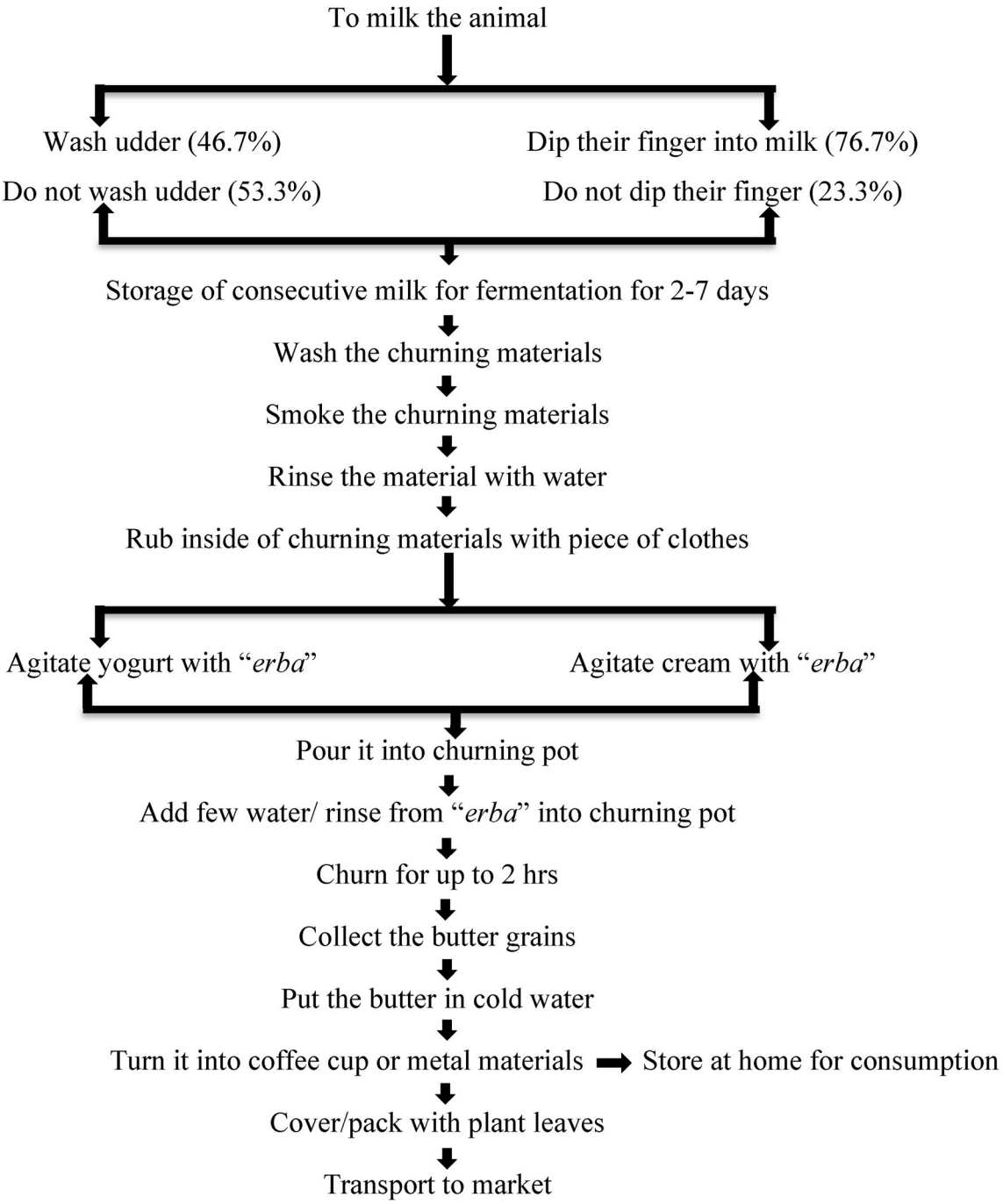

Fig. 3. Flow chart of butter production by farmers in the study area"Erba" is a single stick having three diverged branches at one end, helps to agitate/mix the yogurt (cream and butter milk) before pouring the yogurt into churning material.

butter sample was presented in a random fashion by coding it using three-digit codes. The testing was conducted at the Dairy Technology Laboratory of the Holeta Agricultural Research Centre. Informed consent was obtained from all participants involved in the study.

