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Review

Traditional butter and ghee production, processing and handling in Ethiopia: A review

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In this review, traditional methods of processing, handling and indigenous preservation techniques of butter and ghee were assessed. In Ethiopia, butter and ghee processing are the responsibility of women. Traditional butter and ghee making in Ethiopia are based on indigenous knowledge using local materials and methods. Butter is made by churning naturally fermented milk. Butter is a raw material for ghee making. Salting, spicing, *nigur kibe* and traditional ghee making are major methods of butter preservation. Traditional ghee can be made from untreated butter, spiced butter, salted butter and *nigur kibe*. Butter and ghee are important components of Ethiopian traditional diets. Furthermore, butter is used for hair dressing and wound treatment. Ghee is commonly used for culinary, social functions and therapeutic purposes. There is scanty information on chemical and microbial quality of butter. Both butter and ghee are shelf stable dairy products but ghee is more shelf stable than butter. The chemical composition and microbial quality of butter is substandard. However, so far there is no such information on ghee quality. Hence, the quality and safety of traditional butter and ghee are subjects of further investigation.

Key words: Traditional, butter, ghee, production, processing, handling, preservation.

INTRODUCTION

Demand for dairy products has increased in the tropical areas including Ethiopia as people's income has been growing. Like other countries, Ethiopians have been using milk products such as butter and ghee as part of their diet since pre-historic times (Zelalem et al., 2011). Despite milk's contribution to gross domestic product and value of butter as a food, sub Saharan Africa in self general and Ethiopia in particular have failed to attain sufficiency in dairy products. Butter fat is the second largest component of milk product and is of major commercial value. It serves as an energy source and supplies essential fatty acids. Such indigenous dairy

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products made from different milk sources are traditionally produced and consumed in most of African countries including Ethiopia (Ashenafi, 2006; Almaz et al., 2001).

Worldwide, butter is made from a variety of animal milk including cow, goat, camel, buffalo and sheep (Curry, 2013). However, in Ethiopia, butter, locally named as '*dhadha*/*kibe'* is solely produced from cow milk. Rural producers make butter from the fat fraction of milk. In Ethiopia large amount of dairy products such as butter and ghee are produced on farm from sour milk through spontaneous fermentation (Alganesh and Fekadu, 2012; Fekadu, 1994; Getachew, 2003; Sintayehu et al., 2008). The vast majority of milk produced in the rural areas of the country is processed at household level into milk products such as butter using traditional technologies (O'Connor, 1994). In the rural areas of Ethiopia about 40% of the milk produced is converted to butter. At national level, 80% of butter is used as food ingredient (Getachew, 2003). Seventy percent of butter produced is used in rural and nearby urban areas (Getachew, 2003). *Dhadha /kibe* is the most shelf stable of all traditionally processed fermented milk products except for *niter kibe* (Yonad, 2009).

Butter, in addition to its dietary value, is also a major dairy product marketed in different parts of the country as an income source mainly for women (Fekadu, 1994; Zelalem and Inger, 2001a; Alganesh, 2002; Lemma et al., 2004; Eyassu and Asaminew, 2014). A significant portion of the community (rural women, retailers and assemblers of butter) acquire their household expenditure from butter sales.

In Ethiopia, ghee is used in different traditional diets and culinary purposes in different communities. Traditional butter or its derivative ghee is used as oil in cooking and flavoring purposes for different foods and snacks. The traditional materials and methods of dairy processing are inefficient. Hence, the quality of dairy products including butter is substandard (Zelalem, 2010). For instance, moisture content of *dhadha/ kibe* ranges from 20 to 43% as compared to the international commercial standard of 16% (Mekdes, 2008). Occurrence of spoilage when *dhadha/ kibe* is stored at room temperature for a long time is probably due to putrefactive microorganisms (Almaz et al., 2001; Wondu, 2007; Zelalem, 2010).

So far, in Ethiopia, no comprehensive review work was synthesized at national level to compile relevant endeavors on indigenous butter and traditional ghee production and handling practices. Previous reports indicated that there were some efforts made by post graduate students and very few researchers in the same area. However, comprehensive information on the existing indigenous technologies of butter and ghee handling is essential to plan effective intervention in the future. Hence, the aim of this paper is to combine and review existing information on traditional handling and processing p practices of butter and ghee from cow milk.

