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Quality and Therapeutic aspect of camel milk: A review paper

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Abstract
The camel rearing sub-sector has been an integral part of agriculture in Africa, Ethiopia. It has been contributing to the household food, income and poverty alleviation and national economy through export. The country has huge camel resources and made it the fourth leading country camel milk in world. In most camel rearing societies, camel milk is mainly consumed in its raw state without being subjected to any sort of processing treatment. Consumption of raw state camel milk is the major concern from public health point of view Therefore, the milk produced is likely to cause food-borne diseases and the natural antimicrobial factors can only provide a limited protection against specific pathogens and for a short period. However, only little is known about camel milk quality and therapeutic uses or limited researches have been done on nutritional characteristics. Although camel's milk is known for its various economic and health benefits, unlike the live camel, there is no processing industry, quality and typically not available in pharmacies and also lack of awareness market value for it in Ethiopia. In this review, the quality and therapeutic uses of camel milk deals; as milk is the key base raw material for all dairy products. On the review focused, constituents of camel milk and their therapeutic properties (use) are described, and the factors affecting the chemical composition and processing characteristics of camel milk, and also deals preservation method. Regarding to the chemical composition of camel milk, it contains a high proportion of antibacterial substances and higher concentration of vitamin and minerals in comparison with cow milk. It is also low in protein, sugar and cholesterol and lactose contents. Therefore, camel milk is unique from other ruminant milk in terms of chemical composition as well as functionality as it contains high concentration of immunoglobulins and insulin. The uniqueness (importance of camel milk) as Food security -"second god**,**and Medicinal qualities of camel milk- on diabetes, autism; immunity, stomach cleansing; infectious diseases e.g. tuberculosis. The objective of this review is to review the physicochemical quality, therapeutic uses microbial quality, preservation method and sensory quality of camel milk.

Keywords: camel milk, functionality, physicochemical quality, therapeutic

Introduction

Camel milk is always an important basic food in the arid regions of Africa and growing countries. It may be used alone as single food for children and elderly people. It is highly nutritious and delicious, low in fat, lactose and cholesterol while rich in protein, lactoferrin, insulin, minerals as sodium, potassium, magnesium, iron, iodine and vitamins as vitamin C, B2 and B12 (AL-Turki, 2013). The use of camel milk for medicinal purposes is a recent exciting development, where it proved to fortify the immune system of the human body as well as effective in treating many diseases as malnutrition, jaundice, chronic hepatitis, anaemia, diabetes, asthma, ulcers, milk allergy, lactase deficiency and breast cancer (Farah and Fischer, 2004). Camel milk in addition of being nutritious it considered as favorable medium for multiplication of microorganisms.

Milk and dairy products are part of a healthy diet which, besides cow's milk, consists of sheep's, goat's and buffalo's milk **(**Hinrichs 2004) [25]. Although the milk composition of dairy animals has been widely studied throughout the world, the literature data mainly concerns cow milk, which represents 85% of the milk consumed in the world and to a lesser extent, goat and sheep milk. Studies on other dairy animals (buffalo, yak, mare, and camel) are rather scarce, in spite of their nutritional interest. In this context, camel milk needs further investigation. There are only a few references on camel milk, which concern production or composition aspects (Farah 1993) [20]. Camel milk is an important component of human diet in many parts of the world. It considered as an important source of protein for the people living in the arid lands of the world. Camel's milk is characterized with the high content of potassium, magnesium, iron, copper, manganese, sodium and with the lower content of lactose than cow's milk **(**Gorban and Izzeldin, 1997 and Hashim, 2002**)** [23].

Historically, camel's milk has been used for a number of medical problems (Omer and Eltinay 2009) [36], as it has anti-cancer (Magjeed 2005) [31], hypo-allergic (Shabo *et al.*, 2005) [40] and anti-diabetic properties (Agrawal *et al.*, 2003)

1.1 Objectives

To review the therapeutic quality, microbial quality, preservation method and sensory quality of camel milk

2. Literature review

2.1. Camel milk production

According to FAO (1998) Statistics there are 17 million camels (Camel us dromedaries) in the world, of which 12.2 million are in Africa and 4.8 million in Asia. The camel is an important source of milk. Indeed, in some countries hosting large camel populations, camel milk is one of the main components of the human diet. Available information concerning camel milk is mainly limited to data on gross composition. Information on the nutritional quality of camel milk, especially on important minor constituents, such as vitamins, is scarce. The present investigation was undertaken to study the content of the water soluble vitamins C, B2 and some fat soluble vitamins A and E in camel milk(Farah, Rettenmaier and Atkins, 1992) [22]. Camel milk is still largely a subsistence product, but production in camel milk dairies is a growing industry.

