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THE ETHIOPIAN DAIRY SECTOR WITH FOCUS ON TRADITIONAL BUTTER: A REVIEW

Abebe B [1]*, Zelalem Y[2], Mitiku E[3] and MK Yousuf[3]

Abebe Bereda

*Corresponding author email: ababfereja@gmail.com

[1]Debre Berhan University, Department of Animal Sciences, Debre Berhan, Ethiopia

[2]Land O'Lakes IDF - PAID - Ethiopia Program, Addis Ababa, Ethiopia;

[3]Haramaya University, School of Animal and Range Sciences, Dire Dawa, Ethiopia

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ABSTRACT

Ethiopia is believed to have the largest cattle population in Africa. The total annual milk production from cattle has been estimated at 3.5 billion liters from 11.38 million dairy cows. As a result, cow's milk is the focus of milk processing in Ethiopia. In Ethiopia, the base of milk processing is fermented milk (Ergo) with no defined starter cultures used to initiate fermentation. The main reasons reported for the use of fermented milk as a base of processing are the small volume of milk produced per day, better shelflife of fermented milk, consumer preference and type of available milk processing materials. The success of dairy development to a large extent depends on market for the product combined with other dairy infrastructure and availability of small-scale processing facilities to manufacture high quality dairy products. In Ethiopia, only 6.6 % of the total milk produced in the country is marketed as liquid milk and the remaining 48.8 % and 44.6 % of produced milk is used for home consumption and processing, respectively. Out of the 44.6 % of milk allocated for household processing, 75 % and 25 % go to butter and Ethiopian cottage cheese production, respectively. Thus, the products could be easily transported to market place, and fetch better prices or returns. The microbiological information on traditional butter is not fully available in Ethiopia. However, the available previous research works conducted in Ethiopia revealed that the microbial count of butter is generally above the acceptable limits set for quality butter. The presence of bacteria in butter reduces the keeping quality of the product and certain bacteria with their associated enzymes and toxins may even survive high temperature and create public health hazards. The potential sources of butter microbial contamination are raw materials, air, water and equipment, which usually occur during processing, packaging and storage of finished product. Therefore, all precautions should be taken to avoid contamination of butter and public health hazards.

Key words: Dairy, butter, ergo, hygienic practices, market, milk, quality, safety

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INTRODUCTION

Butter is one of the many dairy products being processed and consumed around the world. Worldwide, butter is made from a variety of animal milk including cow, goat, camel, buffalo and sheep [1]. In Ethiopia, however, butter (*Kibe* in Amharic) is solely produced from cow milk. About 44.6 % of the milk produced in the country was reported to be processed into butter and Ethiopian cottage cheese (*Ayib*) using traditional equipment, which is mainly clay pot and the quality of smallholder dairy products can generally be characterized as substandard [2, 3]. Butter is a traditional food, which is widely consumed all over the world, directly or as an ingredient in a variety of processed foods. Related to its high nutritional value due to high content of fats, vitamins and minerals, and unique and pleasant flavor, butter is not only expensive but also appreciated by consumers [4].

The success of dairy development to a large extent depends on the availability of market for the product combined with other dairy infrastructure and availability of small-scale processing facilities required to manufacture high quality dairy products. In major urban centers of Ethiopia, much of the milk transaction happens in its fresh state [5]. Ninety-eight percent of the annual milk is produced by subsistence farmers who live in rural areas where dairy infrastructure is not well developed. As a result, many of the smallholder farmers tend to produce the Ethiopian traditional butter using traditional techniques. By doing so, milk can be conserved for future sale or consumption [6]. In most rural areas where demand for fresh whole milk is low, processing of milk into various value-added dairy products mainly butter provides higher incomes for small-scale producers in addition to better opportunities to reach regional and urban markets. As stated earlier, much of the milk marketed in the country is in traditional butter form implying its importance in the country's dairy sector though this product has not received the kind of attention it deserves.