Milk collection, cleaning and fumigation of churns and traditional butter making

In Ethiopia, smallholder butter making is based on naturally fermented sour (*ergo/ itittu)* milk (O'Connor, 1994). Souring milk has a number of advantages: it retards the growth of undesirable microorganisms such as pathogens and putrefactive bacteria and makes the milk easier to churn (O'Connor, 1994). Traditional butter is processed and sold by women in every community (Yonad, 2009). Milk for churning is accumulated over several days by adding fresh milk to the milk already accumulated in traditional spherical earthenware vessel or *wesso* or bottle gourds and allowed to sour into *itittu* or naturally fermented milk (Debela, 2016). To make butter, clay pot or bottle gourd (calabash) is used as a churner (Brannang and Persson, 1990; Abebe et al., 2013). Churners are smoked with chips of *Olea Africana* in Asela areas (Taye, 1998). Another report by Alganesh and Fekadu (2012) revealed that stems and leaves of *Ocimum hardiense is* used for cleaning milk vessels and churns in East Wollega. The same study showed that stems and leaves of *Ocimum urticifolium* and are also used for flavor impartation in to milk containers and churners. For the purpose of fumigation of churns most smallholders use chips of *Deinboll kilimandshorica* (*dabaqqaa*). While, some smallholders use *Gaarrii*, *Syzygium guineense and Olea Africana (*Alganesh and Fekadu, 2012). In southern Ethiopia, Mekdes (2008) reported *Gucha*, *Achynthes aspera and Eucalyptus globules* as the most important plants used for smoking churns and milk containers. Another report by Fikirneh et al. (2012) in mid rift valley revealed *Juniperous procera*, *Eruchstrum arabicum and Sida cuneifolia* being used for smoking milk vessels in addition to other trees. According to the local understanding, the practice of smoking vessels by burning wooden chips of specific trees and shrubs has an advantage of imparting special flavour and odour to the product, and to disinfect the vessels, thus reducing the numbers of micro-organisms and thereby extending the shelf life of the product.

The use of each tree and shrub species for the purpose of flavour impartation and disinfection depends on the geographical location and tradition of the smallholders. All the plant species used are believed to impart flavour and disinfect the vessels, but, the degree varies from plant to plant. The report of Ashenafi (2006) supported this assumption, as greater numbers and a faster development of aerobic mesospheric microorganisms occurred in milk kept in non-smoked as compared to smoked containers. Besides imparting a distinct flavor to the butter,this practice has a bacteriostatic effect,andmay reduce processing time by heating the churn (O'Mahony and Ephraim, 1985). After smoking the churn, the curd is

broken either by hand or by agitation with a wooden stick and fermented milk is filled to about half of the capacity of the local churner or filled to a level depending on the availability of fermented milk. After filling, the churner is tightly closed with a plug, a false banana leaf, or piece of skin or leather (specifically made it for this purpose only) over the mouth of the churner. Maize grain outer cover and pieces of skin or hides or plastic materials can also be used. Finally, after the mouth of churn is securely tied agitation is performed for 3-4 h depending on environmental temperature, fat content, level of acidity of fermented milk and the speed at which the churning is done. Churning is exclusively done by women or children (Coppock, 1994; Alganesh and Fekadu, 2012).

Most smallholders perform churning when daily collections of about 3-8 liters of milk are achieved. Churning time usually takes 3-4 h using local churners. '*Ittitu*' /fermented milk made from accumulated milk for a week (20–25 liters) could yield approximately one kg of butter (O'Mahony and Ephraim, 1985; O'Connor, 1994; Zelalem, 1999; Ashenafi, 2006; Eyassu and Asaminew, 2014). In the traditional butter making, the equipments required for processing sour milk are simple and locally available. Local churners are made from clay, gourds and wood, and can be woven from fibre, such as the *gorfu* container used by the Borana pastoralists in Ethiopia (O'Connor, 1994). An on-farm report by Alganesh and Fekadu (2012) in East Wollega, Ethiopia revealed that 97.5% of smallholders use bottle gourd churn while 2.5% use clay pot churn. The smallholders preferred bottle gourd churner for milking and storage of different milk products including butter and ghee. The reason for the preference was that they believe that gourd churns are better in flavor impartation from wood smokes than other local churners.

Most of the traditional methods of milk processing are slow and inefficient. They give low yield of butter per unit of sour milk and require high labor input (O'Mahoney and Peters, 1987). It may take from 2-3 h depending on temperature, fat content, acidity and the milk volume to be churned. The time taken to make butter and to take it to market place is a considerable drain on the already limited time of women (O'Connor, 1990). Wooden paddle wheel internal agitator developed by the former International Livestock Center for Africa (ILCA) currently ILRI (International Livestock Research Institute) had reduced churning time from an average of 139 min to 61 min (O'Connor, 1993). A prototype of ILCA internal agitator was developed and used to introduce and verify the ILCA internal agitator around Bako for smallholder producers (Alganesh et al, 2001).

The efficiency of ILCA internal agitator was also compared with the traditional gourd churners. The result of the on-farm verification revealed an average of 128 min of churning time using the gourd churns, while the churning time for the prototype of ILCA internal agitator was only 23 min. The other advantage of using the internal agitator was that every family member was able to perform churning, on the other hand, in the case of gourd churners; it is only women who performed churning. Besides, the internal agitator had 4% more butter fat recovery efficiency as compared to the gourd churners (Alganesh et al., 2001). According to another report by O'Connor (1993), the length of time required for churning was 65 and 139 min for the traditional churners in Debre Zeit and Debre Birhan areas, respectively. The author attributed the longer churning time in the latter area to the prevailing low ambient temperature.

Churning is the process whereby sour milk or cream is vigorously agitated in such a way that air is incorporated in the liquid (Berg, 1988). Different ways of shaking the churner include putting of the churn on the floor and rocking back and forth. This method is most common with the clay pot churner. In this method, the churner is placed on a mat consisting of a layer of grass, sheep skin or straw. The other option is to hang the churner on tripod or doorpost and swinging it to and fro until butter granules are formed. The third option is to rock the churner on the lap of women and shaking it with two hands. The latter option is only applicable to bottle gourd churners (O'Connor and Tripathi, 1992; Coppock, 1994). Besides, among some pastoral families, women carry sour milk in goat skin bags on their backs and agitate it with their elbows while walking or working (FAO, 1990).