It is difficult to estimate the daily milk yield of a camel under pastoralist conditions owing to the inconsistency of milking frequency. Milk yield also varies with species, breed, stage of lactation, feeding and management conditions. The length of lactation can vary from 9 to18 months. This depends mainly on the husbandry practices, which are largely determined by the need for milk, more being required in the dry months than in the wet months when other sources of food are available.

Estimates of milk yields from various countries are given in Table 2. The data are highly speculative and should be considered as guidelines for milk yields under pastoral conditions. It must also be noted that throughout lactation calves are still suckling and therefore the actual volumes of milk secreted are higher than the figures presented in table 2.

Table 1: The top ten camel milk producers in world (Source FAO, 2013) [17].

Rank	Country	Production (metric tons)
1.	Somalia	1,100,000
2.	Kenya	937,000
3.	Mali	242,911
4.	Ethiopia	170,000
5.	Niger	105,000
6.	Saudi Arabia	105,000
7.	Sudan	60,000
8.	United Arab Emirates	47,000
9.	Mauritania	27,125
10.	Chad	24,600

Table 2: Milk yields of camels reported: (Sources: Aland Kanhal, 2010) [2]

Country	Average daily	Lactation length in months	Calculated yield in kg per 365 day
Algeria	4	9-16	1460
Ethiopia	5	12-18	1825
India	6.8	18	2482
Kenya	4.5	11–16	1643
Pakistan	8	16–18	2920
Somalia	5	9–18	1825
Tunisia	4	9–16	146

2.2. Chemical Composition of Camel Milk

Camel's milk is generally opaque white. It has a sweet and sharp taste, but sometimes it can be salty. The taste generally depends on the type of fodder and availability of drinking water. The pH of camel's milk ranges from 6.2 to 6.5 and the density from 1.026 to 1.035. Both density and pH are lower than those of cow's milk. Compared to cow's milk, camel's milk sours very slowly and can be kept longer without refrigeration. The chemical composition and nutritional quality of camel milk was studied. Results showed 11.7% total solids, 3.0% protein, 3.6% fat, 0.8% ash, 4.4% lactose, 0.13% acidity and a pH of 6.5. The levels of Na, K, Zn, Fe, Cu, Mn, niacin and vitamin C were higher and thiamin, riboflavin, folacin, vitamin Bt_{12}, pantothenic acid, vitamin A, lysine and tryptophan were relatively lower than those of cow milk (Desouky, Shalaby and Soryal, 2013) [11].

The composition of camel's milk quoted from various sources and the corresponding values from other animal species are presented in Table 3 below. There are greater variations in constituents of camel's milk than in cow's milk. Camels are known to produce diluted milk in hot weather when water is scarce. The main difference between cow's and camel's milk lies in the different physicochemical characteristics of the individual components (protein, lipids, ash (Farah, Z. 2005) [21].

Table 3: Gross composition of milk from various animal species

Percentage of chemical composition					
Species	**Moisture**	**Fat**	**Lactos**	**Protein**	**Ash**
Camel	86–88	2.9–5.4	3.3–5.8	3.0–3.9	0.6–1.0
Cow	86–88	3.7–4.4	4.8–4.9	3.2–3.8	0.7–0.8
Goat	87–88	4.0–4.5	3.6–4.2	2.9–3.7	0.8–0.9
Sheep	79–82	6.9–8.6	4.3–4.7	5.6–6.7	0.9–1.0
Human	88.0–88.	4 3.3–4.7	6.8–6.9	1.1–1.3	0.2–0.3

2.2.1. Camel Milk Proteins

Proteins represent one of the greatest contributions of milk to human nutrition. They perform a variety of functions in living organisms ranging from providing structure to reproduction. The main components of milk proteins are casein and whey. Casein is found in no products other than milk. Casein is precipitated when milk sours or when acid or rennin added. In cheese-making, most of the casein is recovered with the milk fat. In camel's milk, the value of casein is the lower limit of casein content of cow's milk and varies between72% and 76% of total protein. Casein is present in milk in the form of finely divided particles similar to clay in muddy water. The particles contain, beside the protein, considerable amounts of calcium phosphate. The most observed particles in cow's milk casein have a diameter from 40 to 160 nano metre (1 nanometre = 10-7cm). In camel's milk, casein particles range in diameter from 20 to more than 300 nanometre. The whey protein content in camel's milk varies between 22% and 28% of total protein, which is slightly more than in cow's milk.

