Trends in Food Science & Technology 62 (2017) 49–58

Contents lists available at ScienceDirect

Trends in Food Science & Technology

journal homepage: http://www.journals.elsevier.com/trends-in-food-science-and-technology

Review

Biomolecular content of camel milk: A traditional superfood towards future healthcare industry

Mohammadreza Khalesi [a, b], Maryam Salami [c], Maryam Moslehishad [d], James Winterburn [e], Ali Akbar Moosavi-Movahedi [b, *]

[a] Department of Food Science and Technology, Shiraz University, Shiraz, Iran
[b] Institute of Biochemistry and Biophysics, University of Tehran, Tehran, Iran
[c] Department of Food Science and Engineering, University College of Agriculture & Natural Resources, University of Tehran, Tehran, Iran
[d] Department of Food Science & Technology, Safadasht Branch, Islamic Azad University, Tehran, Iran
[e] School of Chemical Engineering and Analytical Science, The University of Manchester, Manchester, UK

ARTICLE INFO

Article history:
Received 20 March 2016
Received in revised form
24 December 2016
Accepted 17 February 2017
Available online 27 February 2017

Keywords:
Camel milk
Non-bovine milk
Bioactive compounds
Healthcare
Diabetes

ABSTRACT

Drinking non-bovine milk has been reported to possess bio-functionality for regular consumers. Camel milk is a traditional product that has been used for many years in arid rural communities of Asia and Africa as a biomedicine to cure several health issues such as asthma, oedema, and diabetes. The product consists of appropriate amounts of bioactive compounds. In addition, it contains low amounts of fatty acids and cholesterol, whilst it does not contain β-lactoglobulin. The latter, which is present in bovine milk, causes allergic symptoms in some people. The similarity of the formula to human milk suggests this superfood as an alternative for bovine milk with complete nutrition for infants. In this review, the biomolecules present in camel milk and their positive roles on the health of consumers are extensively discussed.

1. Introduction

Functional foods are the products which resemble traditional foods with verified physiological benefits, offering to improve public health and decreasing the risk of diseases (Al-Sheraji et al., 2013), thus the demands of consumers for these products have been increasing in recent years (Vieira da Silva, Barreira, & Oliveira, 2016). The dairy industry has the potential to become one of the main sources of these products, due to its well-adjusted composition and several biological activities (Kamal & Karoui, 2016; Shuiep, Giambra, El Zubeir, & Erhardt, 2013). Different starters of lactic acid bacteria (*LAB*) isolated from dairy products may possess properties beneficial to health (Rutella, Tagliazucchi, & Solieri, 2016).

Dairy farms have been exposed to extreme economic pressures during 2013–2015, as the prices of bovine milk (BM) have reduced by about 25% (Kersting, Hüttel, & Odening, 2016). The consumption of non-bovine milk in last fifty years has been increased to 17% of the total world milk consumption. The new sources of milk can be used as a substitute for BM to supply the required human nutrition as same quality as BM, improve the medication effects of dairy products which are daily consumed, and eliminate the allergy complications caused by BM-derived products in some people (Alhaj et al., 2013).

Camels are an ideal domestic animal, especially in hot regions, due to the remarkable capability to live in harsh conditions and with little accessibility to water (Salmen, Abu-Tarboush, Al-Saleh, & Metwalli, 2012). The presence of about 18–25 million camel heads has been reported up to now, while camel products have not been widely investigated (Ahmad et al., 2012; Al-Zoreky & Al-Otaibi, 2015; El-Fakharany, Serour, Abdelrahman, Haroun, & Redwan, 2009; Maaroufi, Rezaei, Raftaniamiri, & Mirzaei, 2015). Nevertheless, camel milk (CM) can be considered as one of the alternatives of BM with enhanced functions and better digestibility than BM in human the gastrointestinal system (Salami et al., 2009; Yaqoob & Nawaz, 2007). CM not only provides the required nutrition for local people, but also offers several therapeutic properties (Bai & Zhao, 2015). The whole production of CM was estimated to be 1.3×10^6 tons (Ziane, Couvert, Le, Moussa-boudjemaa, & Leguerinel, 2016), with the global trade of $10 billion per year. In near

* Corresponding author.
E-mail address: moosavi@ut.ac.ir (A.A. Moosavi-Movahedi).

http://dx.doi.org/10.1016/j.tifs.2017.02.004
0924-2244/

Abbreviation

α-LA	α-Lactalbumin
β-LG	β-Lactoglobulin
BM	Bovine Milk
CM	Camel Milk
CSA	Camel Serum Albumin
CN	Casein
DSC	Differential Scanning Calorimetry
FA	Fatty Acid
IgG	Immunoglobulin G
IgM	Immunoglobulin M
LAB	Lactic Acid Bacteria
LF	Lactoferrin
LP	Lactoperoxidase
MY	Milk Yield
MW	Molecular Weight
NPN	Non-Protein Nitrogen
TG	Triglyceride
WP	Whey Protein

future however, it is expected that dairy industries produce higher amount of CM (Al-Ashqar, Al-Mohammad Salem, Al Herz, Al-Haroon, & Alluwaimi, 2015).

The lack of β-lactoglobulin (β-LG) in CM, along with larger quantities of fatty acids (FAs) and fructose, having 3–5 folds higher vitamin C in comparison with BM, high contents of antimicrobial agents such as lysozyme, lactoperoxydase, lactoferrin, immunoglobulin, and bacteriocins mean CM is considered to bea nutritious product with high stability. It is possible to store CM at 30°C for 5 days, while BM is contaminated only after 48 h (Ahamad, Raish, Ahmad, & Shakeel, 2016).

In recent years, CM as a new source for production of dairy products has been given much attention due to its therapeutic properties (Agrawal et al., 2007; Shuangquan, Tsuda & Miyamoto, 2008). Furthermore, CM has been recommended to be consumed for treatment of dropsy, jaundice, tuberculosis, asthma, leishmaniasis or kala-azar (Abdelgadir, Ahmed, & Dirar, 1998; El-agamy, Nawar, Shamsia, Awad, & Haenlein, 2009). Therefore, CM products might have a growth potential in future market of the dairy industry.

The objective of this review is to elucidate the biomolecular characterisation of CM with emphasis on the bioactivities of these molecules as well as their potential benefits for human health.

2. Camel milk composition

2.1. General composition

Until the fifth parity, female-camels can produce large amounts of milk during whole the year, even in dry seasons, due to exceptional adaptation of camel to poor quality and quantity of feed in harsh conditions (Konuspayeva et al., 2010). Milk yield (MY) in camels usually ranges from 3.5 kg/day in a hot summer and under intensive management to 20.0 kg/day in a rainy season and under more favorable conditions (Ahmad et al., 2012). Nevertheless, contribution of CM in household food baskets of the inhabitants of dry regions in dry seasons is higher than any other times (Elhadi, Nyariki, & Wasonga, 2015). MY and milk compositions are influenced by several factors such as age, parity, seasonal variations, ecological conditions, geographical origins, feeding strategy and stage of lactation, and individual variation (Abdalla et al., 2015; Al-Masri et al., 2014; Nagy & Juhasz, 2016). Also, time and number of milkings significantly influence CM composition. It has been shown that with 4 L/day as a result of 6 milkings/day, the MY is reduced to 2.5 L/day if milking once a day (Abdalla et al., 2015). Machine milking of dromedaries is now under design to improve milk production (Nagy & Juhasz, 2016). Nevertheless, camels have not yet been well appreciated for milk production. Accordingly, genetic improvement of camels in order to increase the MY has been rarely considered (Almutairi, Boujenane, Musaad, & Awad-Acharari, 2010; Jans et al., 2013). The only published example in this case has reported a yearly genetic development equal to 50 g MY (Nagy, Skidmore, & Juhasz, 2013).