The break point when butter starts to form can be detected by a change in the sound of the fermented milk up on agitation. A straw is inserted frequently through the vent into the churn; if small butter grains adhere to the straw surface, traditionally thought that the breakpoint has been reached (O' Connor, 1994). After a few minutes, the straw is again inserted through the vent. If it is clean from grains of butter, it indicates that the butter granules have coalesced into larger grains. After butter granules coalesce into large grains, the churn is slowly rotated anticlockwise on its base). This step enables to collect the grains in the centre and forms large mass of butter. The butter is then skimmed off, kneaded in cold water multiple times and washed to remove visible residual buttermilk (O'Mahoney and Ephraim, 1985; FAO, 1990; O'Connor, 1994).

Butter

In Ethiopia, there are two types of butter, ripened/rancid and fresh locally called *besal kibe and lega kibe*, respectively (Mekedes, 2008). However, Abebe and others (2014) reported that there are three types of butter in Ethiopia, namely *lega, mekakelegna* and *besal,* which refer to fresh, semi-rancid and rancid butter, respectively, based on the degree of lipolysis of butter. Butter making and processing is solely done by women in every community in Ethiopia. *Dhadh*a has an attractive appearance with a white to light yellowish color. Like

Table 1. Utilization of butter at regional level (2009/10) in Ethiopia.

Region	Utilization (%)				Total
	Household consumption	Marketed	Payment as a wage in kind	Other	
Oromia	60.38	36.28	0.11	3.23	100
Amhara	59.55	38.85	0.09	1.51	100
Tigray	91.8	1.34	0.42	6.43	100
Afar	74.35	20.48	0.13	5.04	100
Somali	64.61	33.39	0.28	1.73	100
Benshangul-Gumuz	51.55	46.16	0.01	2.28	100
SNNP	58.43	38.51	0.42	2.64	100
Gambella	73.1	24.53	0.41	1.96	100
Harari	66.3	-	-	33.7	100
Dire Dawa	95	-	-	5	100
Total	60.77	36.36	0.23	2.64	100

Source: Zelealem et al. (2011).

factory processed butter, locally produced butter is semi-solid at room temperature. It has a pleasant odor when fresh, but with an increase in storage time, changes will occur in odor and taste, unless refrigerated or further processed into traditional ghee *(dhadha baksaa/ nitir kibe)* by boiling with spices (Lola and Haile, 2015). *Dhadha* is the most stable product of all traditionally processed fermented milk products next to traditional ghee. It has relatively good keeping quality of 4-6 weeks at ambient temperature as compared to other dairy products such as cottage type cheese (Layne, 1994). The storage stability of butter gives it a distinct advantage over fresh milk in terms of more temporal flexibility for household use and marketing (Layne, 1994).

Use of butter from traditional processing

Butter and some dairy products are called yellow fats which contains a number of products for spreading on bread or for indirect consumption as ingredients in other foods (Embaye, 2010). In Ethiopia, butter is exclusively used to make traditional ghee. Fresh/raw butter is used for hair dressing for women as hair cosmetics and as a skin cosmetic by both sexes. A report on the review of Ethiopian dairy sector (Zelalem et al., 2011) revealed that use of butter as hair oil is assumed to have dual functions: for hairdressing and to cure headaches. Butter is also used as ointment and for relief on wounds. Fresh butter is also used by children of weaning age and the elderly (Yonad, 2009). Traditionally, children of weaning age are fed on freshly made butter for different reasons which vary from society to society. In some societies it is believed to help the infants maintain body temperature during cold weather. In other societies, feeding freshly made butter is believed to help infants begin to speak some words earlier during childhood. Fresh butter is also fed to new born babies assuming that it lubricates and facilitates bowl movement to assist ease of discharge of feces. In a study conducted in the Borena region of Ethiopia, butter was found to be an important source of energy as food for humans, and is used for cooking (Yonad, 2009). According to Zelalem et al. (2011) in different regions of Ethiopia, 60.77% is utilized for home consumption, and the remaining 36.36% is sold and used for household expenditure, 0.23% is paid as wage in kind for casual labor and 2.64% is meant for other purposes (Table 1).

Traditional methods of butter preservation

In different communities, producers use various traditional preservatives and preservation techniques to increase shelf life of butter (Alganesh, 2002; Mekdes, 2008; Eyassu and Asaminew, 2014). The traditional preservatives and preservation techniques are used as a principle of acidification and moisture reduction and can give butter good storage stability (O'Mahony and Peters, 1987). Ghee has excellent storage stability. Where Ghee is not made, butter is occasionally spiced and heated for increasing its shelf life (O'Mahony, 1988).