The concept of milk and milk products value chain is not well developed in Ethiopia. Feed, breed and animal health combined with other services are important inputs in milk and butter production. The factors that affect the supply and quality of milk and milk products are not well addressed. The information on butter production and quality is limited in the dynamic condition of production, marketing, processing and consumption [7].

Although butter has longer shelflife, it can undergo spoilage by bacteria, yeast and mould if it is not properly handled. The initial microflora of butter should be that of the raw milk or cream from which it is produced if contamination does not occur during production and processing. The microflora of butter should therefore reflect the sanitary conditions of the equipment used in manufacturing, packaging and handling of the product [8]. The presence of undesirable microorganisms in butter could have a significant impact on its quality and safety through production of off-flavor and physical defects.

Historically, butter is considered among low risk products, however, similar to other dairy products, high chance of bacterial contaminations of the product may occur at any

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point along the butter value chain and thus its consumption may cause health problems [9]. There were evidences of outbreaks of listeriosis in Finland from 1998 to 1999 and England in 2003 due to the consumption of contaminated butter [10, 11]. Therefore, all precautions should be taken even after milk or cream has been pasteurized and during manufacturing of the product. Literature related to the microbial quality of the Ethiopian traditional butter (*Kibe)* is still limited. The few available reports of earlier studies revealed that the microbial quality of butter produced in Ethiopia can be characterized as substandard [7, 12, 13, 14].

The most important selling attribute of butter is its flavor, which is the main reason for its higher selling price than that of other fats [15]. The flavor of good quality butter is very delicate and even small amounts of bacterial growth can change its pleasant flavor and aroma. In most cases, butter consumers or traders consider its sensory characteristics while buying from producers [16]. This same author also reported that butter that fails to meet these sensory characteristics is sold at a lower price, which affects the income of producers. Likewise, the production of safe and wholesome products would improve marketability and demand of the product [7]. Consumers all over the world are now increasingly concerned about the safety of milk and milk products. Rural producers, therefore, need technical support as to how to produce quality and safe butter that has longer shelflife so as to get higher financial returns from their sales. Information on the microbial quality of butter is essential to understand its overall quality during production, marketing and consumption in Ethiopia.

Brief Overview of the Ethiopian Dairy Sector

The agricultural sector plays a central role in the Ethiopian economy with about 82 % of the total population engaging in agriculture [17]. Ethiopia is believed to have the largest livestock population in Africa contributing 16.5 % to the national Gross Domestic Product (GDP) and 35.6 % to agricultural GDP and dairy represents half of the livestock output [18]. Ethiopia manages more than 56.7 million head of cattle, and cows account for 92 % of the total milk production. The total annual milk production from cattle has been estimated at 3.5 billion liters from 11.38 million dairy cows [19]. As a result, cow's milk is the focus of milk processing in Ethiopia.

Ninety-eight percent of the annual milk production at national level comes from smallholder farmers of rural households that have difficulties of entering the formal milk market due to poor dairy infrastructure. Local breeds comprise 98.66 % of the total cattle population. The number of high productive exotic breeds and their crosses is very small, even not reaching 2 % and mainly concentrated in urban and peri-urban areas [19]. The most important norms for cattle rearing are to obtain milk for home use and sale. However, milk yield of indigenous cattle is very low in addition to poor reproductive performance in terms of late age at first calving and long calving interval. The indigenous breeds have an average milk production between 1 and 2 liters per day (average in 2015 was 1.35 liters per cow per day) for a lactation period of six months. This makes the country to spend tremendous amount of hard currency per annum to import milk in different forms. The estimated milk and milk products imports linearly increased from 2011 to 2015, for which the country spent about 75 million USD [20].

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To date, it has been frequently reported that per capita milk consumption oscillates between 16 and 19 liters per annum. However, the latest report on domestic milk production and milk import in different forms showed that per capita milk consumption of Ethiopia is more than 40 liters per annum [20]. However, the per capita consumption of milk is still far behind that of world averages (100 liters) and neighboring country Kenya (130 liters).