2.8. Statistical analysis

The survey data was analyzed using Statistical Package for Social Sciences software, version 20, and descriptive statistics of cross tab was used to obtain the percentage distribution of responses. The microbiological count results of butter samples were analyzed

using the General Linear Model (GLM) procedure and Analysis of Variance (ANOVA) techniques of SAS version 9.0. Significant differences were declared at 5% significance level. The microbiological count data was transformed to $\log_{10}$ values before statistical analysis. Multiple comparisons of means with a significant difference ($p < 0.05$) were separated using the Duncan method for consumer acceptability test and the Tukey method for microbial analysis using SAS version 9.0.

The formula for calculating colony forming units per gram of sample was:

$$N = \frac{\sum C}{[(1 * n1) + (0.1 * n2)]d}$$

Where:

N = Number of colonies per g of product; ΣC = Sum of all colonies on all plates counted; n1 = Number of plates in first dilution counted; n_2 = Number of plates in second dilution counted, d = Dilution from which the first counts were obtained.

3. Results and discussion

3.1. Educational status of the respondents in the study area

The educational status of the respondents comprises of 53.3% illiterates, 33.9% elementary school, and 12.8% high school attendants, respectively.

3.2. Milking practice

Before milking, about 46.7% of peri-urban respondents were not washing the udder, whereas, 40% of rural farmers wash the udder before milking (Fig. 3). According to Saba [13]; 62.2% of the dairy producers washed their cow's udder before milking, while the remaining 37.8% simply allowed calves to suckle before milking, which is in line with the current result, especially for rural respondents. During milking the handwashing practice of the rural respondents was better than that of the peri-urban as 98.9%of the rural and 95.6%of the peri-urban performed washing both before and after milking.

3.3. Equipment used for milk handing

The milking materials used by 97.8% of both peri-urban and rural respondents were plastic bowels, and 2.2% of them used other materials. These other materials include metal (nickel), material locally made from woven grass ("elemtu"), and also gourd ("buqe"). This result is nearly identical to that reported by Abebe and others [14], who reported a similar result in the Gurage Zone's Ezha district, where all farmers used plastic jerry cans as milking utensils. In rural areas, materials used for milk storage are plastic, clay pots, and others, at 42.2, 55.6, and 2.2%, respectively. Clay pots were mostly used in both places, but more so in peri-urban than in rural areas. According to Mogassie [15], in the central highlands of Ethiopia, an earthen pot was used for fermentation and butter churning. Clay pots were mainly used for churning yogurt or cream (which was partially skimmed off of milk that stayed overnight), and 98.9% of peri-urban and all rural respondents use clay pots for churning yogurt ("Itittu") and cream. Plastic material used for butter washing was 58.9% and 35.6% in peri-urban and rural areas, respectively. About 20% of peri-urban and 33.3% of rural respondents used metal (nickel) materials. The remaining 21.1% from peri-urban and 31.1% from rural areas used other materials, including gourd ("buqe"), equipment of clay origin, and material locally made from woven grass ("elemtu") for the butter work.

The respondents used different things for cleaning milk equipment. About 4.4% of the respondents used water alone, while 10.6% use both water and detergent (Ajax) together, and about 42.8 and 42.2% used water plus plant leaves and others, respectively. The plant leaves used for washing equipment for milk handling and processing were *Ocimum hardiency* ("*Kusaye*"), *Ocimum lamifolium* ("*Kaskasse*"), *Zehneria scabra* ("*Araressa*"), and *Juniperous procera* ("*Gatira*"). As reported by Debela [16] Ambo farmers commonly use *"Shokonotaa,"* *"Masarata,"* *"Xoosanyii,"* and *Ocimum hardiency* ("*Kusaye*") for cleaning purposes. Only Ocimum hardiency ("Kusaye") is used for cleaning in both Ambo and the current study areas for cleaning. The difference might be attributed to the availability of plants in the respective areas.

