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Physicochemical analysis and microbial quality of cow butter obtained from Menz district of Amhara region, Ethiopia

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Menz has long been known for its quality butter production but traditional milk products are generally reported to be of substandard quality. Therefore, this investigation was conducted to access physiochemical and microbial quality of butter from Menz district along the market value chain. The study was conducted by using laboratory analysis of physiochemical and microbial quality. The microbiological count data were transformed to log10 values before statistical analysis. Overall values of 15.05%:82.62%:2.09%, 14.26%:83.44%:2.77%, 14.25%:83.30%:1.03%, 14.58%:83.82%:3.58%, and 12.52%:83.96%:2.82% for moisture, fat and free fatty acid contents were observed in samples from farmers, traders, made by investigators, Tarmaber and Addis Ababa, respectively. In general, an overall mean of 3.94×10^9 : 2.66×10^6 : 1.83×10^6, total aerobic mesophilic bacterial count, total coliform and yeast and mold counts were observed in samples from farmers. Total aerobic mesophilic bacterial count, total coliform and yeast and mold counts values were 3.44×10^9:3.03×10^6:1.31×10^6 and 3.26×10^9:1.61×10^6:1.77×10^6 for samples collected from traders and for butter made by invigilators, respectively. For samples collected from Tarmaber and Addis Ababa, these values were 4.19×10^9:2.69×10^6:1.56×10^6 and 4.20×10^9:2.10×10^6:1.45×10^6, respectively. There is unhygienic production and processing of butter in the study area. Both physiochemical and microbial analysis shows the substandard traditional production system of the area which calls for improvement. Improvements are required on introduction of modern butter production technologies and awareness creation on hygienic production, processing and handling of butter.

Key words: Bacterial count, fat content, market value chain, butter from Menz district, moisture content.

INTRODUCTION

Ethiopia has one of the largest livestock inventories in Africa with a national herd estimated at 49.2 million cattle, 46.8 million sheep and goats, and 9 million pack animals. All livestock currently support and sustain livelihoods for 80% of all rural poor. Of the total population, 35 to 40% of all livestock are located in the pastoral areas (MoARD,

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2007). Female cattle constitute about 55.48% of the national herd and of the total female cattle population dairy and milking cows total 16,941,361 with 14.24% dairy cows and 20.12% milking cows (CSA, 2008).

Eighty-three percent of all milk produced in Ethiopia comes from cattle with the remainder coming from goats and camels (MoARD, 2007). The Central Statistics Agency (CSA, 2008) estimates 2.76 billion liters of cow milk produced by sedentary populations annually, while camel milk is estimated at 16.2 million liters annually. The Ministry of Finance and Economic Development (MOFED) estimated the gross value of ruminant livestock production in 2008/2009 at Birr 32.64 billion. The estimate includes the values of livestock off-take (Birr 9.653 billion), milk and milk products (Birr 19.471 billion) and other products. Given the considerable potential for smallholder income and employment generation from high-value dairy products, development of the dairy sector in Ethiopia can contribute significantly to poverty alleviation and nutrition in the country (MoARD, 2007).

Fresh milk is easily perishable if it is not consumed immediately. So when surplus amount of milk is produced, it should be processed into different products like butter, soured milk and cheese. Butter has long shelf life as compared to fresh milk, especially when heated to higher temperature (100-120°C) for 30 min; it can stay for several months without spoilage (Lejko et al., 2009). Butter is one of the primarily 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 (Vernam and Sutherland, 1994; Rady and Badr, 2003).

The quality of butter is closely related to its physico-chemical and microbiological characteristics. Besides fats, butter contains small percentages of proteins, milk sugar and water which make it a suitable substrate for microorganisms (Mahendra et al., 2016, Singh et al., 2011). Although butter spoilage is most often due to the development of chemical rancidity, microbiological problems do also occur in the form of cheesy, rotten or fruity odors and the rancid flavor produced by hydrolysis (Rady and Badr, 2003).

The primary spoilage factors in butter are moulds and the majority of the moulds growing in butter are composed of the species of *Thamnidium*, *Cladosporium* and *Aspergillus*. Through the application of a proper heat treatment, moulds cannot survive in cream even if contamination exists. So, the presence of mould contamination in butter indicates contamination by water or air after production (Bereda et al., 2014). Moreover, some pathogenic microorganisms like *Listeria monocytogenes*, verocytotoxin-producing *Escherichia coli* and *Stapayloccocus. aureus* which are known to cause food borne illness in human beings were also detected in butter (Pal, 2014).