Spicing butter

In different rural areas of Ethiopia, spicing butter by thoroughly mixing with powders of spices is one of the traditional methods of butter preservation technique. To make spiced butter, preservatives such as *Curcuma domestica*, *Trachyspermum ammi*, *Trigonella foenum*, *Afruarum korerima)* are mixed with butter (Alganesh, 2002). Spiced butter can be used for household consumption or for sale. According to different reports butter preserved using such techniques can be kept with minimal spoilage at room temperature for 12 weeks

Table 2. Spices used in traditional butter preservation (spiced butter) in Ethiopia.

Vernacular name	Common Name	Scientific name	Plant part (s) used
Jinjibila	Ginger	*Zingiber officinale*	Tuber
Habasuuda adii	Bishop's weed	*Trachyspermum ammi*	Seeds
Habasuuda gurrachaa	Black cumin	*Nigella sativa*	Seeds
Mimmixa	Chillies	*Capsicum spp.*	Pods
Ogiyoo	Korerima	*Elettaria cardamoum*	Seeds
Qulubbiiadi	Garlic	*Allium sativum*	Tuber
Siqaqibee	Basil	*Ocimum spp.*	Stems & leaves
Sunqoo	Fenugreek	*Trigonella foenum*	Seeds
Xoosinyii	Oregano	Satujera species	Leaves

Source: Alganesh and Fekadu, (2012) and Hailemariam and Lemma (2011).

Table 3. Traditional methods of butter preservation and their reported shelf life.

Methods of preservation	Shelf life (days)
Untreated butter (control)	19
Spiced butter	84-540
Salting butter	111
Melted butter/*Nigur kibe*	111
Traditional ghee	333 -870

Source: Yitaye et al. (2009), Alganesh and Fekadu (2012), Eyassu and Asaminew (2014) and Debela (2016).

especially during Ethiopian Orthodox fasting period (Alganesh, 2002). Another study by Lemma et al. (2004) in east Shewa indicated that surplus butter produced during high production season was either sold at lower price or preserved and stored by mixing with spices for later use. According to Lemma et al. (2004), almost all the women in Adami Tulu and Arsi Negelle and 63.3% of the women in Lume District somehow used some form of preservatives to keep butter for longer period of time. The same study revealed that, according to the respondents, spiced butter can be kept for about 3 years if properly worked, kept clean and mixed with fresh butter from time to time. Another study in northwestern Ethiopia also reported that smallholders practice spicing of butter for preservation purpose (Eyassu and Asaminew, 2014). A former report by Alganesh (2002) also revealed that spiced butter can be kept for 2.80 months in eastern Wollega zone. However, in Northwestern Ethiopia, spiced butter can be kept for up to 11.40 months at an ambient temperature without deterioration (Eyassu and Asaminew, 2014). Table 2 shows different types of spices used to preserve butter in different communities in Ethiopia.

Salted butter

Butter can be slightly salted by kneading in about 10 g of salt/ kg of butter. Salting can also be done by sprinkling salt on the surface of butter. Similarly, salting butter and wrapping it in an air tight condition can partially prevent mould formation (O'Connor, 1994).

According to O'Connor (1994), butter should be salted at a rate of 16 g salt/kg or according to taste. The salt used should be dry and evenly ground and of the best quality available. Butter is highly stable against microbial spoilage after 2% salt addition, because of its high fat, low moisture and nitrogen ratios (Almaz et al., 2001; Wondu, 2007; Zelalem, 2010). The butter is worked mechanically both to disperse the salt and water, and to obtain the correct physical structure. This process greatly influences the microbiological stability of butter. If most of the water droplets present are less than 10 µm in diameter, any microorganisms within the butter will not be able to grow and will gradually die off, owing to nutrient depletion and the inhibitory effect of salt. However, if larger water droplets are present in the butter, as a result of either over or under working, the compartmentalization effect is reduced and microbial survival and growth occurs.

A study conducted in Eastern Wollega by Alganesh (2002) showed that some smallholder farmers preserve butter by salting. According to the study, it is reported that salted butter can be kept for 3.70 months at room temperature. A report from northwestern Ethiopia (Yitaye et al., 2009) (Table 3) also revealed that smallholder producers use salting for preservation of butter. A recent report from west Shewa (Debela, 2016) revealed that a shelf life of 3.79 to 4.65 months for salted butter under smallholder storage condition.

Even though the smallholders use salting to increase shelf life of butter, they use ordinary type of coarse salt (iodine free) which may be inferior in terms of quality and hygiene. A study report by Debela (2016) on fresh butter samples treated with ordinary salt also showed high total bacterial count of (9.58 log cfu/g) compared to melted, spiced butter and traditional ghee. The author suggested that the salt used in butter treatment might be a source of contamination for high microbial load.

Table 4. Requirements of butter set by Ethiopian Standard Authority.

Characteristics	Milk fat/butter (%)	Test method
Milk fat, min,% by mass	99.6	ES 3476
Moisture, max,% by mass	16	ES ISO 5536
Acidity, max, % by mass as oleic acid	0.4	ES ISO 1740
Peroxide value, max, milli equivalent of oxygen/ 1kg fat	0.6	ES ISO 3976
Copper, max, ppm	0.05	ES ISO 5738
Iron, max, ppm	0.2	ES ISO 6732
Salt, NaCI, max, % by mass	2.5	ES ISO 1738 WD

Source: Ethiopian standard (ES), Milk fat products specification, 2008 and 2009.