Three kinds of materials were used for butter wrapping in the study areas: plant leaves by 30.6%, plastic sheet by 11.1%, and plastic sheet and plant leaves in combination by 58.3% of the respondents. The plant leaves used in the current study area were *Ensete ventricosum* ("*Baala warqee*"), *Commicucarpus africanus* ("*Baala qobboo*"), *"Baala Liitii,"* and *Cana indica* L. ("*Baala seetakurii*").

About 77.8 and 85.6% of respondents in peri-urban and rural areas were using gourds for butter storage, respectively. Other materials used for butter storage include plastic, metal-origin materials (Nickel), and equipment locally made from woven grass ("*elemtu*"), which collectively comprised 21.1% of the total for peri-urban farmers and 14.4% of the total for rural farmers in the study area.

3.4. Source of water

The majority of respondents in the study area used underground pump water; 76.7% in peri-urban areas and 75.6% in rural areas, respectively. Well water was mostly used in rural areas (24.4%) compared to peri-urban areas (16.7%). Saba [13] also reported that smallholder producers in Ejerie and Adea Berga districts used different water sources for cleaning purposes, i.e., tap water (67%, 43%),

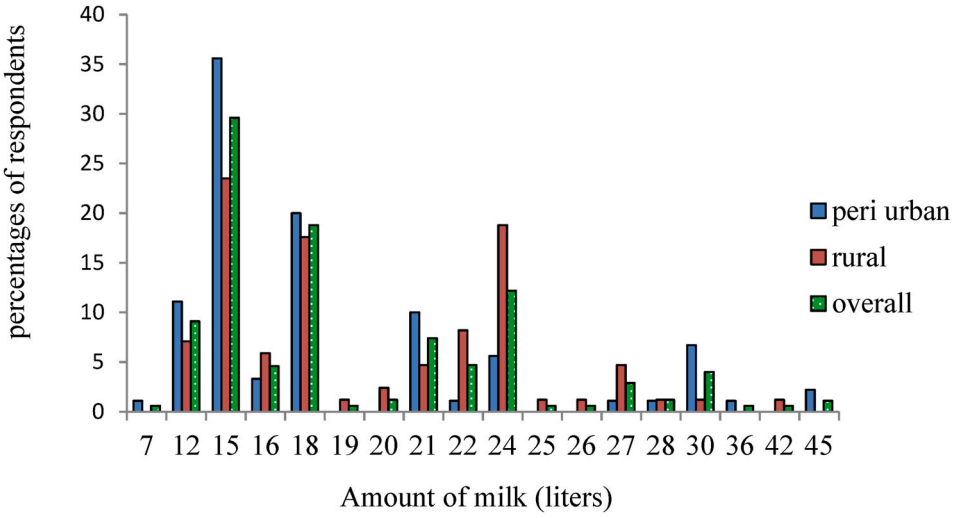

Fig. 4. Amount of milk required for producing one Kg of butter.

river water (19%, 37%), and hand dug wells (14%, 20%).

Warm water (45.6%) is more commonly used for cleaning equipment than cool (33.6%) or scalded (3.3%). However, rural (70%) areas use much more warm water than peri-urban (45.6%) areas, and peri-urban (33.3%) areas use much more cold water than rural (13.3%) areas. This situation has occurred since the peri-urbans use more detergents (12.2%) than rural residents (8.9%) in addition to water for cleaning, which increases cleaning, whereas rural respondents use water and plant leaves (52.2%) than peri-urbans, which need warmer water than cold water to clean out. Hence, it seems that the rural respondents use warm water to increase the cleaning ability of the water.