In most areas of North Shoa zone, livestock production is the main income source of the farmer among those dairy, sheep and equines are mainly adapted in the area. Livestock and livestock products like milk, butter and meat are the main income generators for farmers living specially in the highland areas of the zone. Among these areas, Angolelana Tera, some parts of Basonaworana and Menz districts are known by their dairy production and the livelihood of the farmer also depend on dairy products (milk and butter). Angolelanatera and Basonaworena district are known in cow milk production and supply their product to the surrounding milk processing plant. But Menz districts are well known by their butter production in addition to milk and this product is also preferred by consumers to cow milk butter collected from other areas. Even if the areas have good potential in butter and milk production, there is no enough scientific information or study that inform about the quality of milk and butter made from cow milk. In this background, the present study is intended to describe the physicochemical property and microbiological composition of cow butter collected from different area of the Menz districts.

MATERIALS AND METHODS

Study area

The study was conducted in three purposively selected district of North Shoa zone (Menz Gera, Menz Mama, and Menz Keya) based on their butter production capacity from November 2016 to March 2017. North Shoa zone is one of the ten administrative zones of Amhara National Regional State. This zone covers 17.7 thousand km^2 land areas. Of the total land area, 38.2% is arable, 42.1% grazing and browsing, 7.5% natural vegetation, 2.1% unproductive, and 11.0% unutilized. Traditionally, the zone is divided into Dega (37.4%), Woina Dega (30.1%) and Kola (32.5%) agro-climatic zones (ANRS -BOFED, 2001).

The study was conducted in three districts of Menz, namely, Menz Gera Midir (also called Mehal Meda) with administrative center of Mehal Meda and a total population of 120,469, of whom 58,827 are men and 61,642 are women; 11,055 or 9.18% are urban inhabitants, Menz Mam Midir (also known as Molale) with administrative center of Molale and a total population of 85,129, of whom 42,102 are men and 43,027 are women; 6,513 or 7.65% are urban inhabitants and Menz Keya Gebreal (also called Zemero) with administrative center of Zemero and a total population of 46,219, of whom 22,965 are men and 23,254 are women; 2,623 or 5.68% are urban inhabitants (Figure 1).

Data collection

Laboratory analysis

Traditional butter was elaborated in the laboratory as described by Idoui et al. (2010). Butter samples were collected from each value chain actors (starting from the producer to the traders of different locations of Menz districts, Addis Ababa). In each of the three districts, three samples from the farmers, one sample from trader and fresh milk sample was collected. In addition, two butter samples were collected from the butter market value chain one from Tarmaber and other from Addis Ababa. The fresh milk was processed to butter by investigators following the traditional way of

Figure 1. Study area (left: map od Amhara region; right: North Shoa with the study area signaled by *symbol).

butter making process. After the milk is left to turn into yoghurt, it was churned by hand churner till whipped cream became coarser and semi-solid butter granules were formed that rapidly increased in size and separated sharply from the liquid buttermilk. Butter was washed with cold water several times and the excess water was removed. Butter was filled in sterile disposable polyethylene bags and stored at 4°C till analysis. After collection, the butter samples were brought to the Dairy Laboratory in Holeta by placing it under ice box. Three microbial (TAMBC, total coiform, and yeast and molds) and three physiochemical (%FFA, %Moisture content, and %Fat) were conducted at Holeta Dairy Laboratory following standard procedures according to Richardson (1985).

Data analysis

The microbiological count data were transformed to log10 values. Mean values and frequencies were used to compare data.

RESULTS AND DISCUSSION

Physiochemical property

Traditionally and legally, however, butter must contain >81% of only milk fat (Gebremedhin et al., 2014). As shown in Table 1, the mean value of moisture content in the three districts was 14.17, 15.25, and 15.05 in Mehal Meda, Molale, and Zemero respectively with an overall mean value of 15.05. Highest values of moisture content were observed in Zemero (16.90% at kebele 01) and Molale (16.75% at kebele 06). All of these results are below the maximum legal compositional standards for butter moisture (16%). Table 2 shows almost equal mean value of moisture content both in butter samples from traders (14.36%) and butter made by investigators (14.25%). This is lower than the moisture content registered in samples from farmers.