Either in raw or fermented form, CM is a crucial product which provides nutrition and energy requirements of the minor population of rural communities in dry regions of Africa and Middle East (Benkerroum, Boughdadi, Bennani, & Hidane, 2003; Shori, 2012, 2015). It covers all essential biomaterials including proteins, carbohydrates, fats, high amounts of vitamins and minerals, and possesses great biological value due to its significant content of heat resistant antimicrobials (Ahamad et al., 2016; Felfoul, Lopez, Gaucheron, & Attia, 2015; Rahman, Al-hakmani, Al-alawi, & Al-marhubi, 2012).

Camel's access to water is an important factor which affects the concentration of the various CM components. Milk from camels is more diluted than BM, sometimes reaching up to 91% water, which in desert areas is desirable for the calf (Zhao, Bai, & Niu, 2015). The composition of CM is different from that of milk from other ruminants. It contains lower amounts of fats, proteins and carbohydrates, but higher amounts of vitamins and minerals (Arab et al., 2014) (Konuspayeva, Faye, Pauw, & Focant, 2011). Two important camel types are the Dromedary (one-humped camel) living in the deserts (90% of total camels) and Bactrian (two-humped camel) living in cooler areas (10% of total camels) (Salmen et al., 2012), the Bactrian camel is a low dairy product producer (Konuspayeva et al., 2010). The variation in milk components from these, listed in Table 1, is due to physicochemical parameters rather than seasonal or regional variables (Faye, Konuspayeva, Messad, & Loiseau, 2008).

There are no reports we are aware of concerning allergy indicators possessed by CM. Thus, CM can be considered as a safe product for consumption by those with weak immune-systems. The lactose in CM is metabolized by lactose intolerant people with no trouble, probably because this lactose is more exposed to the action of the lactase (Shori, 2015).

CM consists of high amount of vitamins, especially thiamine (B1), riboflavin (B2) and ascorbic acid (C) (Ereifej, Alu'datt, Alkhalidy, Alli, & Rababah, 2011; Mohamed, Mousa, & Beynen, 2005). The availability of large amount of vitamin C in CM (24–52 mg/kg), i.e. three to five times higher than BM and 1.5 times higher than human milk, is of importance in arid areas where green foods are not easily accessed (Kamal & Karoui, 2016; Zhao et al., 2015; Ziane et al., 2016).

Non-protein nitrogen (NPN) is the second source of nitrogen in milk after proteins. In BM, NPN (including 50% urea) consists less than 6% of the nitrogen content, though in CM, this value is under

Table 1
The components of Bactrian and Dromedary camel milk (Faye et al., 2008).

Component	Bactrian camel milk	Dromedary camel milk
Protein content (%)	5.23 ± 1.17	4.76 ± 1.13
Lactose content (%)	2.77 ± 0.96	3.12 ± 0.92
Fat content (%)	6.67 ± 2.93	5.94 ± 2.26
Ash content (%)	1.0	1.0
Skimmed dry matter (%)	10.64 ± 3.11	10.87 ± 3.19

2% (i.e. in the range of 0–300 mg/L), governed by the seasonal conditions and directly correlated to total protein content (Faye, Konuspayeva, & Loiseau, 2010). This low value may be due to the adaptation of camels to harsh environmental conditions.

Minerals make up less than 1% of the CM including K > Cl > Ca > P > Na > Mg, Cu, Fe, and Zn (Yaqoob & Nawaz, 2007). The iron content of CM is about ten times higher than in BM (Ziane et al., 2016). Also the amounts of K and Cu are higher in CM than BM (Zhao et al., 2015). The heavy metals are in the range of harmless limits concerning the maximum daily intake of these elements (Ahamad et al., 2016; Nagy & Juhasz, 2016). The mineral content in CM is very similar to human milk. Thus, it is well possible to provide the nutritional mineral requirements of human by CM.

A collection of 130 volatile components, mostly from the groups of alcohol, acids and esters, have also been detected in CM using GC/MS (Li et al., 2011). Some examples are: 2-Methyl-1-propanol, 3-Methyl-1-butanol, 2-Hydroxy-propanoic acid ethyl ester, Octanoic acid ethyl ester, Acetic acid, 1-Heptanol, 1,2-Dichloro-benzene, 1-Octanol, Propanoic acid, 1-Nonanol, 3-(Methylthio)-1-propanol, Acetic acid 2-phenylethyl ester, 2-Decen-1-ol, Hexanoic acid, Phenylethyl alcohol, Heptanoic acid, Octanoic acid, etc.

2.2. Fat content of camel milk

CM has a very low fat content, including 96% triglycerides (TGs) (Ereifej et al., 2011) and quite a low amount of cholesterol, i.e. 30 mg/100 g dry matter (Salwa & Lina, 2010) (Ali M S Gorban & Izzeldin, 1999). The main part of fats is long chain FAs (FAs) (92–99%), though CM is poor source of short chain FAs (Ereifej et al., 2011). About 50–65% of total FAs are saturated, predominantly composed of C16:0 (35%), C14:0 (15%), and C18:0 (10%) (Gorban & Izzeldin, 2001). Around 35–50% of FA are polyunsaturated (C18:1 - C18:3) (Nagy et al., 2013), higher than that of in other milk sources (Ereifej et al., 2011). The homogenous form of FAs and low amount of carotenes are probably the reason of the smooth white colour of CM (Ibrahem & Zubeir, 2016).

The composition of FAs obtained from CM has been found to be different from country to country, and correlated to the environmental and farming conditions (Konuspayeva, Lemarie, Faye, Loiseau, & Montet, 2008). There is also a difference between the concentration of cholesterol in serum from cow and camel, suggesting a difference in lipid metabolism. The time of milk drawing, environmental factors (e.g. temperature and relative humidity), and physiological factors (e.g. diet, stage of lactation which normally takes 270–540 days (Abdurahman, 1996), and genetic differences within the species) govern the milk fat composition and cholesterol concentration. Addition of crude olive cake to the diet of settled lactating camels has been reported to have no effect on the fat content of the milk, but can modulate the FA composition by increasing linolenic and palmitic acid (Faye et al., 2013).

Among different tested milk samples (from buffalo, cow, goat and camel), the smallest fat globules have been found to correspond to camel (Fig. 1). It is maybe the reason that the digestibility of CM is the highest (Meena, Rajput, & Sharma, 2014). On the other hand, TGs' arrangement results in the existence of several crystalline forms, accordingly, the melting behaviour of the fat in CM is very complicated (Haddad, Mozzon, Strabbioli, & Frega, 2011). The size of fat globules and melting behaviour cause troubles in technological applications.