About 89.74% of the peri-urban and 76.25% of the rural water was treated by a chemical (chlorine) that was added to underground pumped water by government officials. However, this treatment has only been done once or twice a year. In the case of a river, well water, or stagnant water, the remaining farmers filter the water to clean it: 10.24% from peri-urban areas and 23.75% from rural areas.

3.5. Butter production practice

About 73.3% of the peri-urban respondents store milk for 2–5 days, while 26.7% store it for 6–7 days. From the rural community, 58.4% store milk for 2–5 days and 40.4% for 6–7 days for fermentation to form curd that will be churned to produce butter.

All the respondents (100%) from the study area use only Olea africana ("Ejersa") for the smoking of milk processing equipment. In both peri-urban and rural areas, about 81.1% and 92.2% of respondents, respectively, use yogurt to produce butter. Some of the farmers use a mixture of cream and yogurt to produce butter. The cream is removed by scoop or by hand from milk that has been stored overnight, and this has been done by those farmers who sell raw milk to milk collectors.

Peri-urban (17.8%) and rural (6.7%) respondents were accustomed to churning a yogurt-cream mixture rather than cream alone. According to Mogessie [17], traditional Ethiopian butter ("Kibe") is always made from sour milk ("Ergo") and not from cream. But in the current study, about 12.8% of the farmers produce butter from cream. The result from the current study was in line with Gebremedhin and others' [18] report that butter is produced by churning cream or sour milk, a process that damages the fat globular membranes of butterfat found in cream and results in the production of small butter grains. The addition of water to yogurt prior to churning seems common in both study areas, which are 96.7% for peri-urban and 96.1% for rural, which could probably point to contamination.

3.6. Milk required for churning and production of butter

The milk used for churning ranges from 2 to 20 L. The most usual amount of milk used for churning by peri-urban respondents was 5 L (21.3%), 6 L (19.1%), and 7 L (21.3%) liters (21.3%), 6 L (19.1%), and 7 L (21.3%). Rural respondents, on the other hand, used to churn 5 L (21.2%), 6 L (18.95%), and 7 L (20.65%) of milk (Fig. 4).

According to respondents, the amount of milk required to produce a kg of butter varies greatly, ranging from 7 L by 1.1% to 45 L by 2.2% for the peri-urban respondent. The most frequently occurring amount of milk being used to produce 1 kg of butter was 15 L of milk for 35.6% of peri-urban and 23.5% of rural respondents. In the study areas, the average amount of milk required to produce 1 kg of butter was 19.05 L. The result of Mekdes [19] indicates 22 L of fermented milk are required to produce 1 kg of butter at Delbo Wolayita. This difference might occur due to the accuracy of measuring in either of the two places.

Table 1
Result of microbiological analysis of butter.

Sample Source	Parameter					
	AMBC	TCC	*E. coli*	YM C	SA	LM
Mk	6.48 ± 0.09^{a}	4.25 ± 0.06^{ab}	3.46 ± 0.04^{a}	4.25 ± 0.06^{b}	5.38 ± 0.05^{ab}	2.07 ± 0.18^{c}
Gm	6.42 ± 0.06^{ab}	4.37 ± 0.07^{a}	3.37 ± 0.07^{ab}	4.32 ± 0.07^{ab}	5.46 ± 0.03^{a}	2.96 ± 0.23^{a}
Wb	6.36 ± 0.09^{b}	4.22 ± 0.13^{b}	3.29 ± 0.09^{b}	4.40 ± 0.02^{a}	5.35 ± 0.10^{b}	2.41 ± 0.26^{b}
Cp	5.95 ± 0.05^{c}	3.37 ± 0.10^{c}	0.00 ± 0^{c}	3.87 ± 0.06^{c}	4.88 ± 0.03^{c}	0.00 ± 0^{d}
Cl	5.60 ± 0.076^{d}	2.96 ± 0.13^{d}	0.00 ± 0^{c}	3.58 ± 0.18^{d}	4.53 ± 0.10^{d}	0.00 ± 0^{d}
CV (%)	1.13	2.25	2.34	1.39	1.34	10.71