Legal compositional standards for butter are a minimum of 80% butter fat and a maximum of 16% moisture. Moisture and impurities values of butter samples ranged from 16 to 35.73% and 9.25 to 12.25%, respectively. The moisture level in all butter samples is higher than the international standard (0.05 to 2%). The high level of moisture in traditional butter may have an influence on its microbiological and physicochemical quality since the presence of water in butter can activate lipases, stimulate the growth of micro organisms and cause the hydrolysis of triglycerides spoilage when stored at room temperature (Ronholt et al., 2013). The moisture content of traditional butter ranges from 20 to 43%. Ashenafi has reported that traditional butter has 17.2% moisture, 1.3% protein, 81.2% fat, 0.1% carbohydrate, 0.2% ash, 0.024% calcium, and 0.0015% iron (Ashenafi, 2006). The average moisture content of butter collected from open markets of Delbo and Kucha was 18.86±1.02%/g of butter samples. Generally, there is scanty information on chemical composition of butter in the country (Mekdes, 2008).

The mean fat content of butter collected from Mehal Meda, Molale and Zemero farmers were 83.5, 82.52 and 81.74%, respectively with an overall mean of 82.68%. Highest values of 85.94% (at Molale, kebele 01) and 84.47% (at Mehal Meda, kebele 07) fat% were observed. The value of fat percentage in samples from traders (83.44%) and sample from butter made by investigators (83.30%) were higher than the overall mean seen in samples from farmers. The food value of butter depends on its butterfat content. The fat content of butter is reduced by the incorporation of excess water and most countries protect the consumer by prescribing a legal limit

Table 1. Moisture and fat content of butter samples from farmers.

District	%Moisture content	%Fat
Mehal Meda		
Kebele 02	14.22	83.889
Kebele 03	14.83	82.431
Kebele 07	13.451	84.47
Mean	14.17	83.59
Molale		
Kebele 01	12.561	85.94
Kebele 02	16.45	80.937
Kebele 06	16.75	80.688
Mean	15.25	82.52
Zemero		
Kebele 01	16.90	79.33
Kebele 02	14.604	83.769
Kebele 08	15.674	82.127
Mean	15.72	81.74
Overall mean	15.05	82.62

Table 2. Moisture and fat content of butter samples from traders and other markets.

Type of butter	District	%Moisture content	%Fat
	Mehal Meda	15.42	83.44
Trader	Molale	12.706	84.92
	Zemero	14.672	81.9550
Mean	-	14.26	83.44
	Mehal Meda	14.387	83.749
Churned	Molale	16.00	81.127
	Zemero	12.38	85.05
Mean		14.25	83.30
	Tarmaber	14.58	83.82

for water content. The higher fat content in buttermilk within the traditional methods might be attributed to the long churning time and/or the mechanism of churning that allows the incorporation of large volumes of air. A short churning time corresponds with low churning efficiency (Zelalem et al., 2007)

As shown in Figure 2, the moisture content of all samples was below the maximum standard (16%) expected in butter. Lower moisture content were seen at Tarmaber and Addis Ababa which may be due to long time of storage and evaporation moisture of butter at the final markets away from the production area. The fat content of the samples is also above the minimum required value (81%). But the free fatty acid content indicates unhygienic processing and handling of butter in all samples with the lowest value attained from butter sample made by investigators.

Free fatty acid composition

Hydrolysis is the liberation of free fatty acids from the glycerol backbone in the presence of a lipase enzyme. A large amount lipoprotein lipase is present naturally in milk, but fortunately fat globules with an intact milk fat globule membrane are not susceptible to hydrolysis by the enzyme. Spoilage bacteria provide a heat stable lipase, but the spoilage bacteria must exceed normal levels. Fat that has been lipolysed tastes rancid and smells rancid. The fat globules can be damaged by