Melted butter/*Nigur kibe*

In Ethiopia, melting of butter /*mangor* or making *nigur kibe* is another traditional method of butter preservation technique. Butter made by the household or purchased from local market is put in a clay pot or saucepan and kept on a slow open fire or heat source. In some cases, during heating bishop's weed (*Trachyspermum ammi)* and cardamom (*Elettaria cardamoum)* are added to improve flavor and aroma of the butter. But in most cases, sole butter is melted and refined. Melted butter is kept for overnight in cool dry place to solidify. Impurities are decanted off from the re-solidified melted butter. All residues including residual butter milk and dirty materials that are settled at the bottom of the saucepan/pot are filtered out by making a hole from one side in the solidified butter. The melted butter is either kept by packing in plastic, gourds or wooden containers. The melted butter can also be directly processed into traditional ghee by further boiling and adding spices. Traditional ghee made from *nigur kibe* has longer shelf life and is cleaner due to the pre-removal of impurities. However, when traditional ghee is made directly from raw butter it can have some impurities after clarification and has less shelf life. Melted butter contains about 10% moisture (FAO, 1990). Alganesh and Fekadu (2012) reported that *nigur kibe* can be kept at room temperature for 6 months. But Debela (2016) reported that only a shelf life 87 **-** 93 days.

Chemical composition and microbial quality of butter

According to Zelalem (1999), in the central high lands, traditionally made butter contains approximately 81.7% fat, 1.1% protein and 0.23% ash. However, a study conducted by Mekdes (2008), in Southern Ethiopia, showed that a moisture content of *kibe* as 20 to 43%, 84.82-86.86% total solids, 80.53-82.53% fat and 0.12 - 0.2% ash. The quantities of the main constituents of dairy products including butter can vary considerably depending on the individual animal, its breed, stage of lactation, age and health status. Herd management practices and environmental conditions also influence dairy product composition. Besides, the moisture content of local butter can vary depending on the extent of kneading or working of butter (O'Connor, 1994). On the other hand, in the case of butter that is made using modern technology, the main constituents are standardized.

Alganesh (unpublished data) on butter samples collected from different local markets and butter shops in the central high lands of Ethiopia revealed that traditionally made butter has an average water activity of 0.974, titratable acidity of 1.482*I*mg KOH/g of butter samples, an acid value of 3.0 mg KOH/gram and with peroxide value of 10.1 mg equivalent peroxide/1000 grams of butter. According to O'Mahony and Ephraim (1985) older butter sold in Addis Ababa market had free fatty acids content of as high as 23%. The findings do not fulfill the requirements set by Ethiopian Standard Authority (Table 4). This might highly contribute to oxidative and hydrolytic rancidity in butter due to poor processing, handling and hygienic practices. Moreover, there is scanty information on chemical properties of Ethiopian butter and ghee.

Microbial quality of traditionally produced butter

Butter samples collected from different parts of the country revealed the following microbiological quality. The average total bacterial count of butter samples collected from Selale and Sululta areas had 6.18 cfu/g and 7.25cfu/g, respectively (Zelalem, 2010). Another report by Wondu (2007) in Awassa, Southern, Ethiopia indicated that an average total bacterial count of 7.49 cfu/gram with high variation from different sources. Samples collected from southern Ethiopia from open local markets and rural producers had higher counts compared to dairy farms and urban producers. Besides, total bacterial count of fresh butter samples collected from Addis Ababa by ILCA (1992) showed a range of 4.7 log cfu/g to 8.27 cfu/g of butter samples. Report of Debela (2016) in west Shewa showed a mean aerobic mesophilic bacteria count of 8.71 log cfu/gram of fresh

Table 5. Microbiological limit specification for butter.

Micro organism	Maximum limit	Method of test
Total plate count	1,000,000/ml	ES ISO 6610
E. Coli	Absent / ml	WD 13540, WD 13541
Salmonella	Absent / 2.5 ml	ES ISO 6785
Molds and yeasts	10/ ml	WD 13539

Source: Ethiopian standard (ES), Milk fat products specification (2008).

butter samples. Un unpublished data of Alganesh also showed that a total bacterial count of 2.47 cfu/g of butter samples collected from open markets and whole sale shops in the central high lands of the country. These results are higher than the acceptable level of 6 log cfu/ml set by Ethiopian standard (Table 5) and world standards indicating that traditionally made butter in different areas of the country are substandard.

Studies conducted by different persons (Wondu, 2007; Zelalem et al., 2007; and Mekdes. 2008) showed coliform counts in butter samples ranged from 1.92 to 4.5 cfu/gram. While a Debela (2016) had reported a mean total coliform count of 5.62 log cfu/gram of fresh butter samples from west Shewa, Ethiopia. All the results were higher than the standard showing that butter is produced under unhygienic conditions. This might be attributable to the materials and methods of production, handling, hygiene of the producer and the animal from which the milk is obtained.