Though value chain research approach is highly demanding, it is important and helps to add value to milk in order to satisfy consumer preferences and produce safe and quality dairy products. The concept of milk and milk products value chain development approach is new in Ethiopia though it has been promoted by different development partners and Ethiopian government with the objective of enhancing the livelihoods of rural, peri-urban and urban communities. However, smallholder farmers are challenged with price decline of farm product as their supply increases beyond the market size of their village or nearby small town. This in turn diminishes the net value of return from their agricultural activities in general and that of milk and milk products in particular. On the contrary, such farm products are sold at a higher price elsewhere in the country.

The dairy value chain can be defined as a series of activities required to bring a product to final consumers passing through the different phases of production, processing and delivery [21]. Value chain analysis is essential to an understanding of markets, their relationships, the participation of different actors, qualities of the products and the major constraints that limit the growth of dairy production. There are many and diverse actors engaged in dairy value chain. These are input/service providers and direct actors; producers, milk collectors, processers, retailers and consumers. The major inputs/services required for milk and butter are animal feeds, breeds, and animal health services and combined with others such as credit and extension services.

Dairy Cattle Feeding

Livestock feed resources are classified as natural pasture, crop residues (*teff*, barley, wheat, sorghum and maize), improved forages, agro-industrial by-products and others such as food and vegetable refusals and a by-product of local beer production - *atella* [22, 23, 24]. Natural pasture contributes the biggest proportion (80 to 90 %) of feed for Ethiopian livestock followed by crop residues (10 to 15 %) [22]. However, these grazing land areas are being converted to croplands to cope up with food demand due to the increasing human population. A study conducted in Amhara region in the past 27 years revealed that 30.5 % of grazing lands have been converted to croplands [25]. This tends to increase the potential role of crop residues in livestock feeding. A recent report on the Ethiopian highlands indicated that crop residues contribute 20 to 80 % of the livestock feed supply [26].

Although the country has a potential for cereal crop production and the resulting crop residues, dairy producers may not get reasonable benefits from the crop residues through dairy production due to mishandling and lack of awareness about crop residues improvement. Urea treatment of crop residues has long been suggested to improve the feeding value of low quality feed resources and thereby enhance milk yield. Urea treated wheat straw increased digestibility from 34.2 % (untreated) to 52.8 % (urea treated) and

milk yield from 0.45 liter/head per day in the control grazing natural pasture alone to 2.8 liter/head per day in indigenous cows grazing and supplemented with urea treated wheat straw, with a net profit of 8.13 Ethiopian Birr (ETB) per day [27].

Improved forage crop production is important as adjuncts to crop residues and natural pastures and may be used to fill the feed gaps during periods of inadequate crop residues and natural pasture supply [28]. The same author also indicated that forage crops especially legumes are needed to improve the utilization of crop residues in order to provide energy, while forage legumes provide proteins. In some places, improved forage is cultivated and fed to dairy cows to increase milk production, but the adoption of improved forage by smallholder farmers is low [23].

Agro-industrial by-products mostly produced from the flour/oil industries are wheat bran, maize and wheat middling, which are commonly used as energy supplements, and oil seed cakes like *nouge*, cottonseed, peanut and sesame cake are mainly used as protein supplements, are available only to farmers close to urban areas and unaffordable to most of them for frequent purchases [29]. Feeding of concentrate is not practical in rural areas where most of the butter is produced in the country. Even, most of the smallholder farmers in Ethiopia have no access or links to feed processing plants.

Feed in Ethiopia is generally either not available in sufficient quantities due to fluctuating weather conditions or the available ones are of poor quality [29]. This results in low milk and butter yields, high mortality of young stock, longer calving intervals and decreased live animal weights. As reported from Improving Productivity and Market Success (IPMS) - pilot learning woredas' in four regions of Ethiopia namely: Tigray, Amhara, Oromia and Southern Nations, Nationalities and Peoples Region (SNNPR) on average daily milk production from local cows in the rainy season was 2.5 liters/cow and this reduced to 1 - 1.5 liters/cow during dry season [30]. The same authors also stated that shortage of feed limits the milk production potential of cows with good milk producing ability more than any other single factor. Therefore, adequate and quality feed is a prerequisite for improving dairy productivity.