Values in the table are log cfu/g ± standard deviation (STDV) of butter samples (n = 34). Means in each column bearing similar superscripts are not significantly different (P > 0.05). AMBC = Aerobic Mesophilic Bacteria Count, TCC = Total Coliform Count, YMC= Yeast and Mold Count, SA= *Staphylococcus aureus*, LM = Listeria monocytogenes, Mk = Muke Turi, Gm = Gimbichu, Wb = Wabari, Cp = Cooperative, Cl = Control, CV = Coefficient of variation (%).

3.7. Microbiological analysis

3.7.1. Aerobic mesophilic bacteria count (AMBC)

The AMBC of the Muke Turi butter sample was significantly (P 0.05) higher than that of the Wabari market butter. Butter from the three open markets (i.e., Muke Turi, Gimbichu, and Wabari) was substandard as per the Quality and Standard Authority of Ethiopia (QSAE) [20], which set the maximum limit of AMBC of the butter at 6 log cfu/g. Relatively cooperative and control butter samples meet the limit of Quality and Standard Authority of Ethiopia. The result from the study is comparable with the report made by Zelalem [21], which was an average total bacterial count of 7.25 cfu/g of butter for butter samples collected from the Salale area.

3.7.2. Total coliform count (TCC)

The TCC was significantly (P < 0.05) high in Gimbichu market butter, which was 4.37 log cfu/g (Table 1). The current finding is not comparable with the mean TCC of fresh butter from Ambo and Dire Inchini areas, which was 5.62 log cfu/g [16] and 2 log cfu/g from the open market in the Wolayita Zone, Delbo, and Kucha areas [19]. On the other hand; Zelalem [21] reported a lower value of CC, i.e., 1.92–4.5 log cfu/g, for the Ethiopian market in general. Total coliforms as a hygiene indicator that can be used as an important criterion for determining butter's microbiological quality [21]. Therefore, the observed variation could be an indicator of uneven production and handling practices, which are generally substandard in different production areas.

3.7.3. Escherichia coli

The samples of butter obtained from Muke Turi, Gimbichu, and Wabari markets were substandard with regard to *Escherichia coli* prevalence. However, samples from the cooperative and control (prototype laboratory made sample) met the required standards and did not show any growth of *Escherichia coli* colonies (Table 1). According to Quality and Standard Authority of Ethiopia (QSAE) [20] the samples should be free of *Escherichia coli*, and the presence of any counts of *Escherichia coli* is regarded as unsafe.

3.7.4. Yeast and mold count (YMC)

The YMC of the current study ranges from 3.58 log cfu/g for samples made in the laboratory to 4.40 log cfu/g for Wabari butter samples. The current finding is nearly in line with Mekdes' [19] result, which reported 4.3 and 6.86 log cfu/g for butter sampled from the Wollayta area. The presence of mold contamination in butter indicates post-processing contamination from water or air after production [21].

3.7.5. Staphylococcus aureus

A butter sample collected from Gimbichu and Muke Turi markets had a significantly (P < 0.05) higher *Staphylococcus aureus* count. The butter sample made in the laboratory was significantly (P < 0.05) lower *Staphylococcus aureus* count (Table 1). *Staphylococcus aureus* could mainly come from the teat, udder, skin of the animal, and hands of the milker. Materials for milking can also be a source of *Staphylococcus aureus* [9]. Mastitis is another option for the occurrence of this bacterium. Vautor and others [22] also reported that the main source of contamination of raw milk with *Staphylococcus aureus* was dairy animals.