The yeast and mould counts in butter samples collected from southern Ethiopia (Mekdes, 2008) ranged from 5.52 to 5.74 cfu/g. Contrary to these findings, an average of 7.65 cfu/g of yeast and mold counts was reported in Awassa, Southern Ethiopia by Wondu (2007). A recent report of Debela (2016) revealed yeast and mould count of 6.7 cfu/g of fresh butter samples. Moulds are the primary spoilage factors in butter and their presence in butter indicates post production contamination from air or water.

Traditional ghee

Ghee is a product that is made by indigenous methods in many countries around the world, largely in Asia, the Middle East and Africa (Afsaneh et al., 2016). In different parts of the world, products similar to ghee have been available probably since prehistoric times. They are known as "*Samna*" in Egypt (Aboudhonia and Elagamy, 1993), "*Meshho*" in ancient Assyrian empire (2400 BC to 612 BC) (Abdalla, 1994), "*Samin*" in Sudan (Hamid, 1993), "*Maslee*" or "*Samn*" in Middle East, "*Rogan*" in Iran(Urbach and Gordon, 1994), and "*Samuli*" in Uganda (Mohammed et al*.,* 1998). In Ethiopia ghee is known by the name *dhadha baksa*/ *Neter Kibe*, which stands for heated and clarified butter.

Some ambiguity in the definition of ghee occurs mainly due to regional deference and preferences for the product. The characteristic flavor and aroma of ghee is its major criterion for acceptance. Flavor is greatly influenced by the fermentation of the cream or butter and the heating processes (Mohammed et al., 1998). According to Illingworth et al. (2009) ghee can be defined as a pure clarified fat that is exclusively obtained from milk, cream or butter by application of heat for almost total removal of moisture and solid nonfat to give a product a unique flavor, physical structure and texture. A recent definition of ghee is stated as 'a product exclusively obtained from milk, cream or butter by means of processes which result in almost total removal of water and non-fat solids, with an especially developed flavor and physical structure (Afsaneh et al., 2016). According to Mohammed et al. (1998) carbonyls, lactones and free fatty acids are reported to be the key ghee flavoring compounds. In the case of Ethiopian ghee, flavor determinants are fermentation time, type of fumigants used for milk vessels and churns and spices used in ghee making. Ethiopian traditional ghee *Nitir kibe* is made from butter made of sour milk. It has an attractive appearance, a grainy texture and a light yellow color. At room temperature it is semi-solid. It has a pleasant odor and good taste. Its good keeping quality allows storage for more than a year without significant deterioration (Almaz et al., 2001; Eyassu and Asaminew, 2014).

The western world standard specifies ghee to have 96% minimum milk fat, 0.3% maximum moisture, 0.3% maximum free fatty acids (FFA) (expressed as butyric acid), and a peroxide value (PV) less than 1.0. Its physical structure should consist of a mixture of higher softening point fats in crystalline form dispersed in the liquid lower softening point fats and this gives the ghee a somewhat granular appearance (Mohammed et al., 1998). However, there is no report on such parameters on the Ethiopian ghee. But the standard authority has set minimum requirements for the parameters as indicated in Table 6. Furthermore there is no information available on the effects of traditionally made ghee on human health.

Traditional ghee is a more convenient product than butter in the tropics, because of its better shelf life even under warm conditions (O'Connor and Tripathi 1992). In Ethiopia, traditional ghee is made exclusively for home consumption, not for market. Traditional ghee manufacture is based on individual experience and taste. Addition of combinations of spice powders, chopped tubers and or dry herbs, leaves and stems of green spices are used in traditional ghee making (Alganesh, 2002; Hailemariam and Lemma, 2011).

The main features of clarified butter manufacturing are identical in every country. However, some differences exist specially in the duration of heating and whether or not some clarifying agents are added to the boiling butter. According to survey reports (Alganesh and Fekadu,

Table 6. Requirements of ghee set by Ethiopian standard.

Characteristics	Value	Test method
Milk fat, min,% by mass	99.6	ES 3476
Moisture, max,% by mass	-	ES ISO 5536
Acidity, max, % by mass as oleic acid	0.4	ES ISO 1740
Peroxide value, max, milliequivalent of oxygen/ 1kg fat	0.6	ES ISO 3976
Copper, max, ppm	0.05	ES ISO 5738
Iron, max, ppm	0.2	ES ISO 6732

Source: Ethiopian Standard (ES), Milk fat products specification, 2009).

2012; Eyassu and Asaminew, 2014; Debela, 2016) traditional ghee making is the major option of preserving butter in Eastern Wollega, North Western and West Shewa of Ethiopia. According to the above authors' reports from different sites, traditional ghee can be kept at ambient temperature of between 20 to 30°C for 11.10, 19.20 and 7.3 to 7.7 months, respectively in East Wollega, North west and West Shewa, Ethiopia without significant change on quality. Another report from Dewachefo area of Amhara region showed that smallholders store ghee from 6 months up to 7 years and use such ghee for medicinal purpose to cure chronic coughs (Kefyalew et al., 2016). O'Mahony and Peters (1987) showed that salt is added to traditional ghee as a combination of preservative to prolong storage life. This view has been refuted on grounds that salt is not fat soluble and hence does not have a preservative effect against deteriorative reactions taking place in the fat.