According to several studies, the FA composition of CM in comparison with BM contains a lower percentage of short-chain saturated FAs (C4-C12) and higher concentration of long-chain FAs such as stearic and palmitic acids (Farah, Streiff, & Bachmann, 1989).

2.3. Proteins and bioactive peptides

CM is an important source of proteins for a broad range of the population (Al-Ashqar et al., 2015). The total amount of protein is not similar in all CMs, even for the same breeds, but it is in the range of 2.5–5.5% according to season conditions (Zhao et al., 2015). The effect of lactation stage on protein content has been reported to be negligible (Konuspayeva et al., 2010).

Proteins of CM are split into caseins (CN) and whey proteins (WP) (Shuiep et al., 2013). CN involves 80% of BM proteins, though the amount of this protein in CM is in the range of 50–80%,

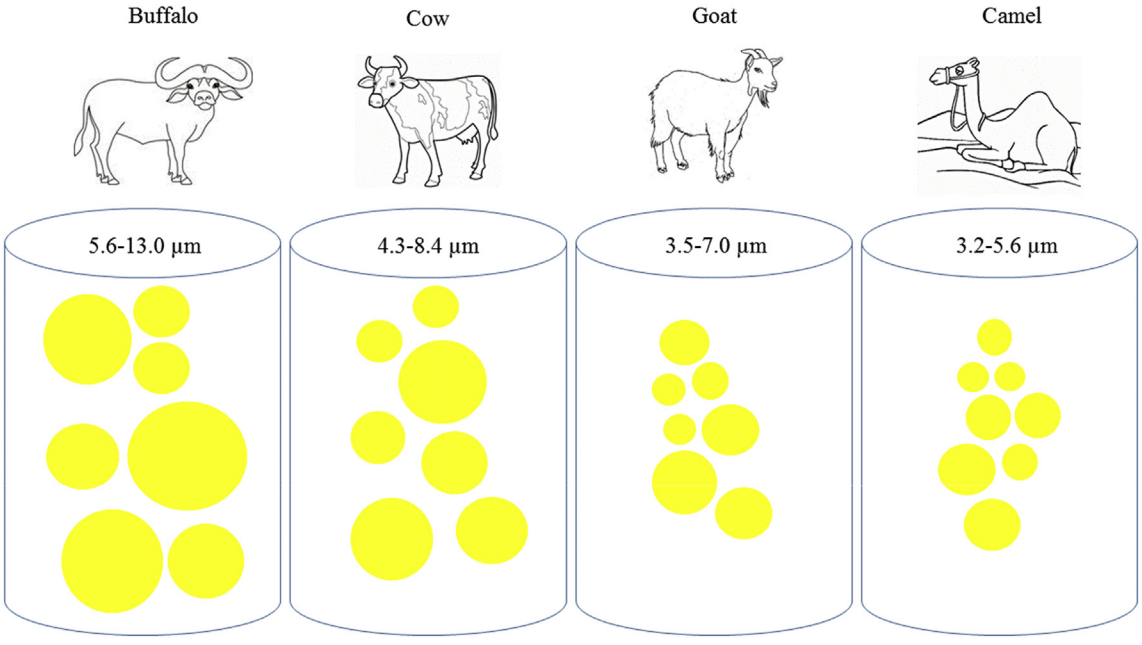

Fig. 1. Size distribution of fat particles in the milk from buffalo, cow, goat and camel (Meena et al., 2014).

including three main fractions: αs_1- (22.0%), αs_2- (9.5%), and β- (65.0%) (Shuiep et al., 2013). The molecular weight (MW) of CN patterns of CM breeds are generally higher than that of BM (Zhao et al., 2015). The range of the size of CN micelles are between 260 and 300 nm, though these are in the range of 100 and 140 nm in the case of BM (Hailu, Bech, Seifu, Eshetu, & Ipsen, 2016; Zhao et al., 2015). This difference is inversely correlated with the amount of calcium phosphate in the micelles.

Moreover, the biological activities are linked to the structural properties and the presence of bioactive peptides and proteins (Homayouni-Tabrizi, Shabestarin, Asoodeh, & Soltani, 2016, pp. 187–195; Khalesi et al., 2016; Lacou, Leonil, & Gagnaire, 2016). CN from CM can be considered to be a promising source for the production of peptides with potential of ACE-inhibitory activity ($IC_{50} = 73$ μg/mL) and radical scavenging activity ($IC_{50} = 6.8$ μg/mL) (Rahimi et al., 2016). Of around 200 peptides identified in CM, 15–20% have been detected as bioactive with ACE-inhibitory potential and/or antioxidant activity. Use of hydrolysing enzymes enhances bioactivity (Jrad et al., 2014).

α_{S1}-CN from CM possesses chaperone-like activity at neutral conditions (Badraghi, Yousefi, et al., 2009). This effect may be hindered by the low concentration of sodium dodecyl sulfate (SDS) due to electrostatic interactions between negative charged head groups of SDS and α_{S1}-CN, and the net negative charge of insulin, resulting in the more exposure of hydrophobic parts of insulin and its enhanced aggregation, or by dehydration effect of salt, leading to greater aggregation of insulins. Inversely, the presence of high concentrations of SDS has been reported to enhance the hydrophobic interaction of SDS/α-CN and insulin, consequently suppressing the aggregation of insulin (Badraghi, Moosavi-Movahedi et al., 2009).

Like bovine β-CN, camel β-CN shares a number of hydrophobic amino acids possessing a strong hydrophobicity, and also several serine and threonine residues with potential of being phosphate group acceptors (Esmaili et al., 2011). These properties and the potential of self-assembly and formation of nanostructures highlight the capability of camel β-CN to be used as a carrier of hydrophobic components. Encapsulation of curcumin by camel β-CN via hydrophobic interactions has been reported to significantly enhance the solubility of curcumin, its bioavailability and also antioxidant activity (Esmaili et al., 2011).

WP is the second main component of CM proteins and constitutes up to 30% of the total protein (Zhao et al., 2015). The major WP in CM belongs to α-lactalbumin (α-LA, 12 kDa), camel serum albumin (CSA, 70 kDa), lactoferrin (LF, 80 kDa) and thermostable immunoglobulins (IgG and IgM > 200 kDa) (Alhaider, Abdel Gader, Almeshaal, & Saraswati, 2014; Raei, Rajabzadeh, Zibaei, Jafari, & Sani, 2015). Moreover, several minor fractions in CM protein have been detected with a MW of between 40 and 60 kDa (Zhao et al., 2015). In contrast to BM that contains β-LG as the main protein (52.6%), and α-LA as the secondary (26.0%) protein (Zhao et al., 2015), in CM whey, α-LA is the main component (50%) and CSA is the second (35%). CM contains a very low to zero β-LG. This protein is responsible for BM's triggering of allergies, accordingly, CM causes little or no allergic effect (Omar, Harbourne, & Oruna-concha, 2016; Shori, 2015; Zhang et al., 2016).

CM contains greater amounts of proteins with positive roles in immunology systems than BM: these include lactoperoxidase (LP), *N*-acetyl glucosaminidase, secretory IgA and IgM, serum albumin, and peptidoglycan recognition protein, insulin and insulin like proteins (Korish et al., 2015).