Dairy Cattle Breeding

The dairy sector in the country is largely dependent on indigenous breeds of low productivity, which yield yearly about 8 to 20 times lower than exotic breeds [31]. It is noted that milk of local breeds has higher fat content, which is economically more attractive for processing traditional products (butter) [5]. As reported from four main regions of Ethiopia (Tigray, Amhara, Oromia and SNNPR), smallholder farmers preferred local breeds for butter production regardless of the amount of milk produced [30]. Provision of genetically improved and adaptable dairy cattle and/or good breeding services as per the demands of milk producers is one of the important points for the development of dairying.

In Ethiopia, dairy farmers practice three breeding methods: indigenous bulls, genetically improved bulls and Artificial Insemination (AI). Uncontrolled natural mating is the dominant form of animal breeding system practiced under extensive dairy production in rural areas. However, urban and peri-urban dairy farming systems have better access to

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AI services and genetically improved bulls. Currently access to AI service is increasingly expanding in the highlands, though the efficiency of the service may not be as would be expected by users [32].

The National Artificial Insemination Center's (NAIC) is the only governmental organization that produces semen in the country, aimed at boosting milk production of local cattle breeds. Differences in AI service and price between technicians as well as limited availability of logistics and technicians are the major limitations of its services. Service provision by private actors is limited though, since 2009 a group of private livestock professionals founded ALPPIS (Addis Livestock Production and Productivity Improvement Service), which promotes livestock production through imports and distribution of semen from the US exporter World Wide Sire (WWS). Addis livestock production and productivity improvement service also supplies AI equipment, AI service, veterinary drugs, advisory services and trainings for AI technicians and farmers.

Dairy Animal Health

Ethiopia is affected by a broad range of animal diseases. The prevalence of various animal diseases affects dairy development programs in varying scales, depending on agro-ecological zones and management levels. The main impact of animal diseases is loss of production and productivity, hindrance to access the international livestock and livestock products' markets and reduction in the quality of hides and skins, which causes substantial economic losses. Out of 8.96 million cattle suffering from diseases in Ethiopia, 3.45 million died and the remaining were treated and cured [2].

In Ethiopia, the government is the major animal health service provider. There is also limited involvement of the private sector in the provision of drugs and animal health services. Most of the private veterinary drug wholesalers are found in Addis, and do not have *online* services to check the availability, quantity and price of drugs. Thus, veterinary service providers are forced to visit each supplier around Addis and spend two to four days on procurement. During this time, they cannot serve the farmers in their area [33]. The major constraints of animal health services in Ethiopia are high price and shortage of drugs, poor diagnostic capability of animal health technicians, lack of transport, limited finance and shortage of manpower. It is essential to ensure that producers have access to efficient and reliable veterinary services, which is of particular importance when less resistant crossbred animals are being introduced.

Milk Processing and Handling Practices of Butter

Milk processing started with the objective of converting perishable milk into long shelflife dairy products and helps to reduce food-borne illnesses. Processing alone cannot eliminate milk quality problems and, therefore, it is important that appropriate processing and storage materials are used and the required care is taken while handling milk and milk products. Milk processing is growing in Ethiopia. Every year new processing plants are established. Based on the latest reports there are at least 35 active dairy processors in the country [33]. Most of the dairy plants are found in the vicinity of Addis Ababa and they are still operating below capacity due to limited access to finance, low supply of raw milk, seasonal demands of milk and milk products and lack of technical expertise on processing [33].

Out of 44.6 % of milk allocated for household processing, 75 % and 25 % go to butter and Ethiopian cottage cheese production, respectively. Thus, the products could be easily transported to market place because they fetch better prices or returns [13]. In Ethiopia, the base of milk processing is fermented milk (*Ergo*), with no defined starter cultures for initiation. Raw milk is mixed with fermented milk and left at ambient temperature for 5 days for fermentation [34]. The main reasons given for fermenting milk are the small volume of milk produced per day, better shelflife of fermented milk, consumer preference and type of available milk processing materials.