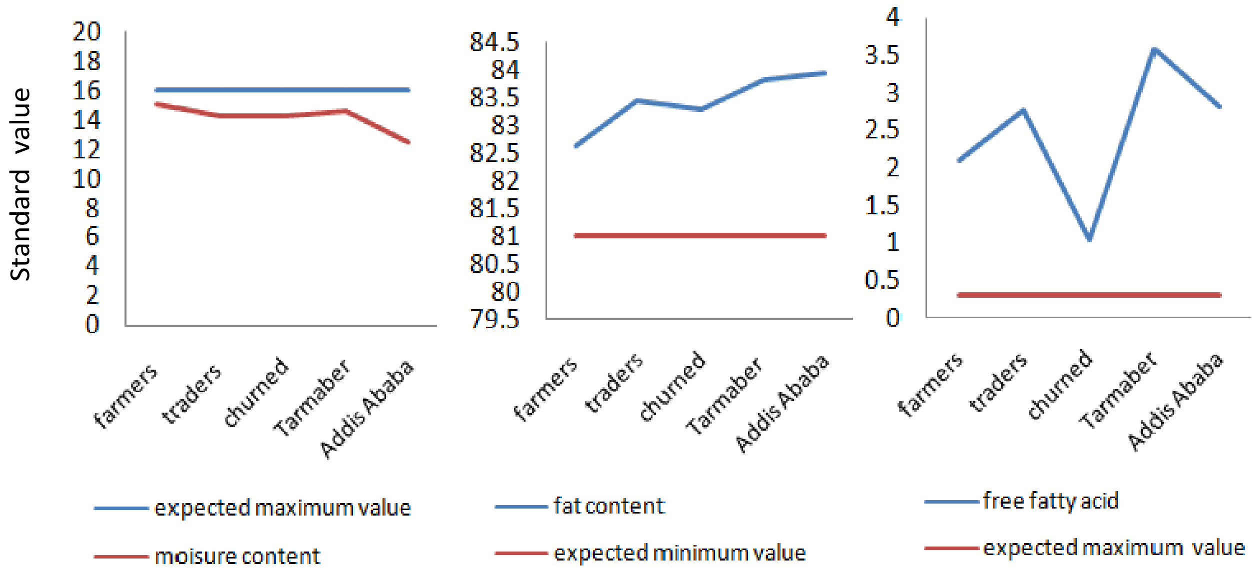

Figure 2. Comparison of moisture, fat and free fatty acid contents of butter with standard values.

Table 3. Free fatty acid composition of butter samples collected from producers (farmers).

Parameter	Districts								
	Mehal Meda			Molale			Zemero		
	Kebele 02	Kebele 03	Kebele 07	Kebele 01	Kebele 02	Kebele 06	Kebele 01	Kebele 02	Kebele 08
% Free fatty acid	2.87	1.49	1.81	2.00	1.10	1.56	3.01	3.77	1.24
Mean		2.06			1.55			2.67	

pumping, stirring, or splashing the milk. Therefore, unnecessary agitation of unpasteurized milk should be avoided to prevent the damage of the fat globules. The free fatty acids of milk fat are believed to be involved in imparting flavor properties to milk and other dairy products. The reduction in quality was caused by rancidity and bitterness that are related to high levels of free fatty acids and break down of proteins (Dieffenbacher et al., 2000). The standard specifies butter to have 0.3% maximum free fatty acids expressed as oleic acid, and a peroxide value less than 1.0 (Sserunjogi et al., 1998).

The mean value of free fatty acid in Mehal Meda, Molale and Zemero are 2.06, 1.55 and 2.67, respectively with an overall mean of 2.09%. In Table 3, the mean value of free fatty acid in butter from traders and butter made by investigators were 2.77 and 1.03%, respectively. But the highest values were seen in samples from Tarmaber (3.58%) and Addis Ababa (2.82%) (Table 4). The content of free fatty acids in the butter sold in rural markets varied from 0.23 to 1.20%. Older butter sold in the Addis Ababa market had free fatty acids content of as high as 23%. In Debre Zehit content, free fatty acids was between 0.07 and 3.32% (O'Mahony and Ephraim, 1985).

A study conducted in Algeria by Idoui et al. (2010) reviled that traditional cows' butter contained a high percentage of saturated fatty acids (SFA) and palmitic acid was the major SFA (24.33 to 36.95%), followed by myristic acid (18.49 to 27.35%) and stearic acid (7.68 to 14.05%). In other study, palmitic acid was reported to be the major SFA (22.81%) followed by stearic acid (10.21%) (Rady and Badr, 2003).

Microbial properties of butter from Menz district

Microbial criteria require that specific microorganisms or toxins produced by a microorganism must not be present at all, are allowed in a limited number per gram of samples, or be present at less than a specified number or amount in a given quantity of a food ingredient (Michael and Joseph, 2004). Average value of total aerobic mesophilic bacterial count (TAMBC) from farmers sample was 3.94×10^9 with the maximum value of 4.11×10^9 at Zemero district Kebele 01. A mean value of 3.89×10^9, 3.99×10^9 and 3.94×10^9 TAMBC was recorded from Mehal

Table 4. Free fatty acid composition of butter samples from traders and other markets.