As mentioned earlier, CM also contains LF protein (Salwa & Lina, 2010), an iron-binding glycoprotein marked for several biological roles, e.g. antioxidant activity and anti-inflammatory (Arab et al., 2014). Though LF content in BM is only 100–120 mg/L, in CM, it is in the range of 200–1000 mg/L up to 0.5% of total protein (Raei et al., 2015). Interestingly, the antibacterial activity of LF in CM can tolerate heating up to 80°C.

Lysozyme is also present in much higher amounts in CM (3000 mg/mL) than in BM (130 mg/L) (Shori, 2015). CM also contains higher amounts of niacin (Moslehishad, Ehsani, et al., 2013). Given these and the fact that CM contains several antibodies with marked antibacterial and antiviral activities, these effects are more visible in CM than in BM (Benkerroum, Mekkaoui, Bennani, & Hidane, 2004). Moreover, proteolysis is higher in CM bioyogurt than in BM bioyogurt, causing enhanced antioxidant activity. Fermentation of milk by *Lactobacillus rhamnosus* as a proteolytic strain has shown to trigger the release of ACE-inhibitory and antioxidant peptides from CM proteins (Moslehishad, Ehsani, et al., 2013).

The concepts in nutrition have considerably changed during the past decade. Growing interest in functional foods, which apart from nutritional values might be health-promoting and reduce the risk of several diseases, is a distinct change which has occurred in the last decade. One excellent source for producing functional foods is food protein. Bioactive peptides produced from food protein have shown remarkable health effects in human body including mineral binding, growth factors, reduction of blood pressure, antioxidant activity, anticancer activity, immunomodulatory function, cholesterol-lowering effects, and protective properties against different microorganisms and viruses (Salami et al., 2010). CM due to its different and excellent protein and amino acids profile is a super source for production of bioactive peptides. Higher digestibility and antioxidant activity of CM's α-LA in comparison with BM was also demonstrated by Salami et al. (2009) (Salami et al., 2009). The bioactive peptides obtained after enzymatic treatment of camel and bovine WP using microbial and digestive enzymes showed higher antioxidant and antibacterial activities of peptides obtained from camel WP, making camel WP a rich source for the production of bioactive peptides (Salami et al., 2010). β-CN is the main CN in CM. CN and in particular β-CN of CM is an excellent source for production of peptides with ACE-inhibitory and antioxidant activity. Studies have shown that using digestive enzymes bioactive peptide with high ACE-inhibitory and antioxidant activity could be obtained, which makes CM a good candidate for the production of functional foods (Salami et al., 2008). The use of peptides obtained from CM and its derived products using hydrolysing proteases such as alcalase, α-chymotrypsin and papain, has been suggested for formulating nutraceuticals and enhancing their functionalities (Kumar, Chatli, Singh, Mehta, & Kumar, 2016). Recently, two peptides derived from CM [Asn-Glu-Asp-Asn-His-Pro-Gly-Ala-Leu-Gly-Glu-Pro-Val and Lys-Val-Leu-Pro-Val-Pro-Gln-Gln-Met-Val-Pro-Tyr-Pro-Arg-Gln with MW of 1.3 kDa and 1.8 kDa, respectively] have been identified as potential antioxidants (Homayouni-Tabrizi et al., 2016, pp. 187–195).

The lack of β-LG and the presence of protective proteins, a similar situation to that in human milk (Arab et al., 2014), make CM a potential source of inhibitory antibiotics, and a good choice as a substitute for BM, especially in the manufacture of infant milk (Konuspayeva et al., 2011; Salami et al., 2009).

Interestingly, purification of hyper active β-amylase and low active xanthine oxidoreductase from CM was also reported (Baghiani, Harrison, & Benboubetra, 2003).

The measurement of differential scanning calorimetry (DSC) thermograms of CM has indicated the denaturation temperature of proteins equal to 78°C, i.e. 4°C lower than BM proteins (Imene Felfoul, Lopez, Gaucheron, Attia, & Ayadi, 2015). The mechanism of protein fouling in CM is totally different from that of BM. Sticking of unwanted deposits on surfaces of heat exchangers, a fouling phenomenon that occurs in BM proteins correlates to changes in the

tertiary structure of β-LG. In CM, this phenomenon is highly related to α-LA and CSA (Felfoul et al., 2015; Ghamari et al., 2013; Tayefi-Nasrabadi, Hoseinpour-fayzi, & Mohasseli, 2011). The denaturation temperatures for camel rennet whey and camel acid whey have been reported to be 73.8°C and 60.5°C, respectively (Felfoul et al., 2015). The reports have shown that a temperature of 90 °C caused CSA to totally disappear. The amount of α-LA as a function of temperature and heating time has been shown to decline significantly (Felfoul et al., 2015). In a recent study by Felfoul, Jardin, Gaucheron, Attia, and Ayadi (2017) (Felfoul et al., 2017), α-La and peptidoglycan recognition protein from camels were not detectable after heating at 80°C for 60 min, while CSA was significantly reduced. In the case of BM, β-LG and α-LA totally disappeared. CN fractions of CM and BM were retained intact under the above mentioned conditions. Felfoul et al. (2015) also observed deposit formation after heating both CM and BM at 80°C for 60 min. The deposit contained 57% protein and 35% mineral (w/w) in the case of CM, and 69% protein and 28% mineral (w/w) in the case of BM. Scanning electron microscopy results indicated that the structures of both deposits comprised of bulky clumps of 100 nm protein aggregates, while the CM deposit showed an amorphous structure due to the lack of β-LG. Given this information and the fact that CM does not contain β-LG, heat denaturation of CM proteins becomes feasible. Table 2 lists a brief on the bio-functionality of crucial protein based components from CM. Fig. 2 also represents different aspects for obtaining CM-derived bioactive peptides.

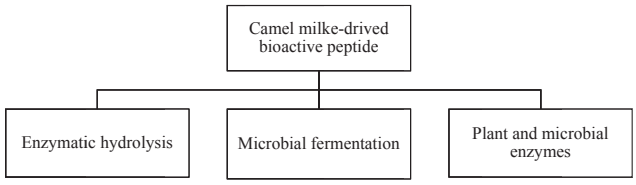

Fig. 2. The process of CM-derived bioactive peptides.

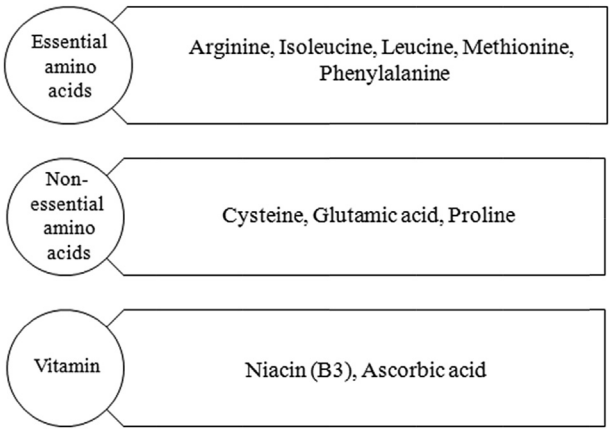

Fig. 3. Essential, non-essential amino acids and vitamins of camel milk that is greater than bovine milk.