2.2.2. Camel milk fat

Milk fat serves nutritionally as an energy source, acts as a solvent for the fat soluble vitamins and supplies essential fatty acids. About 99% of milk fat is a mixture of fatty acids (triglycerides) of varying chain length from 4 to 20 carbon atoms. The fatty acids are divided according to the linkage of the carbon atoms into saturated and unsaturated fatty acids. In saturated fatty acids the carbon atoms are linked in chain by single bonds, in unsaturated fatty acids by one or more double bonds. The bulk of the fat in milk exists in the form of small spherical globules of varying sizes. The surface of these fat globules is coated with a thin layer known as a fat globule membrane, which acts as an emulsifying agent for the fat suspended in milk. The membrane protects the fat and prevents the globules coalescing into butter grains and can be broken by mechanical action. The fat content of camel's milk varies between 2.9% and 5.4% and the average size of the fat globules is about the same as cow's milk fat globules.

According to, present knowledge, the main differences between the fat in cow's milk and camel's milk are as follows. Natural creaming of camel's milk differs markedly from that of cow's milk. On standing, camel's milk creams less rapidly and completely than cow's milk and no skimmable cream can be obtained even after standing for several days. Compared to cow's milk fat, camel's milk fat contains less short-chain fatty acids. Long chain unsaturated fatty acids occur to about the same extents in both. Butter can be obtained from camel's milk only at high churning temperature of 20 °C to 25 °C. These values are considerably higher than that of cow's milk, which normally vary between 8 °C and 12 °C. The mean melting point of camel's butter is around 41.5 °C and is on average 8 °C higher than that of corresponding values in cow's milk butter.

2.2.3. Lactose content

Lactose is the major carbohydrate fraction in milk and is a source of energy for the young calf. It is made up of two sugars, glucose and galactose, which are fermented to lactic acid when milk goes sour. The lactose content in camel's milk ranges from 4.8% to 5.8% and is slightly higher than the lactose in cow's milk. It seems that the lactose content in camel's milk is relatively constant throughout lactation.

2.2.4. Mineral salts and vitamins

Milk mineral salts are mainly chlorides, phosphates and citrates of sodium, calcium and magnesium. Although salts comprise less than 1% of the milk, they influence its rates of coagulation and other functional properties. The mineral content of camel's milk expressed in ash ranges from 0.6% to 0.8%. There is still little information about the mineral content of camel's milk.

Data available however, indicate that camel's milk is rich in chloride and phosphorous, and low in calcium. Camel's milk contains less vitamin A, B1, B2, E, folic acid and pantothenic acid than cow's milk while the content of vitamin B6 and B12 is about the same level. The content of niacin and vitamin C is substantially higher than that of cow's milk. In particular the high level of vitamin C in camel's milk has been confirmed by several studies. The availability of a relatively fair amount of vitamin C (range reported in the literature 25-60 mg/l) in camel's milk is of significant relevance from the nutritional standpoint in the arid areas where fruits and vegetables containing vitamin C are scarce.

2.2.5. Composition of animal's milks

Milk is an excellent source of macro- and micro nutrients, and therefore can play an important role in helping individuals to meet their nutritional requirements. Milk protein contains all the essential amino acids and thus provides an important source of protein of high biological value, especially useful in developing countries where rice or tubers are staples. Dairy animals are a key factor in household food security for small-scale livestock holders, who supply the vast majority of milk in developing countries. Cow, goat and sheep milks account for about 87% of the global milk production (FAO. 2010) [19]. However, minor dairy animal species are nutritionally and economically important in several countries.

2.3. Nutritional and healthy aspect of camel milk

Camel milk is an important nutritional and functional source and could provide particular health benefits due to the presence of bioactive substances in milk. Camel milk have been acknowledged for a long time in different parts of the world to provide a potential treatment for a series of diseases such as dropsy, jaundice, tuberculosis, asthma, and leishmaniasis orkala-azar (Al and Kanhal, 2010) [2]. These potential health benefits are obtained through a number of bioactive components in camel milk.

2.3.1. Angiotension I-converting enzyme (ACE) inhibitor activity

ACE is one of the major regulators of blood pressure (Smith &Vane, 2003) [41]. ACE (peptidyldipeptide hydrolase, EC 3.4.15.1) was defined by Pan, Luo, and Tanokura (2005) [37] as "an exopeptidase that cleaves dipeptides from the C-terminal ends of various peptide substrates and regulates the activity of several endogenous bioactive peptides". ACE-inhibitory peptides are present in the primary structure of various food protein sources including milk proteins.

To produce these bioactive peptides, which have been reported to have health benefits, milk proteins (casein and whey) were hydrolyzed by proteolytic digestion, such as by lactic acid bacteria (probiotic) or proteolytic enzymes

(Alhaj, Kanekanian, and Peters, 2006) [3]. Probiotic bacteria have been shown to hydrolyze the major components of milk proteins to increase the number of peptides and amino acids to enable their growth (Alhaj, Kanekanian, and Peters, 2007) [3]. Lactobacillus helveticus130B4 was used to release the ACE-inhibitory peptides from camel milk proteins. The mechanism of ACE inhibitor activity was reported to depend on the structure-activity of the ACE-inhibitory peptide (Li *et al*., 2004). Such an ACE-inhibitory peptide should have the ability to bind to the active site of the ACE to inhibit ACE activity. The C-terminal sequence of these ACE-inhibitory peptides was found to play a predominant role in the binding to the ACE (López-Fandiño, Otte, and Van Camp 2006) [30].