Procedure for traditional ghee making

According to Illingworth et al. *(*2009), worldwide, there are four methods for the production of ghee: the indigenous milk butter method, the direct cream method, the cream butter method and the pre-stratification method. In Ethiopia, traditional ghee is made from butter made of fermented milk, or butter preserved using different butter preservation methods. Hence, raw materials used for ghee making can be *nigur kibe,* spiced butter, salted butter, untreated rancid butter or fresh butter. Variety of herbs, powders and chopped tubers of spices are added during ghee making (Alganesh, 2002; Debela, 2016).

To make traditional ghee, butter is inspected and cleaned of any visible impurities and placed into a saucepan or clay pot and put on open fire or heat source (actual heating temperature not known) to melt. Heating and stirring continues until foam is formed and a clear liquid is obtained. Along heating the butter, combination of one or more spices are added to induce good aroma, increased shelf life and taste (Table 7). Heating of melted butter is continued until bubbling ceases and all moisture evaporates (assumed that foam and bubble are appearing due to water evaporation). When the non-fat solid turns to brown and frothing stops, boiling is stopped (Kefyalew et al., 2016). Melted butter is then filtered through sieve or piece of cheese cloth to remove impurities and decanted into another vessel leaving the curd material in the pan. Well dried containers free from moisture with tight stopper are used to keep refined butter. Commonly ghee processed in such a step is stored in cool dark areas of the house. Small amount is daily removed and used in cooking and preparation of various traditional foods (Almaz, et al., 2001; Alganesh and Fekadu, 2012). Similar procedures have also been reported by Asamnew (2007) in Bahir Dar area. Some of the spices used for traditional–ghee making in different communities are indicated in Table 7.

Use of traditional ghee

Ghee is the most important ingredient in food and it is rich source of dietary energy and contains high calorific value. Indian ghee contains approximately 0.5% moisture, 99% milk fat and other minor chemical components (Sukumar, 1980). Ghee contains certain acids which are very important and essential for the human beings. They are vehicle for the fat soluble vitamins (Jariwala, 2014). So far, there is no information on the chemical composition of Ethiopian ghee.

Traditional ghee is commonly used for culinary, social functions and therapeutic purposes (Mohammed et al., 1998). A major portion of ghee is utilized for culinary purposes such as a dressing for various foods, cooking and frying of different foods. In Ethiopia, traditional ghee is usually utilized for flavoring and as condiment for different types of pulse stews (lentils, beans and peas), chicken and meat stews and sauces from different species of domestic animals. Particularly no chicken stew is being thought with the absence of ghee, and commonly is an indication of well-being of a family who used ghee in their daily meal.

This is in agreement with a report of Zelalem et al. (2011) that stated that ghee is added to a variety of Ethiopian traditional dishes such as *Kitifo* (minced beef served raw or half cooked) and a variety of cereal, pulse and meat based sauces. It is also used in mixture with

Table 7. Spices used in traditional ghee making in Ethiopia.

Vernacular name	Common name	Scientific name	Plant parts used
Qullubii adii	Garlic	*Allium sativum*	Tuber
Jinjibila	Ginger	*Zingiber officinale*	Tuber
Irdii	Turmeric	*Curcuma domestica*	*Tuber*
Sunqoo	Fenugreek	*Trigonella foeniculum*	*Seeds*
Oogiyoo	Kororima	*Aframomum korarimao*	*Seeds*
Qurunfudii	Clove	*Syzygium aromatium*	Seeds
Qarafaa	Cinnamon	*Cinnamomum verum*	Seeds
Habasuuda adii	Bishop's weed	*Trachyspermum ammi*	*Seeds*
Habasuuda gurraacha	Black cumin	*Nigella sativa*	*Seeds*
Kefoo	Basobila	*Ocimum urticifolium*	*Seeds, stems and leaves*
Qundabarbarree	Black pepper	*Piper nigrum*	*Seeds*
Siqaaqibee	Basil	*Ocimum spp*	*Seeds, stems and leaves*
Kusaayee		*Ocimum hardiense*	*Stems and leaves*
Mimmixa	Chillies	*Cupsicum spp.*	*Pods*
Gaawwuzii		*Myristica fragrans*	*Pods*
Qullubbii dhiima	Onion	*Allium cepa*	*Tuber*
Cilaattama	Rue	*Ruta graveolence*	*Stems and leaves*
Dimbilaala	Cordiander	*Cordiandrum sativum*	*Seeds, stems and leaves*
Mekimeko	Spinach Rhubarb	*abyssinicus Rumex*	*Stems and leaves*
Xoosinyii	Oregano	*Satujera species*	*Leaves*

Source: Alganesh (2002), Hailemariam and Lemma (2011) and Bekele et al. (2015).

cottage type cheese and *kochkocha* and served with indigenous diets such as *chumbo* and *chororsa*. Traditional ghee is occasionally drunk with coffee. It is also used as input in cultural ceremonies for roasting coffee to make *buna kala* that is served during special occasions and holidays. Ghee is also used to prepare delicious indigenous snack foods such as '*chachabsa, chiko, anababiro, silcho* (traditional ghee and table salt mixed with roasted or boiled maize green cobs) and porridge (Yonad, 2009; Alganesh and Fekadu, 2012; Lola and Haile, 2015). According to study conducted, traditionally made ghee stored for more than a year is recommended for patients to treat chronic coughs (Alganesh and Fekadu, 2012). Ghee is also consumed with coffee and tea especially when important guests are received in a home and during major holidays.