Traditional butter (*Kibe)* is produced by churning fermented milk (*Ergo)* using traditional smoked equipment (usually clay pot). The curd is broken by agitation before churning starts. Agitation of churn is carried out by rocking the churn placed on the ground forwards and backwards or by suspending it from a tripod or doorpost [35]. This process results in the formation of fat granules, which will coalesce into larger grains towards the end of the churning time (up to 4 hours). Final rotating of the churn on its base would lump the fat grains together into *Kibe*, which is then skimmed off. The *Kibe* is kneaded in cold water to remove any residual defatted sour milk.

The production of quality dairy products begins on the farm and continues through processing and further handling of the products by consumers. However, in most cases under smallholder conditions, production of clean milk is difficult due to poor dairy cattle barn, poor personnel hygienic conditions, insufficient udder washing, inaccessibility of clean water, inappropriate utensils used for milk, ineffective cleaning of milk utensils and lack of storage facilities. Thus, all factors contribute for production of poor quality milk and subsequent products made from it. In traditional butter making, microbial contamination can also come from unclean working surfaces, the butter maker, the churn and storage utensils and wash water. Packaging materials such as leaves from different plants can also represent important sources of contamination of the butter [36].

Recently reported trends in the central highlands of Ethiopia showed that plastic vessels are replacing clay pot for butter storage [14, 37, 38]. However, the use of plastic containers and/or clay pots, which are often porous and difficult to clean off fat residues, can be a potential source of the contamination of butter [36]. Producers need, therefore, to pay attention to the type as well as cleanliness of milk equipment. Milk utensils should be easy to clean. Hence, certified food grade containers such as aluminum and stainless steel are mostly preferred.

Marketing of Milk and Milk Products in Ethiopia

Milk and milk products in Ethiopia can be channeled to consumers through both formal and informal marketing chains. In the formal market chain, milk is produced and marketed through registered marketing channels, processed in established processing plants and put on the market in packed products. In this market system, milk is collected at collection centers that belong to cooperatives or private collectors and subjected to preliminary milk quality tests upon delivery, and finally transported to processing plants [5]. This has encouraged the producers to improve the hygienic conditions, storage and transportation of the milk in order to avoid rejection of the product upon delivery to the

collection centres [39]. Only 2 % of the milk produced in Ethiopia reaches the market through this channel.

The informal milk market involves a direct delivery of milk and milk products by producers to consumers or it may pass through two or more market agents. Producers sell the surplus milk produced to their neighbours and/or to the local markets, either as liquid milk or in the form of butter and/or Ethiopian cottage cheese. This system is characterized by absence of license to operate, low cost of operation, higher producer prices as compared with formal market and no regulation of operation [40]. The hygienic condition of milk and milk products channeled through this system is poor mainly due to the prevailing situation where producers have limited knowledge of dairy product handling coupled with the inadequacy of dairy infrastructure such as cooling facilities and unavailability of clean water in the production areas.

Only 6.6 % of the total milk produced in the country is marketed as liquid milk and the remaining 48.5 % and 44.6 % of produced milk is used for household milk consumption and processing, respectively. More milk products especially butter (36.6 %) and Ethiopian cottage cheese (14.4 %) were sold as compared to milk. In Ethiopia, therefore, fresh milk sales by smallholder farmers are important only when the producers are close to the main roads or formal milk marketing channels [2]. The demand for milk is dropping during fasting periods when Orthodox Christians abstain from consuming dairy products; therefore, any surplus liquid milk is routinely converted into butter and Ethiopian cottage cheese, which dominates the dairy markets [5]. The traditional butter market is part of the informal market. Farmers mainly women take the products weekly or monthly to market places or sell at farm gates to traders/brokers who then accumulate it and pass it on in bulk to licensed butter traders who transport it to more distant markets mostly to Addis Ababa by truck. Traders also purchase butter of better shelflife from farmers at farm gates or at market places for resell in urban and rural market relatively at high prices. The retail price for butter fluctuates depending on its quality and market demand, which is high during feasts but low during fasting periods [41].