2.3.2. Hypocholesterolaemic effect

Coronary heart disease is one of the major causes of death in the industrialized countries (Pereira & Gibson, 2002). Elevated levels of blood and dietary cholesterol are considered to be a major risk factor for coronary heart diseases. Fermented camel milk (Gariss) and Gariss containing Bifidobacterium lactis (BB-12) administration have been reported topossess a hypocholesterolaemic effect *in vivo* in rats (Elayan *et al*.,2008)

2.3.3. Hypoglycaemic effect

Camel milk consumption has been reported to be responsible for the low prevalence of diabetes (Agrawal *et al*., 2008). Camel milk consumption also provides effective management for patients with type diabetes and the lack of coagulation of camel milk in the human stomach have also contributed to the hypoglycaemic effect (Agrawal *et al*., 2003) as well as for rats (Sahani *et al*., 2005) [7]. These were related to various factors, including the presence of high concentration of insulin/insulin like substances in camel milk, such as half cystine.

2.3.4. Antimicrobial effect

Camel milk was reported to have an antimicrobial effect against Gram positive and Gram negative bacteria, including Escherichia coli, Listeria monocytogenes, Staphylococcus aureus and Salmonella typhimurium (Kamal, 2004) [27]. This inhibitory activity was attributed to the presence of antimicrobial substances in camel milk, including lysozyme, hydrogen peroxide, lactoferrin, lactoperoxidase and immunoglobulins (El-Agamy *et al*., 1992) [12]. The inhibitory action of camel milk against L. monocytogenes, S. aureus and E. coli might be attributed to the presence of lactoperoxidase, hydrogen peroxide and lysozyme respectively (Benkerroum *et al*., 2004) [9].

2.3.5. Hypoallergenicity effect

Mothers' milk provides the ideal nutrition for newborn infants during the early stage of life, however, some infants are only partly breast-fed, or not at all. Hence, different alternatives to human milk can be employed, such as soy milk and extensively hydrolyzed milk protein formulae (El-Agamy, 2007) [14]. Researchers report that children (10-20%) possessing allergenicity to bovine milk are also nottolerant to soy derivatives (Businco, *et al*., 2009) [10]. Camel milk was recently suggested as a food alternative to children with allergenicity to bovine milk. Hypoallergenicity of mothers' milk was reported to be due to the high percentage of β-CN, low percentage of α-CN (Al haj *et al*., 2006) [3]. It is expected to cause little hypersensitivity reactions because camel milk protein percentages are similar to that found in human milk

2.3.6. Health Benefits Properties of Camel Milk

Insulin is a protein of 51 residues produced in specialized beta cell, islet of the Langerhans in the pancreas. Carbohydrate and fat metabolism in the body is regulated by Insulin. Insulin binds on transmembrane tyrosine kinase receptor (insulin receptor) present in liver, muscle and cells in the fat tissues and stimulates glucose uptake from blood and converts it into glycogen to store in the liver and muscles. Failure to control insulin level leads to diabetes mellitus type I or II. Diabetic patients need insulin to control their blood glucose level. Type II diabetes is the most common and results from insulin resistance; a condition in which cells fail to use insulin properly (Malik *et al*., 2012) [32].

Researchers proved that Camel milk has medicinal properties. Camel milk Insulin possesses special properties that make absorption into circulation easier than insulin from other sources or cause resistance to proteolysis, camel insulin is encapsulated in nanoparticles like lipid vesicles that make possible its passage through stomach and entry into circulation. Camel milk is different from other milk because it contains a large concentration of insulin and high amounts of vitamins C, B2, A and E. They also suggested that it contains protective proteins which may have a possible role for enhancing the immune defense mechanism & it can destroy Mycobacterium tuberculosis. Moreover inhibition of pathogenic bacteria by camel milk was also observed. People with several food allergies improved with camel milk because it can be consumed by lactase deficient patients and those with weak immune system. In pulmonary tuberculosis beneficial role of camel milk has also been reported (Elimam and Baragob, 2014) [15].

Insulin contents are also present in other mammals like cows, goat, and sheep. Moreover in colostrum, levels of all the ruminating mammals were higher than those of their milk. In Human woman colostrum's contained insulin but in levels similar to those of milk of the other animals. Cow milk has the lowest amount of insulin & no evidence of anti-diabetic properties has been reported. Studies also report that store milk has the lowest amount of insulin as compared to raw or fresh milk (Zagòrski *et al* 1998).