Parameter	District	Free fatty acid
Trader	Mehal Meda	1.89
	Molale	3.02
	Zemero	3.4
	Mean	2.77
Churned	Mehal Meda	1.2
	Molale	0.92
	Zemero	0.96
	Mean	1.03
-	Tarmaber	3.58
	Addis Ababa	2.82

Table 5. Microbial quality of butter samples collected from farmers.

Districts	TAMBC (CFU/g)	Total coiform (CFU/g)	Yeast and molds (CFU/g)
Mehal Meda			
Kebele 02	4.07×10^9	3.16×10^6	1.90×10^6
Kebele 03	3.43×10^9	2.89×10^6	1.65×10^6
Kebele 07	4.17×10^9	2.45×10^6	1.82×10^6
Mean	3.89×10^9	2.83×10^6	1.79×10^6
Molale			
Kebele 01	4.08×10^9	2.58×10^6	2.32×10^6
Kebele 02	3.85×10^9	2.31×10^6	1.68×10^6
Kebele 06	4.06×10^9	2.48×10^6	1.75×10^6
Mean	3.99×10^9	2.46×10^6	1.92×10^6
Zemero			
Kebele 01	4.11×10^9	2.63×10^6	1.37×10^6
Kebele 02	3.57×10^9	2.12×10^6	1.75×10^6
Kebele 08	4.15×10^9	3.32×10^6	2.22×10^6
Mean	3.94×10^9	2.69×10^6	1.78×10^6
Overall mean	3.94×10^9	2.66×10^6	1.83×10^6

Meda, Molale and Zemero respectively (Table 5). Lower results of 3.64×109, 3.23×10^9 and 3.45×10^9 were obtained in samples collected from traders at Mehal Meda, Molale and Zemero, respectively (Table 6). In samples taken from butter made by the investigators (*churned*), lowest values of 3.26×109, 3.21×10^9 and 3.32×10^9 were recorded as shown in Table 6. But much higher results were seen at Tarmaber (4.19×10^9) and at Addis Ababa (4.20×10^9) (Figure 3).

In general, an overall mean of 3.94×10^9 TAMBC from farmers sample, 3.44×10^9 from traders, 3.26×10^9 from churned samples, 4.19×10^9 from Tarmaber and 4.20×10^9 from Addis Ababa were recorded. These values are higher than the acceptable limit of 5×10^4 cfu/g (Mostert and Jooste, 2002). Here, highly contaminated butter was found at Addis Ababa and Tarmaber followed by butter collected from farmers. At the time of collection, necessary measures were taken to collect butter which is not aged; this may rules out the source of variation to be age of butter. And there will not be seasonal variation since all samples were collected and tested on month of august which is supposed to be rainy season. Accordingly, the source of contamination seems to be at farmers and secondary/final market places (Table 7). Mamo (2007) reported a total microbial load of 3.15×10^7 where he suggests there is a high variability among samples depending on the sources with samples collected from open markets and rural producers for

Table 6. Microbial quality of butter samples collected from traders and churned by investigators.

District	TAMBC (CFU/g)	Total coliform (CFU/g)	Yeast and molds (CFU/g)
Mehal Meda			
Traders	3.64×10^9	3.00×10^6	1.92×10^6
Churned	3.26×10^9	1.38×10^6	1.99×10^6
Molale			
Traders	3.23×10^9	3.16×10^6	1.37×10^6
Churned	3.21×10^9	2.10×10^6	1.79×10^6
Zemero			
Traders	3.45×10^9	2.92×10^6	6.27×10^5
Churned	3.32×10^9	1.36×10^6	1.52×10^6