2.4. Amino acids

The essential and non-essential amino acid content of BM is significantly higher than in CM (Zhao et al., 2015) (Fig. 3). Glutamic acid is the major amino acid in CM. The level of Lysin in CM is lower than that of BM. The level of Methionine in CM is higher than that of BM and human milk. The cystine level was quite close to human milk. Additionally, the presence of several half-cystines in the sequences of small proteins of CM has been recorded (Beg & Bahr-lindstrom, 1984; Beg, Bahr-Lindstrom, Zaidi, & Jornvall, 1986). CM contained also a higher amount of Alanine and Valine (Ahamad et al., 2016). It seems that 0.5 L CM can supply a sufficient amount of amino acids to meet an adult's daily needs (Zhao et al., 2015).

3. Microorganisms and camel milk

The amount of CM consumed in some regions is very high. For instance, the rural people in Kazakhstan drink 30–35 kg person^{-1} year^{-1} (Konuspayeva et al., 2011). Thus, controlling the hygiene of the CM during the collection, transportation, processing and storage is essential (N Benkerroum et al., 2003). The high risk of spreading brucellosis with CM contaminated by *Brucella melitensis* observed in rural areas (Garcell et al., 2016) suggests it is necessary to analyse the microbial quality of milk more frequently. It is also very important to keep strict hygiene of raw CM in order to minimize the risks of listeriosis with *Listeria monocytogenes* (Osman, Samir, Orabi, & Zolnikov, 2014). In addition, isolation of *Staphylococcus aureus* which results in gastroenteritis from the consumption of contaminated raw CM has been reported (Shuiep et al., 2009). Raw CM may contain a number of contaminants such as *Staphylococcus aureus*, *Streptococcus* spp. and *Escherichia coli*. The identification of *Bacillus cereus*, *Bacillus licheniformis*, *Bacillus subtilis*, *Bacillus pumilus*, *Bacillus sonorensis*, *Geobacillus stearothermophilus*, *Salmonella* spp., *Klebsiella* spp. and *Enterobacter* spp. was carried out as well. *Bacillus cereus* has been reported to be eliminated by a light sterilization (Kadri et al., 2014; Nagy & Juhasz, 2016).

Some novel microbial species such as *Streptococcus tangierensis*, *Streptococcus cameli* and *Enterococcus bulliens* have been also isolated from CM (Kadri et al., 2014, 2015). Isolation of safe culture *Enterococcus durans* from a traditional fresh camel cheese with the ability to produce bacteriocin-like inhibitory substance against *Listeria monocytogenses*, and *Lactobacillus acidophilus* from CM, with the potential of producing substance against gram positive and gram negative pathogens have been also reported (Abo-Amer, 2013; Khay, Idaomar, El Moussaoui, & Abrini, 2014).

It is possible to obtain CM with excellent microbial quality (P.

Table 2
Some examples of proteins in CM and their roles in health of consumers.

Protein	Biological functions	Reference
α_{S1}-CN	Chaperone-like activity	(Badraghi et al., 2009)
β-CN	ACE-inhibitory and antioxidant activity, α-Glucosidase inhibitory, carrier of hydrophobic compounds	(Esmaili et al., 2011; Moslehishad et al., 2013)
α-LA	Antioxidant activity and improved digestibility	(Jrad et al., 2014; Salami et al., 2009)
LF	Antioxidant, anti-inflammatory, antibacterial activity, prevention the growth of colon tumour cells	(Arab et al., 2014)
LP	Enzyme indicator of effective pasteurization	(Tayefi-Nasrabadi et al., 2011)
IgG and IgM	Immunology	(Alhaider et al., 2014; Raei et al., 2015)
Lysozyme	Antibacterial and antiviral activities	(Shori, 2015)
Lack of β-LG	No allergy	(Shori, 2015)

Nagy et al., 2013). In the case of BM, LP-activity has been used for a long time as an indicator of a correct pasteurization pathway (Tayefi-Nasrabadi et al., 2011). There have been several candidates such as alkaline phosphatase, γ-glutamyl transferase, lipase, leucine arylamidase and LP to be considered as an enzyme indicator of effective pasteurization in CM. Among those, the results of LP are promising (Lorenzen, Wernery, Johnson, Jose, & Wernery, 2011), although LP in CM is less stable than in BM versus thermal denaturation (Arab et al., 2014).

Besides, a number of studies reported the presence of *LAB* in CM (Ziane et al., 2016). Several probiotic *LAB* strains from the categories of *Lactobacillus fermentum* and *Lactobacillus plantarum* were able to tolerate the condition of the gastrointestinal tract, and exhibited antibacterial activity against *Staphylococcus aureus*, *Listeria monocytogenes*, *Salmonella thyphimirium* and *Escherchia coli*, thus have been proposed to be used as additives to enhance the quality of dairy products (Mahmoudi et al., 2016).

4. Camel milk-derived functional products

The viscosity and electrical conductivity of CM are 7 mPa.s and 4.5×10^3 μs/cm, respectively. Its ethanol stability is slightly lower than that of BM (Zhao et al., 2015). The titratable acidity and pH of CM are about 0.2% and 6.4, respectively. Various new dairy products from CM, such as pasteurized milk, flavoured milk, butter, yogurt, cheese and milk tea have been obtained so far (Al-Saleh, Metwalli, & Ismail, 2011; Park, 2009). Nowadays, pasteurized CM (shelf life: 10 days at 4°C) is one of the most important CM products in some countries such as Mauritania, for instance (Park, 2009). Pasteurized CM is produced at large scale in these countries.

Fresh CM is hard to preserve and is rarely acceptable due to its unpleasant flavour. Spearmint and wild thyme oils have been reported to increase the aroma acceptability of the product and the shelf-life (Maaroufi et al., 2015). The fermented milk on the other hand, is relatively easy to store, it tastes better (Gorban & Izzeldin, 2001), and shows improved radical scavenging activity (Soleymanzadeh, Mirdamadi, & Kianirad, 2016). Low pH and consequently, low amount of microbial cells enable commercialisation of fermented products derived from CM (Fguiri et al., 2015). The diversity in acidity development in CM-derived products and BM-derived products are due to the differences in proteolysis activity (Al-Sheraji et al., 2013).

The dominant microbial strains during the CM fermentation process are governed by several factors such as a highly adapted metabolism, and the production of antimicrobial compounds (Jans, Bugnard, Njage, Lacroix, & Meile, 2012). Fermentation of CM using *Lactobacillus plantarum* PTCC 1058, *Lactobacillu srhamnosus* and *Lactobacillus fermentum* with high protease activity and sensory scores recommended for producing fermented CM containing high amount of bioactive peptides (Moslehishad, Mirdamadi, Ehsani, Ezzatpanah, & Moosavi-Movahedi, 2013; Nanda et al., 2011). This may be extended in the presence of some products like soybean. The inconsistency of the texture of yogurt from CM has not yet been improved, even by addition of different types of stabilizers (Al-Zoreky & Al-Otaibi, 2015). Fermentation processes for obtaining camel bioyogurt needs more time than that required to obtain yogurt from BM (Ereifej et al., 2011). Yoghurt from camel–sheeps' milk mixtures have shown to have higher total solids, fat and protein and better satisfactoriness in comparison with those obtained from CM alone (Ibrahem & Zubeir, 2016).