2.4. Microbial quality of camel milk

Camel's milk is one of the key foods available in arid and sub-arid regions where it covers a substantial part of the quantitative and qualitative nutritional needs. The indigenous populations have long believed that raw camel's milk is safe and even has therapeutic virtues. Such empirical observation was scientifically substantiated by demonstrating the stronger antimicrobial activity of camel's milk as compared to that of other animal species and its ability to inhibit Gram-positive and Gram-negative pathogens of concern to food safety (Barbour *et al*. 2004) [6]

Nowadays, public health concern associated with microbial food safety has arisen. Numerous epidemiological reports have implicated non-heat treated milk and raw-milk products as the major factors responsible for illnesses caused by food-borne pathogens (Harrington *et al*.,2002) [24]

Cross-contamination with pathogenic microorganisms can gain access to milk either by faecal contamination or by direct excretion from the udder into milk.

Camel milk in addition of being nutritious it considered as favorable medium for multiplication of microorganisms. Microbial contaminants together with high temperature reduce the milk quality and cause economical and public health hazards. They could attack camel milk protein and fat leading to milk spoilage. The battle of milk spoilage is assisted by new information on enzyme production by spoilage fungi. It is proved to produce lipase and protease enzymes resulting off-flavours. As camel milk rich in specific protease inhibitors so lipase enzyme considered as the main factor affecting milk spoilage. Toxigenic fungi may constitute a real public health concern through production of secondary toxic metabolites known as mycotoxins (Saxena *et al.*, 2003).

Table 4: Microbiological examination of raw camel milk samples (cfu/ml) (N* =50) Source:(Aly, 2014).

Tests	No.	%	Min	Max	Mean	± S.E.M.
Aerobic spore former	15	30	10	$5.1x10^5$	$7.8x10^3$	$0.1x10^2$
Coliform count	12	24	40	$8.2x10^5$	$9.5x10^4$	$2.6x10^3$
Total Enterocoocai count	10	20	10	$7.1x10^4$	$3.2x10^3$	$0.04x10^2$
Pseudomonas & Aeromonas	11	22	10	$9.4x10^4$	$4.1x10^3$	$1.1 x10^2$
Stapylococcus count	9	14	10	$6x10^4$	$5.3x10^3$	$1.5 x10^2$
Total mold & yeast count	50	100	10	$.7x10^6$	$6 x10^5$	$2.9 x10^3$

2.5. Preservation method of Camel Milk

The shelf life of camels milk is longer compared to other milk animals since it contain antibacterial agent such as lysozyme, lactoferrin and immunoglobulin than do bovineor buffalo milk (, however raw camel milk may contain some potential pathogens. Pasteurized camel milk can last for more than 10 days at 4°C found that pasteurization of camel milk before its fermentation improved the microbial content and increasing the shelf life of the product (Mohamed *et al.*, 2014) [33].

Most of the milk intended for human consumption is heattreated to prevent public health hazards due to pathogenic microorganisms present in raw milk. In developing countries, a significant proportion of milk is produced by small dairy farmers and sold directly to the consumer, where it is often boiled prior to consumption. The common industrial heat treatments for liquid milk include pasteurization, ultra-heat treatment or ultra-high temperature (UHT), and sterilization. To obtain dried milk, fresh milk is first heat-treated and then dried through a spray-dryingroller-drying or drum-drying process.

These industrial processes destroy some nutrients, especially the vitamins naturally present in milk, and the extent of the losses depends on the nutrient and the processing method. Nutrients that are lost during processing, however, can be replaced through fortification of the milk.

2.6. Organoleptic Quality and properties of Camel Milk

Testing milk for organoleptic characteristics is also called sensory testing and uses the normal senses of sight, smell and taste in order to determine the overall quality. The result of this test is obtained immediately and is of minimum cost. This type of testing can be very reliable if carried out by an experienced person. Testing for organoleptic characteristics is used as a screening test to determine whether to accept the milk or test the milk further.

2.6.1. Sensory characteristics

Colour: Camel milk is generally Opaque white in colour (Farah, 1993) [20].

Taste: AL-Ani (2004) explained, the taste of camel milk varies during the lactation period; at the first months the taste is sweet, but salty at late lactation period. The change in taste is caused by type of fodder and availability of drinking water.

Smell: Like other milks, camel milk has no distinctive or particular smell. But milk has high capability to absorb different smells from the surrounding environment, specially chemicals as noticed by (Zidan, 2004). The smell of animal, sheds or that of certain feeds e.g. Silage, onion can also enter the milk (Osman2007).