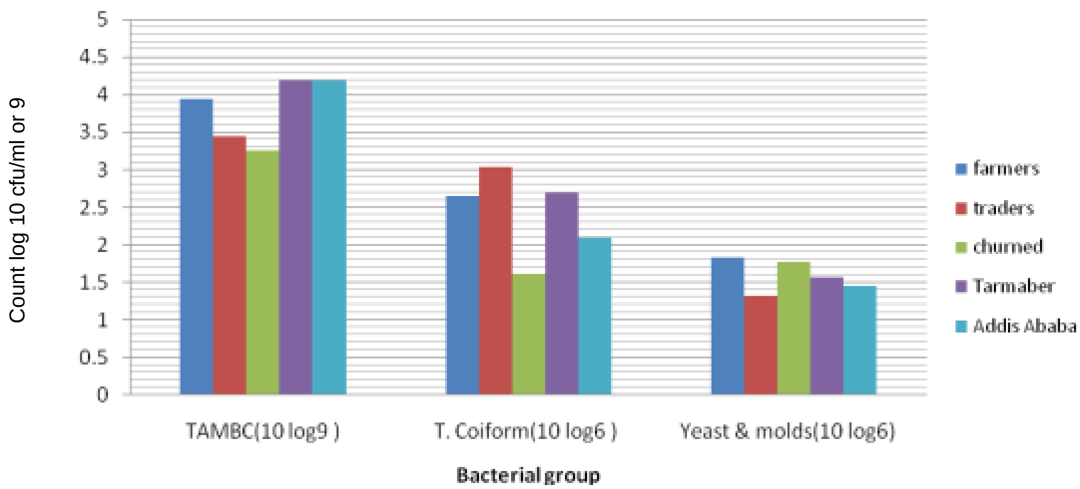

Figure 3. Microbial counts of butter samples from Menz district.

Table 7. Microbial quality of butter samples collected from Tarmaber and Addis Ababa.

Place	TAMBC (CFU/g)	Total coliform (CFU/g)	Yeast and molds (CFU/g)
Tarmaber	4.19×10^9	2.69×10^6	1.56×10^6
Addis Ababa	4.20×10^9	2.10×10^6	1.45×10^6

instance had higher counts as compared to that obtained from dairy farms and urban producers. According to Zelalem (2010), butter samples collected from Selale area average total bacterial counts of 7.25 cfu/g of butter. A study conducted by Mekedes (2008) in Southern Ethiopia on samples collected from open markets in Delbo and Kucha areas in Southern Ethiopia revealed mean total bacterial counts of 8.19±0.12 log cfu/g. The mean AMBC in fresh butter samples collected from Ambo and Dire Inchini districts of west shewa revealed log8.71 cfu/g (Alganesh, 2017).

A study conducted in other parts of the world recorded higher values of TAMBC than the present study. In Sudan, a value of log107.24 cfu/g, log10 7.68 cfu/g and log10 7.89 cfu/g, respectively for butter traditionally made by farmers, butter manufactured in dairy plant and butter made by investigators (Ahmed et al., 2016). Other researchers (Samet-Bali et al., 2009) also reported total microbial count of log 4.70±0.05 in traditional Tunisian butter and total bacteria count of log 5.18 to 6.83 in traditional Algerian cow's and goat's milk, respectively (Idoui et al., 2010). Additionally, a mean total bacteria count of log 5.18 to 6.08 cfu/g in Karın traditional butter from Turkey was reported (Gökce et al., 2010). The high count of bacteria in these studies may be attributed to the absence of heat treatment (pasteurization) and salt. High total bacteria count in butter may be attributed to high microbial load initially present in the milk, absence of pasteurization and salt, and the effect of both separation and churning processes on the breaking up of bacterial clumps which increases their number (Idoui et al., 2010). Butter was classified according to its total aerobic mesophilic bacteria as very good quality (<1.0×10^6 cfu/g), good quality (1.0×10^6 - 2.0×10^6 cfu/g) and low quality (>2.0×10^6 cfu/g) (Gökce et al., 2010). In this respect, quality of butter collected from the present study belongs to low quality because the lowest value observed in the study area is 3.21×10^9 from churned sample at Molale district. The microflora of butter reflects the quality of cream, the sanitary conditions of equipment used in the manufacture of butter and the environmental and sanitary conditions during packaging and handling. It is advisable to adopt strict hygienic measures during milk handling to prevent contamination and improve its quality, in addition to proper heat treatment of milk (Meshref, 2010).

Total coliforms as hygiene indicator can be used as important criteria for determination of microbiological quality of butter (Zelalem, 2010). Overall average mean value of 2.66×10^6 total coliform counts was observed from farmer's sample. Looking into the three districts separately, mean value of *2.83*×10^6, *2.46*×10^6 and *2.69*×10^6 were gathered from Mehal Meda, Molale and Zemero, respectively. Both the highest (3.32×10^6) and the lowest (2.12×10^6) value were seen in Zemero district (Table 6). Unlike in the case of TAMBC, the values for total coliform counts were higher in samples collected from traders in Mehal Meda (3.00×10^6), Molale (3.16×10^6) and Zemero (2.92×10^6) (overall average being 3.03×10^6). The lowest values were obtained from butter samples manufactured by investigators (1.38×10^6, 2.10×10^6 and 1.36×10^6 in Mehal Meda, Molale and Zemero districts, respectively with overall value of 1.61×10^6). The result in Tramaber (2.69×10^6) is higher than the value of butter manufactured by investigators, butter from farmers, and also butter sample from Addis Ababa. The total coliform count of butter sample from Addis Ababa (2.10×10^6) indicates a lower value than farmers, traders and Tramaber. Therefore, higher total coliform count records were from traders (3.03×10^6) and from Tarmaber (2.69×10^6).