The Microbial Quality and Safety of Ethiopian Traditional Butter (*Kibe)*

Milk is among the most nutritious food for humans and young mammals, but improper handling contaminates it with microorganisms and renders it unsafe for human consumption and/or unfit for further processing [8]. Microorganisms can enter milk via the cow, air, feeds, milk handling equipment and the milker. Once microorganisms get into the milk, their numbers increase rapidly [42]. The microbial load of milk is a major feature in determining its quality. As reported by Richard [9] total bacterial count is a good indicator of the manner of milk handling practices from the time of milking to consumption. Earlier research conducted in Ethiopia revealed that the microbial count of milk is generally above the acceptable limits of 5 log cfu/ml. For instance, the average Aerobic Mesophilic Bacterial Counts (AMBC) reported for raw milk in different parts of the country were within the ranges of 6 to 9.28 log cfu/ml [13, 38, 43, 44, 45, 46, 47].

High Coliform Counts (CC) in raw cow milk sampled from different parts of the country that ranged from 4.03 to 6.57 log cfu/ml was also reported by many previous works [43, 44, 46, 47, 48]. Since it is not practical to produce milk free of coliforms even at high

level of hygienic condition; their presence in raw milk to a certain extent may be tolerated. However, if present in large numbers, that means over 2 log cfu/ml of raw milk, it means that the milk was produced under unsanitary conditions and/or from cow with mastitis infection [49].

Microorganisms such as *Staphylococcus* spp., *Escherichia* spp. and *Bacillus* spp. were the most abundantly isolated species in raw milk samples collected from different areas of the country [38, 50, 51]. Furthermore, the occurrence of pathogenic microorganisms in milk products could be hazardous for consumers particularly in countries like Ethiopia where consumption of raw milk and its derivatives is common [52]. In Ethiopia, therefore, the present quality of raw milk is not good enough to produce a product with good quality and a long shelflife. This could be associated with poor milking hygiene, absence of milk storage facilities at farm and chilled transport to the collection centers, insufficient quality checks at the collection centers and processing plants and lack of payment systems based on quality that provide incentives to smallholder farmers.

Though there has been little action to improve the situation. It will be worth noting that Elemtu Integrated Milk Industry has introduced a payment system where the raw milk price depends on the percentage of fat content of milk as an incentive to discourage dilution of milk with water, a practice that tends to result in contamination of the milk. The lactometer reading and an alcohol test are the two quality control measures implemented at milk collection centers and processing plants in Ethiopia. The lactometer combined with a thermometer reading determines the density of milk to ensure that milk has not been adulterated or removal of cream, while an alcohol test is used to check freshness. The milk that fails in either of these tests is often processed into butter within the cooperatives or by the dairy producers. Unfortunately, neither of these tests can determine the presence of bacterial pathogens of public health significance [53].

Unlike raw whole milk, the microbiological information on traditional butter is not fully available in Ethiopia. Few research works on the microbial qualities of traditional butter (*Kibe*) have been carried out in some parts of the country. For example, the average AMBC reported in Ethiopia were between 6.18 and 9.4 log cfu/g for butter samples obtained from different parts of the country [12,14, 39]. These values are higher than the acceptable limit (4.69 log cfu/g) of butter quality [54]. This indicates that butter produced from different parts of the country is of substandard hygienic conditions at all stages along the butter value chain.

Other common tests used to measure the sanitary quality of butter are to estimate counts of coliform, yeast, mould and lipolytic bacteria. The presence of coliforms in butter is an indicator of poor hygiene standards during preparation of the product. This implies that the more hygienically the butter is produced and handled, the lower the coliform count [55]. Compared to the acceptable limit of 2 log cfu/g for butter, previous researchers reported high CC in butter samples from different parts of the country that ranged from 2.2 to 4.5 log cfu/g [7, 12, 39, 56, 57].