Consistency: Camel milk is generally light consistent and varies very little in texture compared to that of cow's milk. In order to obtain high quality milk, it should be produced by healthy animals given controlled diet, the milking procedure should be carried out under hygienic conditions with properly maintained machines and free of potential human pathogenic bacteria, antibiotics and chemical residues as suggested by (Nagy *et.al.*,2007) [35].

2.6.2. Organoleptic quality test of camel milk

2.6.2.1. Appearance

The color of camel milk should be slightly yellowish white; a different color may indicate milk, which is unsuitable for processing. In order to judge the appearance of the milk, remove the lid of the milk container and note the appearance of the surface of the milk and the lid, note any abnormal colour of the milk, visible dirt and particles, changes in viscosity etc. After emptying the container, inspect the inside of the lid and the container for visible dirt and impurities. Take note of the following; visible dirt and impurities can indicate that the milk is produced under unhygienic conditions, yellow milk can indicate pus or colostrums, Reddish milk could indicate that there is blood in the milk. A “blue thin” colour and a thin and watery appearance can indicate that the milk contains added water or skimming (fat removal).Large clots can indicate sour milk or mastitis milk. Small white clots or grains can indicate either Mastitis milk or milk adulterated with flour and / or skim milk powder.

2.6.2.2. Taste and smell

A bad smell or taste of the milk may be caused by bacteria, chemical reactions or by other flavours absorbed by the milk. Judging the quality of milk by its taste and smell requires considerable skill, which can only be acquired by practice. The taste of milk is more permanent and easy to define than smell. Taste raw milk only after making sure that it is from healthy animals. Any abnormal smell is noticed by inhalation of air standing above the milk in the upper part of the milk can.

Samples for tasting must be spread around in the mouth in order to identify the taste. In addition to these basic tastes, the mouth also allows us to distinguish characteristics such as coolness, warmth, sweetness, etc. The different abnormal flavours are described as follows as acid flavours are easily detected by smell and taste. The flavour is caused by the growth of acid-producing bacteria that reduce lactose to lactic acid. Rancid and bitter flavours: a pure bitter flavour can be detected by taste only.

The rancid flavour can be detected by both the senses of smell and taste and is caused by lipolysis (deterioration) of fat. Feed flavours like garlic, onion, beets, poorly made silage, certain plants and pastures can cause off-flavours to milk. Flat flavours are quite easy to detect. A very slight oxidized flavor suggests flat flavour as well as low solids and/or low-fat milk. Malty Flavours are very suggestive of malt. The flavour is caused by the growth of the bacteria Streptococcus lactis var. maltigenes. Oxidized flavours are sometimes described in such terms as "oily", "stale, "tallowy", "cardboard" or "sunshine". The oxidized flavor is characterized by a quick taste reaction. Salty flavours are easy to detect; and often associated with milk from cows in an advanced stage of lactation or mastitis milk. It is caused by an increase in chlorine and decrease in lactose content. Unclean flavours suggest mustiness, staleness and foul stable air. Other flavours such as drugs, disinfectants and detergents can also be causes bad smell and flavor (FAO, 2002) [18].

2.7. Properties of Camel Milk

2.7.1. pH -Value and Acidity

All Inpladairy (2010) stated, the acidity of fresh camel milk and milk diluted with water (1:1) and stored at room temperature was0.12±0.03%.Al-Ani (2004) also mentioned, the pH of camel milk between (6.5) and (6.7), which is similar to the pH of sheep milk. Since camel milk contains antimicrobial and protective effects compounds of protein-nature, the growth of bacteria in milk can be inhibited and as a result the developed acidity, this allows camel milk can be kept for longer periods compared with other milks.(Wernery, 2007) [46].

Dukwal *et.al.* (2007) [12], pointed out, camel milk remains quite stable at room temperature and takes a comparatively longer time to become sour. The rate of developed acidity is lowered, especially at pH (5.2), while the natural acidity of camelmilk is maintained for 13 days, when the milk is kept at 10 ℃(Zaid *et.al*. 1991).

2.7.2. Specific gravity

A wide range was observed in the specific gravity of camel milk. Khan (Muliro, Shalo, & Kutima, 2013) [34] (2014) [28] estimated the density of camel milk to range between 1.014 – 1.017 at 20 ℃According to Takele (2014), the specific gravity of camel milk ranged 1. 020–1.022 at 20 ℃

2.7.3. Boiling point: Compared to that of cow's milk (100. 17 ℃), it is higher. The boiling point is influenced by the water content in the milk, the dissolved substances in it and the pressure under which the milk is boiled (Osman, 2007).