These high deviations from the acceptable value of 10 cfu/g (Mostert and Jooste, 2002) indicate substandard handling conditions at all stages in the milk chain. Higher values were reported from similar studies conducted in Sudan (Ahmed et al., 2016) where values of log10 2.51 cfu/g, log10 2.38 cfu/g and log10 2.41 cfu/g for butter from farmers, butter from dairy plant and butter made by investigators were seen, respectively. Coliforms are indicators of cleanliness of handling of milk and cream, premises and equipment Idoui et al. (2010). Coliform was found in all samples of fresh butter from rural and public butter markets in Addis Ababa which indicates poor hygienic practices ILCA (1992). Zelalem (2010) reported coliform counts ranging from 1.92 to 4.5 log cfu/gram of butter. Similarly high values were reported by Gökce et al. (2010), Meshref (2010), Idoui et al. (2010), Asresie et al. (2013). Kacem and Karam (2006) reported coliform bacteria count of 0.90-1.66 log cfu/g at refrigerator temperature. Karagozlu and Ergonul (2008) reported that coliform and total fecal coliform count of the samples were found between <3->1400 cfu/g. Elkhidir (2003), observed that 41.71% of butter samples examined in Khartoum State had total coliforms in the range of ≥10 to ≤1400 MPN/g. The existence of coliform bacteria in food material is of greatest importance because it indicates that the food product is exposed to an insufficient heat treatment or is re-contaminated afterwards (Gökce et al., 2010).

Average yeast and mold counts of 1.83×10^6 was recorded from farmers butter with the highest record of 2.32×10^6 (Kebele 01, Molale) and lowest value of 1.37×10^6 (Kebele 01, Zemero). The mean yeast and mold count in the three districts was *1*.79×10^6, 1.92×10^6 and 1.78×10^6 in Mehal Meda, Molale and Zemero, respectively. Butter collected from traders shows 1.92×10^6, 1.37×10^6 and 6.27×10^5 in Mehal meda, Molale and Zemero districts, respectively. Lower values were observed from traders sample than farmers except in Mehal Meda. Values from butter samples made by the investigators were 1.99×10^6, 1.79×10^6 and 1.52×10^6 with an overall mean value of 1.77 ×10^6. Lower values of yeast and mold count in butter prepared by investigators were with lower values than farmers except the value at Mehal Meda district. Even lowest values were observed from samples taken from Tarmaber (1.56×10^6) and Addis Ababa (1.45×10^6).

The presence of mould contamination in butter indicates contamination by water or air after production. The mean yeast and mould count observed in the Ethiopian highlands was 8 cfu/g of butter (Zelalem, 2010). According to Mekdes (2008), yeast and mould counts ranged between 4.3 and 6.86 log cfu/g of butter sampled from Wollayta area. In Sudan, higher values of log10 3.39 cfu/g, log10 3.03 cfu/g and log10 3.08 cfu/g were reported for butter samples from traders, butter samples from dairy plants and samples from butter made by investigators (Ahmed et al., 2016). Other studies also report same result like Samet-Bali et al. (2009) who reported yeasts and moulds count of log10 4.80±0.00 in Turkish butter, Karagözlü and Ergonul (2008) who reported yeast and mould counts of butter <log10 1.00-6.62 cfu/g, Idoui et al. (2010) and Gökce et al. (2010). Moulds and yeasts grow faster than bacteria and cause spoilage in food with low water activity. In Egypt, a lower content of molds and yeasts with a mean count of $6.3\times10^3 \pm 1.07\times10^3$ cfu/g was reported (Meshref, 2010). Beside spoilage, mycotoxin risk also exists and the high amount of moulds and yeasts is as an indicator of

incorrect processing and packaging (Gökce et al., 2010). *Geotrichum candidum* is responsible for yeast smell in butter and after a time it causes a disgusting taste and aroma, while *Penicillium, Aspergillus, Mucor, Candida, Cladosporium, Fusarium, Rizopus, Torula* and *Geotrichum* from spots on the surface and mouldy taste in butter, *Mucor stolonifer* causes lipolytic and proteolytic decomposition in butter and *Candida lipolitica* causes a caustic and cheese-like taste by exerting lipolytic activity in butter (Gökce et al., 2010).