Traditionally, fermented CM is allowed to naturally ferment without prior heat treatment and without the addition of starter cultures (Shori, 2012). Nevertheless, based on the methodology of fermentation, currently different fermented milk products have been identified, e.g. Gariss, Suusac and Shubat. Garissis is produced by fermentation at 25–30°C in goat skin bag for 1 day. Total solid content of Gariss ranged from 10 to 11%. It contains fat around 2.8–5.0%. Protein and ash contents in Gariss are 3.0% and 1.0%, respectively (Shori, 2012). Suusac can be produced with or without starter culture. It is spontaneously fermented at 25–30°C for 1 or 2 days in a pre-smoked gourd. It is a white, watery product with a special flavour and taste, with potential to be contaminated with high loads of microorganisms (Mwangi, Matofari, Muliro, & Bebe, 2016). Suusac contains total solids of 12.5% and fat 4.0%. Additionally, other chemical components in Suusac such as protein, carbohydrate and calcium were approximately 0.030, 0.050 and 0.001 g/g, respectively. The incubation time for Shubat is 8 h at 25–30°C in a leather bag or a ceramic jar. The fat content in Shubat was reported to be 4.3% equal to the fat in fresh CM used for production. However, Shubat contains lower amounts of non-fat solids, lactose, ash, and vitamin C than raw CM. The ethyl alcohol in Shubat is 1.1%, resulting from the presence of *LAB*, especially *Lactobacillus* and *Enterococcus*, and from yeasts, especially *Kluyveromyces*, and produced during the fermentation process (Rahman, Xiaohong, Meiqin, & Mingsheng, 2009).

The production of ethanol (over 0.5%) during CM fermentation, which also may be the reason of undesirable flavour in the final product, is a concern of using CM for Muslims (Shori, 2012). There are several ways to overcome this problem by dealcoholisation, using similar to the methods used for making free alcohol beer, e.g. vacuum rectification and evaporation, use of membrane extraction, applying supercritical CO_2 extraction, pervaporative separation, and adsorption on hydrophobic zeolites (Brányik, Silva, Baszczyňski, Lehnert, & Almeida E Silva, 2012).

Chal is a traditional sparkling beverage of fermented CM with a sour flavour, popular in the north of Iran, Kazakhstan and Turkmenistan. It is produced by fermentation of CM by *LAB* as well as yeast (Lorenzen et al., 2011; Soleymanzadeh et al., 2016). Oggtt is dry fermented CM which can be consumed either as dry or after rehydration. Orom is another type of fermented CM product usually consumed fresh. It is a soured cream produced from Bactrian CM in Mongolia. After heating the milk at 75–85°C and mixing to make foam, it is incubated at 18–20°C for 10–15 h to obtain Orom (Lorenzen et al., 2011).

A traditional fermented soured BM (namely Doogh, known as Ayran in Europe) has been consumed widely in countries around Persian Gulf, possessing several healthy impacts on the human body. Recently, the members of IBB (Institute of Biochemistry and Biophysics, Iran) have introduced a similar product obtained from CM with natural fermentation (unpublished data). Although the product yet needs to be improved regarding its extreme sour taste, it is promising as a novel nutraceutical product for future industry.

Camel cheese has not been extensively investigated due to weak and long coagulation (El Zubeir & Jabreel, 2008). This has been correlated to the differences in total solid content, concentration of calcium and phosphorus, low electrophoretic mobility of CN, CN composition, and the size of the CN micelles (Ibrahem & Zubeir, 2016). Among those, the lower ratio of κ-CN to β-CN in CM is most probably the major reason for the observed differences in coagulation. Hydrolysis of CN of CM can be maximised with increasing gelation temperature, camel chymosin concentration and decreasing pH (Hailu et al., 2016). Thus, production of camel cheese at industrial scale is limited. Optimization of salting rate and supplementation of rennet and calcium chloride may partially solve this problem to produce a soft light coagulum.

For the cheese making process, bovine chymosin is the preferred enzyme due to its specific effect on κ-CN. The optimal activity is achieved in slightly acidic conditions. This results in the optimal flavour development for mature cheese, beside curdling of a strong curd, leading to high cheese yield. κ-CN content of CM is only 3.5%.

Despite having 85% similarity in sequences, camel chymosin has different characteristics than bovine chymosin and shows seven-fold higher ratio of clotting to normal proteolytic action (Langholm Jensen et al., 2013). The enzyme from CM is slightly more thermostable than bovine chymosin. CM is not sensitive to coagulation after exposure to bovine chymosin. Given this information, performing the same procedure as used in the production of bovine cheese to produce camel cheese results in a product with an undesirable taste and not acceptable for local consumers. Fermentation by using camel chymosin has partially solved this problem by unique specificity towards camel κ-CN, thus providing a way to produce high quality camel cheese (Kappeler et al., 2006).

Although it is possible to make butter from CM, it takes a long time to churn the milk (Berhe, Seifu, & Kurtu, 2013). Pastoralists claim the difficulty of churning CM into butter because of its low tendency to cream due to the lack of a protein, namely agglutinin. The fat in CM is distributed as micelle-like globules and it is strictly bound to the protein. Moreover, the fat globule membrane of CM is thick (Haddad et al., 2011). The butter from CM has been used for clinical purposes or as hair pomade (Kappeler et al., 2006).

5. Camel milk as healthcare product

CM and its fermented products have been traditionally used for many years due to the belief that those promote bone formation in infants, and possess healing properties against many internal diseases (Lü, Hu, Dang, & Liu, 2014). Nowadays, it has been verified that these products include valuable nutrition, in addition to possessing exceptional functions such as antigenotoxic, anticytotoxic, antimicrobial, antioxidative, antithrombotic, antihypertensive, anthelmintic activity, immuno-modulatory, anti-inflammatory, hypoallergenic, hypoglycemic, and anti-hypertensive (Abdalla et al., 2015; Alhaider et al., 2014; Alimi et al., 2016; Arab et al., 2014; Nagy et al., 2013; Osman et al., 2014; Salwa & Lina, 2010). CM and its derived products have been therapeutically used to treat jaundice, lung and spleen-related ailments, asthma, anemia, autism, oedema, piles, milk allergies, hepatitis C virus, diarrhea-causing viruses tuberculosis, gastrointestinal ulcers, dermatological autoimmune diseases and more importantly, diabetes (Arab et al., 2014; Gorban & Izzeldin, 1999; Konuspayeva et al., 2011; Osman et al., 2014; Salwa & Lina, 2010). In addition, the cholesterol-lowering activity of CM by an undefined mechanism has been reported in rats (Al haj & Al Kanhal, 2010; Al-Numair, 2010). CM is digested in the stomach with no trouble and no allergic reactions. It also positively protects consumers against heavy metal toxicity and potential infections (Ahamad et al., 2016).