2.7.4. Freezing Point: The freezing point of camel milkranges between -0.57 and -0.61 ℃(Wangoh 1997) [45].

2.8. The Nutritive Value of Camel Milk

According to Wernery (2003) [46], camel milk is a rich source of protein with potential anti- microbial and protective activities, e.g. lacto albumin, which are absent or found in minor amounts in cattle milk. It was noticed by .Khan (2014) [28], that 1.8 kilogram of camel milk may provide the human body with its all protein requirements. The proteins and carbohydrates contents of camel milk were significantly higher as compared to cattle milk (Dukwal *et.al*. 2007) [12]. Wernery (2007) [46] reported, lactose intolerance against camel milk does not exist. Schwartz (1992) [39] noted, camel milk contains high amounts of vitamin C (2.9ml/100 ml) compared with milks of other animals. Thiagarajan (2001) [43] also noted, camel milk has beside the high quantities of Vit. C, also considerable amounts of Vit. A and B. Gihad (1995) mentioned, the nutritive value of camel milk is higher than that of cattle milk, since it contains higher quantities of elements, such as Fe, Na, Ca, P, Mn, K and Mg. The energy content of camel milk ranges between 900- 1000 k-calori/liter, which is considerably higher than of cow's milk (700- 750 k-cal / liter) as pointed out by Gindeel (2003).

2.9. Quality Assessment of Camel Milk

Milk hygiene and quality control are an important part of milk collection. Processing and marketing of milk requires it to be fresh and of high hygienic quality. Milk which is not fresh may curdle when heated (Bachmann, 1990). To ensure that the milk is of desirable quality for processing it is subjected to quick quality assessment tests referred to as "platform" tests. These are methods of assessing milk quality at the reception in the presence of the milk producers and which do require elaborate laboratory facilities. They are carried out with the help of simple, readily available means. They in clude among other tests, dye reduction tests that assess the freshness and hygienic quality of milk by me asuring the biochemical activity of microorganisms in milk. Methylene blue and resazurin dyes change or lose their colour when reduced. Quick reduction or colour change of a given quantity of dye means high microbiological activity and vice versa. The colour of the dyes is sensitive to presence or absence of oxygen (Muliro *et al*., 2013) [34].

2.8.1 Dye Reduction Test

Therate of dye reduction by microorganisms is assayed according to the method described by Wango and Farah (2004) [45]. Pooled fresh cow and camel milk samples with resazurin disc reading of six (6) are inoculated with 3 % cow milk that had a resazurin disc reading of zero (0) and their rate of dye reduction determined. This was a simulation of formal raw milk marketing which is expected on reception at the processing plant to take at least three hours before undergoing processing. Ten-minutes resazurin test was carried out by adding1ml resazurin dye to 10 ml milk sample in a sterile test tube and incubated in a thermostatically controlled water bath at 37 ˚C for 10 minutes. A Lovibond Comparator with resazurin disc 4/9 was used to check the colour change in the given milk samples.

This mechanism is applied to evaluate the microbialload in a liquid medium. The shorter time required for the disappearance of the blue color is indicative of a higher microbial load. It is assumed that greater the number of microorganisms, more the oxygen demand and lesser the oxygen concentration in the medium resulting in the faster disappearance of the color. This fact has been used as abroad indicative test of a microbial load representing microbial quality of milk (Atherton and Newlander, 1977)

[8]. However; methylene blue reduction has not been used for quantification of viable count in cell cultures.

Table 5: Minutes Resazurin Test on Camel and Cow Milks (n = 4) Source: Muliro *et al.*, (2013) [34]

Incubation time (Hour)	Camel milk discreading	Disc reading	Cow milk disc reading	Disc reading per hour
0	6.0		6.0	
1	5.4	0.6	5.5	0.5
2	4.5	0.9	4.0	1.5
3	3.5	1.0	0.0	4.0

2.8.2 Titratable Acidity Test

The developed acidity in the samples was determined according to the method described by International Dairy Federation (1990). This involved measuring 9 ml of the milk samples into the conical flasks, and adding 1 ml 0.5 % alcoholic phenolphthalein indicator then titrating with 0.1 N sodium hydroxide (NaOH) until a faint pink colour appeared. The results were expressed as % lactic acid where 1/10 ml NaOH is equal to 0.09 % w/v lactic acid.

Table 6: Titratable Acidity expressed as % lactic acid (n = 4)

Incubation time (Hour)	Camel milk	% Lactic acid per hour	Cow milk	% Lactic acid per hour
0	0.17		0.15	
1	0.19	0.02	0.17	0.02
2	0.22	0.03	0.19	0.02
3	0.23	0.01	0.20	0.01

3. Summary

Camel milk contains high concentrations of lactoferrin, immunoglobulins, lysozyme and lactoperoxidase. These inflammation-inhibiting proteins, camel milk has been known for its health-promoting properties (El-Agamy ESI, 2006) [13]. Camel milk has been used to combat intestinal diseases. It also contains a protein with characteristics similar to insulin (FAO, 2006) [16]. This explains the results of epidemiological, animal experimental and clinical research which reveal that camel milk can help to prevent and treat diabetes. Furthermore, like human milk, camel milk does not contain β lactoglobulin, the protein present in cow's, goat's and horse's milk that is the main cause of cow's milk allergy.