The presence of large numbers of coliforms are not only an evidence of unsatisfactory hygienic conditions of butter production but also an indication that the product may

potentially carry serious pathogenic coliforms that are hazardous to the consumers' health [58]. Coliforms are groups of bacteria, which inhabit the human and animal intestinal tracts. They are excreted in large numbers with human excreta and animal droppings. Hence, coliform bacteria in raw milk and milk products are often an indicator of fecal contamination.

Yeast and mould contamination not only causes deterioration of food and feeds, but also can adversely affect the health of humans and animals because of their ability to grow under a wide range of temperature (10 – 35 ^{o}C) and pH value (2 - 9). They also require relatively low level of moisture for their growth [59]. The high fat content and low water content make butter more susceptible to spoilage by moulds than bacteria. Moulds are capable of producing toxic metabolites known as mycotoxins that cause food poisoning in humans [60]. Therefore, the hygienic limit for yeast and mould is < 50 cfu/g of butter. However, high average counts of yeast and mould were recorded (4.3 to 8 log cfu/g) in Ethiopia [7, 12, 39]. The potential sources of butter microbial contamination are air, water and equipment, but additional contamination occurs during processing, packaging and storage of finished product.

Lipolytic bacteria are pyschrotrophic bacteria, which are ubiquitous bacteria that are able to grow at refrigeration temperature and their natural habitats are soil, water and animals. They are heterogeneous groups of bacteria, which cause fat hydrolysis and pose serious flavor defects to butter and other dairy products. Therefore, the butter hygienic limit for lipolytic bacteria is ≤ 1.69 log cfu/g [9]. Lipolytic bacteria in dairy products produce thermostable lipases, which may survive pasteurization and cause rancidity or spoilage [61]. The main lipolytic bacteria are *Pseudomonas florescence*, *Staphylococcus*, *Micrococcus*, *Bacillus*, *Clostridium*, coliforms and *Enterococcus*. Butter also undergoes spoilage by mould species of *Geotrichum candidum* and Candida species of yeast [62]. Higher average Lipolytic Bacterial Count (LPBC) was recorded in butter made from camel and goat milk that ranged from 5.29 to 5.6 log cfu/g in Ethiopia, while high LPBC of 5.0 log cfu/g was also reported in butter made from cow milk [57, 63]. This same author stated that the high counts of butter produced from camel and cow milk could be attributed to the poor hygienic practices during milking and subsequent handling of milk by the operatives.

Some pathogenic bacteria associated with traditional butter (*Kibe*) may pose health threat for consumers. Food-borne diseases are wide spread public health concerns of both developed and developing countries. Among the food-borne pathogens *Salmonella, Listeria monocytogenes* and *Staphylococcus aureus* are recognized as the major causes of food contaminations, and food-borne diseases throughout the world. These are usually associated with the difficulties in securing optimal hygienic food handling practices, improper food storage, and poor personal hygiene during preparation of food as well as prolonged time lapse between production and consumption [64].

Salmonella spp. remains a leading cause of bacterial food-borne diseases in developed and developing countries although incidence rates vary according to the country of origin [65]. According to Majowicz *et al*. [66] *Salmonella* causes 93.8 million cases of food-borne illnesses around the globe, leading to 155,000 deaths each year. The genus of

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Salmonella belongs to the family *Enterobacteriaceae* and consists of two species *Salmonella enterica* and *Salmonella bongori. Salmonella enterica* is divided into six sub species (subsp. *enterica,* subsp. *salamae,* subsp. *arizonae,* subsp. *diarizonae,* subsp. *houtenae* and subsp. *indica*). *Salmonella* contains more than 2,500 serovars, and most of them are capable of causing infection in humans [67]. Salmonellae are facultative anaerobe, gram-negative and rod-shaped bacteria.