Packaging materials and methods for butter and ghee

Ghee is susceptible to deterioration from exposure to light, air and metal ions (Illingworth et al., 2009). Ghee is preserved by a combination of heat, which destroys enzymes and contaminating microorganisms and by removing water from the oil to prevent microorganisms growing during storage. According to ES (Ethiopian Standard Authority) (2009), butter shall be packed in containers that are proof to water and fat, non absorbent and non-harmful to its composition, flavor and appearance. In smallholder farmers' case butter making, contamination can come from packing material, unclean surface, the butter maker, the wash water, cups and leaves. Moreover, traditional equipments are often porous and harbor dirt and microorganisms (O'Mahoney, 1988). Fellows (2008) recommended that, butter and ghee can have a longer shelf life if they are stored in cool place, using airtight, light-proof and moisture-proof containers to slow down the development of rancidity. Simon (2012) also stressed that the keeping quality of ghee can be affected by many factors, such as type of packaging material, permeability to oxygen and moisture, method of manufacture, presence of antioxidants, light and others.

A leaf of plant called *koba/inset* (false banana) is the most common material used for butter packaging in southern parts of Ethiopia. *Koba/inset* is believed to be important to keep butter fresh until marketed. However, some respondents indicated that the leaves may reduce the weight of the butter because when the cover is removed some butter remains stacked on the leaves (Mekdes, 2008). The same author recommended the need of further study on the effect of packaging butter with leaves on the quality and sensory characteristics. In other parts of Ethiopia, use of clay pot for storage or packaging of various dairy products including butter and ghee is common (O'Mahony and Ephirem, 1985; Zelalemand Inger, 2001b; Eyassu and Asaminew, 2014).

Use of gourd as a storage vessel or packaging material for *kibe* and *nitir kibe and* packaging *kibe in kobo (*Castor bean leaf*)* and other leaves during storage and while markets is common in east Wollega and Shashamane areas (Alganesh, 2002; Lemma et al., 2004).

CONCLUSION AND RECOMMENDATION

Indigenous methods of production, processing and handling of butter and ghee were assessed. Butter is made from sour/naturally fermented whole milk. Butter and ghee are important component of Ethiopian traditional diets. Ghee can be made from untreated butter, spiced, salted butter and *nigur kibe*. During ghee making different types of spices are added for flavor impartation, acceptable taste and increased shelf life. There is scanty information available on chemical and microbial quality of butter. However, the available information on the quality and safety of butter shows that the products are in substandard state. Moreover, there is limited or no information on the quality and safety of ghee. The safety and quality aspect of butter and ghee and handling as well as processing practices still are subject of further investigation. Besides, there is a need to develop and optimize butter and ghee processing methods for better yield and quality for future commercialization.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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GLOSSARY OF TERMS

Anababiro- Ethiopian flat bread (*injera*) made from unleavened powder of red colored *Eragrostis tef* where two flat bread are merged together and freshly made traditional ghee and *Kochkocha* or spiced hot pepper powder mixture are rubbed on it. It is very delicious, it is served as snack or breakfast.

Bala kobo - Castor bean leaf.

Buna qala/*buna kala*- Coffee bean roasted with freshly made traditional butter that is served on special occasions.

Chachabsa - Traditional pancake made from unleavened powder of red colored *Eragrostis tef.* The pan cake is chopped and mixed with freshly made traditional ghee and salt. It is served as breakfast and snack.

Chiko- A delicious traditional snack food made of roasted barley powder, barley powder is thoroughly mixed with fresh traditional ghee, salt and *Aframomum korarimao.*

Chororsa- Soft cottage cheese on which mixture of clarified butter and *kochkocha* served with tef.

Chumbo- Unleavened delicious Oromo cultural bread made of red seeded tef (*Eragrostis teff*) flour served with cottage cheese on which clarified butter mixed with *kochkocha* is sprinkled on it.

Dhadha baksaa/ *nitir kibe*- Traditional ghee made from local butter boiled with different spices and clarified.

Dhaadha/'kibe -Local butter made by churning fermented milk.

Ergo/ itittu- Spontaneously fermented milk without defined starter culture.

*Gorfu***-** Traditional milk vessel used by borana pastoralists.

Kitifo-minced beef served raw or half cooked.

Kochkocha- Finely chopped green hot pepper that is mixed with ginger, garlic, onions, and herbs of desirable aroma and salt and is served as sauce for different traditional foods.

Mangor- To make *nigur kibe*/the process of making *nigur kibe*/melting of butter keeping it to settle for overnight and decanting off impurities from the butter.

Nigur kibe - butter that is melted cooled over night and decanted off any impurities and residual butter milk settled at the bottom of pot/sauce pan.

Silcho - Roasted or boiled maize green cobs mixed with traditional ghee (made from freshly made butter) and table sprinkled on it and served hot and fresh.

Spiced butter**-** Homemade butter or butter purchased from local market that is meant for future use or sale is mixed with powders of some spices and wrapped in traditional containers.