Camel milk has been available in the Netherlands since 2007. Investigation of this Dutch camel milk has shown that its composition is the same as the composition of camel milk in Africa and the Middle East. Camel milk powder dissolves well. The composition of the caseins and whey proteins is different in camel milk than in cow's milk.

Camel milk contains less protein and lactose than cow's milk. Camel milk powder dissolves better than cow's milk powder. The composition of camel milk proteins and caseins is different to those in cow's milk. These specific camel milk proteins explain possible specific health-promoting properties. Camel milk does not contain any β lactoglobulin, and for that reason seems suitable for people who are allergic to β lactoglobulin, the most common cause of cow's milk allergy. Nutritional claims can be as claims that indicate what a food contains and health claims. The absence of β lactoglobulin can fall under the first claim. The significance for people with diabetes and intestinal complaints falls under the second claim.

Camel milk contains less protein, fat and lactose than cow's milk (3.4% versus 4.2%, respectively 4.2% versus 4.7% and 4.3% versus 4.9 %) which corresponds with investigations performed elsewhere (El-Agamy ESI, 2006) [13]. Milk powder made from camel milk dissolves better than milk powder made from cow's milk (dissolvability index 74% and 63% respectively). When making cow's milk powder, the dissolvability is increased by all sorts of processes, which changes the composition of the cow's milk. Fresh camel milk and their products are a good nutritional source for the people living in the arid and urban areas. The production of camel milk is gradually increasing due to an increased interest by consumers in recent years.

Camel milk is found to be different in some aspects from milk of other animal species, such as bovine milk. Variations observed in camel milk composition are attributed to several factors, such as different analytical procedures, geographical locations, seasonal variations, feeding conditions and breed of camel.

Camel milk in addition of being nutritious it considered as favorable medium for multiplication of microorganisms. Microbial contaminants together with high temperature reduce the milk quality and cause economical and public health hazards. Camel milk not only contains more nutrients compared to cow milk (Arrowal *et al.*, 2005) [7] but also it has therapeutic and antimicrobial agents.

4. Recommendation and conclusion

Various dairy products were reported to be produced successfully from camel milk with some modifications to their production procedure. Some difficulties were reported in producing cheese. Fresh and fermented camel milk were reported to provide particular health benefits to the consumer depending on the bioactive substances in milk.

More extensive research is needed to confirm these proposed health benefits. Studies need to be carried out to investigate the fat globule membrane, and protein composition and structure. Further work is also needed on camel milk protein coagulation by acid and chymosin enzyme to solve problems associated with cheese making.

Therefore, encouragement of camel milk consumption as an important source of different varieties of nutrients. Increasing awareness of camel milk consumption and the health benefiting effects gained through it. Incorporation of camel milk in the national milk consumption cycle to cover the shortage in milk.

Increasing interest in camel milk consumption in developing country is noticed. Thus, it is of vital importance to study composition, properties and sensory characteristics of marketed camel milk to investigate its suitability for consumption, and if it satisfies the standards required for human nutrition. The current study is dealing with the above-mentioned parameters and slight compositional differences were found in the marketed camel milk. This is also valid for properties and sensory evaluation. The differences are of no harm on the nutritive value of the marketed camel milk.

The potential of the camel milk industry is enormous but will only be realized if there is strategic reorganization of its operations for commercialization. The reorganization must focus on development of milk marketing systems. Improvement of milk production and attainment of desirable milk quality through training of all milk handlers in the chain as well as restructuring milk collection and transportation is critical to commercialization. These efforts cannot be done piecemeal but must focus on the entire milk value chain targeting both the formal and informal segments of the industry which are equally critical to commercialization.

It is evident that the government, through the Ministry of Livestock and Fisheries Development is committed to the development of the camel milk industry. It is hoped that this support through policy development will translate into resource allocation and standards development which are very critical in driving the industry forward by enabling market access and regulation.

List of Abbreviations

No abbreviation was in this review

Data Availability

The data used to support the findings of this review are available from the corresponding author upon request.

Ethical Approval

Since this is a review paper no ethical clearance was obtained from ethical committee. The collected data were used for this review purpose only and give direction for researcher or interested body work on it.

Consent

This manuscript contains none of an individual person's data.

Conflicts of Interest

None of the authors has any competing interests in the manuscript**.**

Authors' Contributions

All the authors actively participated during the conception of the review issue, development of a review paper report by Desta Dugassa and Abebe Haile designed the protocol, the overall a review paper process, and prepared the manuscript. All the authors read and approved the final manuscript.

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