Salmonella spp. are mesophilic bacteria that have a broad range of growth temperature extending between 5 ºC and 46 ºC with the optimum growth temperature of 37 ºC. However, they are killed by pasteurization temperature. *Salmonellae* also have a broad range of pH between 4.0 and 9.0, while optimum pH being around 7.0. *Salmonella* does not multiply at ^{a}w of 0.94, especially in combination with a pH of 5.5 and below; however, the cells survive in frozen and dried states for a long time.

Most human infections are acquired through consumption of contaminated foods [68]. It has been evident that livestock and their products can contribute to 96 % of the total *Salmonella* infections in humans. *Salmonella* causes food-borne salmonellosis that varies from mild and self-limiting gastroenteritis to sometimes systemic infections such as bacteremia. The symptoms include fever, nausea, abdominal cramping and non-bloody diarrhea. Therefore, EU regulations require *Salmonella* spp. to be absent in 25 gram of butter samples [69]. In Ethiopia the prevalence of *Salmonella* in butter is not well documented except for the report that 1 % of the butter samples were contaminated with *Salmonella* from traditional butter in Addis Ababa, Ethiopia [70].

Listeria monocytogenes is among the ten species of Listeria species (*Listeria monocytogenes, Listeria ivanovii, Listeria welshimeri, Listeria grayi, Listeria innocua, Listeria seligeri*, *Listeria rocourtiae, Listeria marthii, Listeria fleischmannii and Listeria weihenstephanensis*) [71]. *Listeria monocytogenes* is pathogenic both for humans and animals. *Listeria ivanovii,* however, is pathogenic for animals and rarely associated with the human infection, while other species are mostly nonpathogenic. *Listeria monocytogenes* is a short, rod-shaped, psychrotrophic, facultative anaerobe, non-spore forming, oxidase negative and gram-positive bacterial species [72]. It can grow at refrigeration temperature and at unfavorable conditions of pH (up to 4.7) and salt concentrations of up to 10 %.

It is known to be the causative agent of listeriosis in humans that leads to septicemia, abortion, stillbirth, meningitis and meningoencephalitis, especially in the risk group such as the young, old, pregnant and immunocompromised persons with a mortality rate of up to 30 % [73]. Therefore, EU regulations require *Listeria monocytogenes* to be absent in a gram of butter sample. In Ethiopia, there is no research report of butter associated outbreaks of listeriosis [69].

In this regard, many countries have implemented laws and regulations concerning the hygienic quality of milk and milk products to protect consumers' health [74]. As opposed to this, the occurrence of *Listeria monocytogenes* in butter made with raw and/or pasteurized milk has been described over the past years for example, in USA; Finland from 1998 to 1999 and England in 2003 [10, 11, 75]. Unfortunately, these laws and

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regulations are often not adhered to in developing countries including Ethiopia and as a result food-borne diseases are considered as high-risk diseases to public health.

Listeria species are ubiquitous in nature, occurring in soil, silage, vegetation, slaughter house wastes, sewage, food processing environments and water and, therefore, are frequently carried by humans and animals [76]. Raw or contaminated food is the most common mode of *Listeria monocytogenes* infection in humans [76]. Keeping proper sanitation measures, safe and hygienic food handling practice, and enhancing public awareness through appropriate education are some of the essential steps for the prevention of food-borne salmonellosis and listeriosis.

CONCLUSION

In Ethiopia, butter is one of the major marketed dairy commodities. It has high dietary value, which is entirely produced from cow milk. In general, smallholder farmers do not benefit from the butter marketing as compared to traders who sell butter for better price without any value additions. Smallholder farmers need to have access to breed, feed and services such as extension and credit besides linking with the market to sell their product at better prices. Ethiopia has limited study on butter marketing; therefore, detailed research is required on butter value chain starting from production to consumption. Despite limited research outputs being available regarding the microbial quality of butter, the current information revealed that butter produced in Ethiopia is substandard. Therefore, more research findings on pathogenic microorganisms, which have public health significance such as *Bacillus cereus* and *Clostridium perfringens* are paramount to protecting human health.

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