3.7.6. Listeria monocytogenes

Listeria monocytogenes was significantly (P < 0.05) higher in the Gimbichu market sample (2.96 log cfu/g), followed by the Wabari and Muke Turi market samples. The prototype and sample collected from the cooperative were free of Listeria monocytogenes (Table 1). This could happen since the prototype sample was controlled for pre- and post-production contamination of butter, which indicates that the production process is the predisposing factor for L. monocytogen. Butter-making cooperatives also adhere to relatively hygienic and standard production procedures, which they obtain through various trainings and intervention projects.

Table 2
Consumer acceptability of butter made under different condition.

Sample Source	Parameter			
	Color	Smell/Aroma	Texture	Overall Acceptability
Muke Turi	5.25 ± 0.17^{c}	5.38 ± 0.13^{c}	4.93 ± 0.09^{b}	5.01 ± 0.16^{c}
Wabari	5.34 ± 0.184^{c}	5.35 ± 0.140^{c}	4.89 ± 0.16^{b}	5.04 ± 0.14^{bc}
Gimbichu	5.44 ± 0.15^{bc}	5.44 ± 0.10^{c}	4.98 ± 0.16^{b}	5.03 ± 0.14^{bc}
Cooperative	5.75 ± 0.35^{ab}	5.70 ± 0.28^{b}	5.50 ± 0.35^{a}	5.40 ± 0.57^{a}
Control	6.05 ± 0.50^{a}	6.00 ± 0.28^{a}	5.65 ± 0.35^{a}	5.35 ± 0.28^{ab}
CV (%)	3.94	2.74	3.5	4.14

Values in the table are mean ± standard deviation (STDV) *of acceptability score for each attribute (N=34). Means in each column bearing similar superscripts are not significantly different (P > 0.05).*

3.8. Consumer acceptability test

The color and aroma of prototype butter made in the laboratory have a significantly ($P < 0.05$) higher score than butter collected from three open markets (i.e., Muke Turi, Wabari, and Gimbichu). The texture values of the prototype butter and cooperative butter samples were significantly ($P < 0.05$) higher than the remaining butter samples. The observed difference between prototype butter made in the laboratory and butter collected from cooperatives could be due to improved handling and processing practices that minimize contamination that would degrade product quality, as degradation of fat by microorganisms could affect both the texture and aroma of the butter. According to Jay [23], the two most common types of microbial spoilage in butter are surface taint and hydrolytic rancidity. Consumers may be less accepting of the open market as a result of this. Butter collected from cooperatives has significantly ($p < 0.05$) higher acceptability than butter collected from Muke Turi and Gimbichu markets (Table 2). Generally, the consumer acceptability test revealed that butter made in the laboratory using similar procedures in the study area and those collected from cooperatives were more acceptable in all three (i.e., color, smell/aroma, and texture) attributes, which could be due to the standard procedures used for butter production. Therefore, in order to avoid the post-harvest loss of butter as a result of poor quality, these butters marketed on the open market should follow standard procedure.

4. Conclusion

The production practice, starting from milking to butter marketing, in the study area was prone to contamination. Hence, the microbial quality of butter was substandard because of these problems, which could not be overcome by the skill of such (illiterate) individuals. Accordingly, butters from three open markets (i.e., Muke Turi, Gimbichu, and Wabari markets) were substandard in terms of AMBC, CC, YMC, *Staphylococcus aureus*, and Listeria monocytogenes and were below the stated microbial quality standard regarding Quality and Standard Authority of Ethiopia, unlike the cooperative and control butter samples. Consumer acceptance of laboratory-produced butter and cooperative-collected butter was relatively high. Hence, this indicates that there is room for improvement in both the microbial quality and acceptance level of traditionally produced butter.

Author contribution statement

Asrat Diriba: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper. Mitiku Eshetu: Conceived and designed the experiments; Wrote the paper. Yonas Hailu: Analyzed and interpreted the data; Wrote the paper.

Data availability statement

Data will be made available on request.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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