Yogurt from CM can be used as a probiotic with promising dose-dependent therapeutic properties (Elayan, Sulieman, & Salah, 2010). The minimum viable numbers of probiotics in the final fermented CM is considered to be around 10^6–10^7 CFU/g. Recently, a novel bacteriocin with special heat and pH stability produced by *Lactobacillus casei* isolated from fermented CM has been purified and characterized (Lü et al., 2014).

Moreover, there are several promising applications for daily consumption of CM for human health. For instance, CM has been proposed as a potential candidate for suppression of both alcoholic and non-alcoholic fatty liver disease (Althnaian, Albokhadaim, & El-Bahr, 2013). The alleviating effect of CM as complementary approach for the management of inflammatory bowel diseases has been also suggested (Arab et al., 2014).

As stated earlier, LF from CM induces oxidant stability and inhibits DNA damage through binding catalytic iron, and exhibits antibacterial and antiviral activities. Consequently, it can be influential to control diseases such as cancer, Alzheimer's, Hepatitis C, HIV and Tuberculosis. LF prevents the growth of colon tumour cells as well. Also, having high content of iron promoted using of CM to control hypochromic anemia (Ebaid et al., 2015; Habib, Ibrahim, Schneider-Stock, & Hassan, 2013).

It is common for inhabitants of camel rich regions to consume CM in its fresh or sour state with the purpose of diabetes treatment and improvement of wound healing (Althnaian et al., 2013). The latter is the consequence of interaction between inflammatory cells and biochemical mediators (Althnaian et al., 2013). CM has been reported to exhibit protective properties against diabetes, including type I and II, by reducing demand for insulin in patients and improving residual β-cell function in the pancreas, considering its immunomodulatory influence. The anti-inflammatory effect and high concentration of antioxidants probably possess positive roles in curing diabetes too (Limon et al., 2014). CM with high amount of insulin can resist against coagulum formation in the stomach, and therefore becomes available for absorption in the small intestine (Korish, Abdel Gader, & Alhaider, 2015). Interestingly, it has been reported that camel breeders in India, who regularly drink CM, have shown no diabetes mellitus, though in places which CM is not consumed, 5.5% have shown diabetes mellitus (Korish et al., 2015).

Additionally, regularly drinking of 500 mL CM over a period of a few months by type I diabetes mellitus patients has resulted in 30–35% reduction in the daily insulin requirements, with a significant drop in blood glucose (R P Agrawal et al., 2003; Agrawal, Jain, Shah, Chopra, & Agarwal, 2011; Agrawal et al., 2009). A similar study on type II diabetes patients has been carried out, showing increasing of insulin concentration from 64.59 to 84.03 pmol/L in only two months, probably due to glycemic control (Ejtahed et al., 2015). This time-, quantity-dependent effect has been previously reported in both humans and animals such as dogs and rats (Ebaid, 2014; Sboui et al., 2010). Also, the capability of insulin-like small molecules in CM to mimic insulin interaction with its receptor, transformation of insulin to indigestible nanoparticles and carry on this hormone into the bloodstream have been reported as the possible mechanisms to reduce the blood glucose (Malik, Al-Senaidy, Skrzypczak-Jankun, & Jankun, 2012). The above mentioned results support the idea of the beneficial effect of CM in the management of diabetes. Nevertheless, upscaling the laboratory experiments with larger human groups are required to endorse the curative results obtained from CM.

6. Conclusion

Dairy industries have produced bovine milk and bovine milk-derived products at different scales for many years. The benefits of dairy products to human health have been extensively studied and repeatedly emphasised. Although the recent development of new products from milk have been advanced slowly, the industry still survived, due to the importance of health-required components present in the milk. Nevertheless, the future industries tend to develop new products for consumers and finding new sources rather than cow. In this case, camel is probably a good candidate. The exceptional properties of camel milk encourage food technologists in the regions where there exist large camel populations, to produce and process camel milk. Towards bringing the benefits of camel milk in human diet, we recommend establishing a camel milk industry-traditional system.

In the current study, several recent advances concerning camel milk as a superfood and its applications with an emphasis on healthcare properties were described. The highlights of using camel milk are given in brief as below:

- CM is accessible in dry and semi-dry area.
- The nutritional value of CM is higher than BM.

- CM contains higher amounts of proteins with positive roles in immunology systems than BM.
- CM possesses little or no allergy effects, due to the lack of β-LG.
- The lactose from CM is metabolized by lactose intolerant people with no difficulty.
- CM exhibits great biological values due to its significant amount of bioactive peptides.
- CM's digestibility is greater than BM's.
- CM has been reported to possess alleviative roles against diabetes.

Acknowledgment

The authors would like to thank Iran National Elites Foundation (INEF)-International Department and Iran National Science Foundation (INSF). The support of International Scientific Studies & Collaboration (CISSC)-Ministry of Science, Research and Technology in Iran and UNESCO Chair on Interdisciplinary Research in Diabetes is also acknowledged.

References

Abdalla, E. B., Anis Ashmawy, A. E. H., Farouk, M. H., Abd El-Rahman Salama, O., Khalil, F. A., & Seioudy, A. F. (2015). Milk production potential in Maghrebi she-camels. *Small Ruminant Research, 123*(1), 129–135. http://doi.org/10.1016/j.smallrumres.2014.11.004.

Abdelgadir, W. S., Ahmed, T. K., & Dirar, H. A. (1998). The traditional fermented milk products of the Sudan. *International Journal of Food Microbiology, 44*(1–2), 1–13. http://doi.org/10.1016/S0168-1605(98)00090-7.

Abdurahman, O. A. S. (1996). The detection of subclinical mastitis in the bactrian camel (*Camelus bactrianus*) by somatic cell count and California mastitis test. *Veterinary Research Communications, 20*(1), 9–14.

Abo-Amer, A. E. (2013). Inhibition of Foodborne pathogens by a bacteriocin-like substance produced by a novel strain of Lactobacillus acidophilus isolated from camel milk. *Applied Biochemistry and Microbiology, 49*(3), 270–279. http://doi.org/10.1134/s0003683813030174.

Agrawal, R. P., Budania, S., Sharma, P., Gupta, R., Kochar, D. K., Panwar, R. B., et al. (2007). Zero prevalence of diabetes in camel milk consuming Raica community of north-west Rajasthan, India. *Diabetes Research and Clinical Practice, 76*(2), 290–296. http://doi.org/10.1016/j.diabres.2006.09.036.

Agrawal, R. P., Dogra, R., Mohta, N., Tiwari, R., Singhal, S., & Sultania, S. (2009). Beneficial effect of camel milk in diabetic nephropathy. *Acta bio-medica: Atenei Parmensis, 80*(6), 131–134.

Agrawal, R. P., Jain, S., Shah, S., Chopra, A., & Agarwal, V. (2011). Effect of camel milk on glycemic control and insulin requirement in patients with type 1 diabetes: 2-years randomized controlled trial. *European Journal of Clinical Nutrition*. http://doi.org/10.1038/ejcn.2011.98.

Agrawal, R. P., Swami, S. C., Beniwal, R., Kochar, D. K., Sahani, M. S., Tuteja, F. C., et al. (2003). Effect of camel milk on glycemic control, risk factors and diabetes quality of life in type-1 diabetes: A randomised prospective controlled study. *Journal of Camel Practice and Research, 10*(1), 45–50.