Conclusion

The fat content of butter samples collected from different actors in the market value chain are greater than 80% except in one sample collected from farmers in Zemero district (79.33%) ranging from 80.68 to 85.94% which is adequate amount since butter must contain ≥81% of only milk fat. The moisture content of butter in most of the samples is also less than the maximum amount of moisture expected in butter (16%). Only four samples (three from farmers and one sample from butter made by investigators) show higher moisture content than the maximum standard moister content of butter. Moisture content of butter samples vary from 12.38 to 16.9%. Values of free fatty acids which are indicators of quality deterioration are also variable in the samples ranging from 1.10 to 3.77%.

Different values of Total Aerobic Mesophilic Bacterial Count (TAMBC) were observed in samples collected from different butter market actors. 3.94×10^9 cfu/g (mean value of farmers), 3.44×10^9 cfu/g (mean value of traders), 3.26×10^9 cfu/g (mean value of butter made by investigators), 4.19×10^9 cfu/g (Tarmaber) and 4.20×10^9 cfu/g (Addis Ababa) were recorded. Accordingly, total microbial quality is lowest in samples taken at the secondary (Tarmaber) and central markets (Addis Ababa) unlike butter made by investigators which shows best total microbial quality. Even if these records are generally lower than records in previous studies, the results reflect low quality butter as compared to the acceptable limit of 5×10^4 cfu/g. Coliforms were found in all samples that indicate poor hygienic practices. The total coliform counts (cfu/g) were 2.66×10^6, 3.03×10^6, 1.61×10^6, 2.69×10^6 and 2.10×10^6 cfu/g in samples from farmers, traders, butter made by investigators, Tarmaber and Addis Ababa, respectively. Higher value of yeast and mold counts were seen in samples collected from farmers (1.83×10^6 cfu/g) and in butter made by investigators (1.77×10^6 cfu/g).

RECOMMENDATIONS

According to the current study, cooking butter is produced under unhygienic condition. Therefore, there is a necessity for developing the hygienic status of locally produced butter through provision of information to rural women on good process hygiene and to consumers on how to handle their foods including correct storage to protect them from infection and to save a lot of products from being deteriorated. The education on the principles of food hygiene should be imparted to all who form a part of food chain program (Pal, 2014). Many studies indicate that the microbial properties of Ethiopian traditional fermented milk products made from different dairy producer were substandard in quality (Bereda et al., 2014). Maintenance of the proper hygienic conditions during the processing of milk can reduce the prevalence of bacteria, which spoil the milk product (Singh et al., 2011). Good hygiene practices (GHP) during milking and subsequent handling of milk are essential to reduce the risk of contamination on the farm and in the milk processing plant (Sarkar, 2015). Furthermore, the application of hazard analysis and critical control point system (HACCP) seems imperative in all food processing industries from safety point of view (Pal and Jadhav, 2013). Alganesh (2017) stated that the materials used for milking, storage, processing and marketing are local materials which are porous, not easy to clean and disinfect and harbor microorganisms. Consequently, the dairy products are substandard and do not fulfill the safety and quality standards. Moreover, standard operating procedures are not followed on clean milk production and handling. Besides, safety and quality standards were not enforced. The information on safety and quality of dairy products in Ethiopia is not comprehensive. There is a need for further research and authentication policy guidelines of dairy products focusing on spoilage and pathogenic microorganisms, drug and pesticide residues, aflatoxins and adulteration practices. Generally, there is a need to devise means of promotion of modern dairy industry that is responsive to market demand and public health concerns. This would be possible by enforcing quality assurance programs and minimum standard requirements for delivery of authentic dairy products. Therefore, as Teshome and Tesfaye (2016) suggested the need for enriched hygienic practices and educating the public on safety issues and personal hygiene in milk handling. It would be a great interest if further investigations are to be carried out to identify and isolate different species of pathogenic microorganisms that might cause public health importance. There is also a need for assessment of seasonal variation of physiochemical and microbial quality of butter. The study also indicates that high fat content in the fluid milk is a preferred trait by farmers. In this context, animal breeds with higher fat content should be considered for the rural, butter-oriented production systems.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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