Ahamad, S. R., Raish, M., Ahmad, A., & Shakeel, F. (2016). Potential health benefits and metabolomics of camel milk by GC-MS and ICP-MS. *Biological Trace Element Research*, 1–9. http://doi.org/10.1007/s12011-016-0771-7.

Ahmad, S., Yaqoob, M., Bilal, M. Q., Khan, M. K., Muhammad, G., Yang, L. G., et al. (2012). Factors affecting yield and composition of camel milk kept under desert conditions of central Punjab, Pakistan. *Tropical Animal Health and Production, 44*(7), 1403–1410. http://doi.org/10.1007/s11250-012-0079-3.

Al-Ashqar, R. A., Al-Mohammad Salem, K. M., Al Herz, A. K. M., Al-Haroon, A. I., & Alluwaimi, A. M. (2015). The CD markers of camel (*Camelus dromedarius*) milk cells during mastitis: The LPAM-1 expression is an indication of possible mucosal nature of the cellular trafficking. *Research in Veterinary Science, 99*, 77–81. http://doi.org/10.1016/j.rvsc.2015.01.011.

Al-Masri, M. S., Al-Hamwi, A., Amin, Y., Safieh, M. B., Zarkawi, M., Soukouti, A., et al. (2014). Radionuclide transfer from feed to camel milk. *Journal of Environmental Radioactivity, 132*, 8–14. http://doi.org/10.1016/j.jenvrad.2014.01.009.

Al-Numair, K. S. (2010). Type II diabetic rats and the hypolipidemic effect of camel milk. *Journal of Food Agriculture & Environment*.

Al-Saleh, A. A., Metwalli, A. A. M., & Ismail, E. A. (2011). Physicochemical properties of probiotic frozen yoghurt made from camel milk. *International Journal of Dairy Technology, 64*(4), 557–562. http://doi.org/10.1111/j.1471-0307.2011.00699.x.

Al-Sheraji, S. H., Ismail, A., Manap, M. Y., Mustafa, S., Yusof, R. M., & Hassan, F. A. (2013). Prebiotics as functional foods: A review. *Journal of Functional Foods, 5*(4), 1542–1553. http://doi.org/10.1016/j.jff.2013.08.009.

Al-Zoreky, N. S., & Al-Otaibi, M. M. (2015). Suitability of camel milk for making yogurt. *Food Science and Biotechnology, 24*(2), 601–606. http://doi.org/10.1007/s10068-015-0078-z.

Alhaider, A. A., Abdel Gader, A. G. M., Almeshaal, N., & Saraswati, S. (2014). Camel milk inhibits inflammatory angiogenesis via downregulation of proangiogenic and proinflammatory cytokines in mice. *Apmis, 122*(7), 599–607. http://doi.org/10.1111/apm.12199.

Alhaj, O. A., Taufik, E., Handa, Y., Fukuda, K., Saito, T., & Urashima, T. (2013). Chemical characterisation of oligosaccharides in commercially pasteurised dromedary camel (*Camelus dromedarius*) milk. *International Dairy Journal, 28*(2), 70–75. http://doi.org/10.1016/j.idairyj.2012.08.008.

Alimi, D., Hajaji, S., Rekik, M., Abidi, A., Gharbi, M., & Akkari, H. (2016). Veterinary Parasitology First report of the in vitro nematicidal effects of camel milk. *Veterinary Parasitology, 228*, 153–159.

Al haj, O. A., & Al Kanhal, H. A. (2010). Compositional, technological and nutritional aspects of dromedary camel milk. *International Dairy Journal, 20*(12), 811–821. http://doi.org/10.1016/j.idairyj.2010.04.003.

Almutairi, S. E., Boujenane, I., Musaad, A., & Awad-Acharari, F. (2010). Genetic and nongenetic effects for milk yield and growth traits in Saudi camels. *Tropical Animal Health and Production, 42*(8), 1845–1853. http://doi.org/10.1007/s11250-010-9647-6.

Althnaian, T., Albokhadaim, I., & El-Bahr, S. M. (2013). Biochemical and histopathological study in rats intoxicated with carbontetrachloride and treated with camel milk. *SpringerPlus, 2*(1), 57. http://doi.org/10.1186/2193-1801-2-57.

Arab, H. H., Salama, S. A., Eid, A. H., Omar, H. A., Arafa, E. S. A., & Maghrabi, I. A. (2014). Camel's milk ameliorates TNBS-induced colitis in rats via down-regulation of inflammatory cytokines and oxidative stress. *Food and Chemical Toxicology, 69*, 294–302. http://doi.org/10.1016/j.fct.2014.04.032.

Badraghi, J., Moosavi-Movahedi, A. A., Saboury, A. A., Yousefi, R., Sharifzadeh, A., Hong, J., et al. (2009). Dual behavior of sodium dodecyl sulfate as enhancer or suppressor of insulin aggregation and chaperone-like activity of camel α_{S1}-casein. *International Journal of Biological Macromolecules, 45*(5), 511–517. http://doi.org/10.1016/j.ijbiomac.2009.08.008.

Badraghi, J., Yousefi, R., Saboury, A. A., Sharifzadeh, A., Haertl, T., Ahmad, F., et al. (2009). Effect of salts and sodium dodecyl sulfate on chaperone activity of camel α_{S1}-CN: Insulin as the target protein. *Colloids and Surfaces B: Biointerfaces, 71*(2), 300–305. http://doi.org/10.1016/j.colsurfb.2009.03.008.

Baghiani, A., Harrison, R., & Benboubetra, M. (2003). Purification and partial characterisation of camel milk xanthine oxidoreductase. *Archives of Physiology and Biochemistry, 111*(5), 407–414. http://doi.org/10.3109/13813450312331342265.

Bai, Y. hong, & Zhao, D. bo (2015). The acid-base buffering properties of Alxa bactrian camel milk. *Small Ruminant Research, 123*(2–3), 287–292. http://doi.org/10.1016/j.smallrumres.2014.10.011.

Beg, O. U., & Bahr-lindstrom, H. V. O. N. (1984). structure-function relationships of caseins and of β-lactoglobulins. The purification and preliminary characterization of the small camel-milk protein rich in cysteine/half-cystine is now reported. Camel milk was treated as described for the. *Bioscience Reports, 4*, 1065–1070.

Beg, O. U., Bahr-Lindstrom, H. V., Zaidi, Z. H., & Jornvall, H. (1986). A camel milk whey protein rich in half-cystine. *European Journal of Biochemistry, 201*, 195–201.

Benkerroum, N., Boughdadi, A., Bennani, N., & Hidane, K. (2003). Microbiological quality assessment of Moroccan camel's milk and identification of predominating *lactic acid bacteria*. *World Journal of Microbiology & Biotechnology, 19*, 645–648.

Benkerroum, N., Mekkaoui, M., Bennani, N., & Hidane, K. (2004). Antimicrobial activity of camel's milk against pathogenic strains of *Escherichia coli* and *Listeria monocytogenes*. *International Journal Of Dairy Technology, 57*(1), 39–43.

Berhe, T., Seifu, E., & Kurtu, M. Y. (2013). Physicochemical properties of butter made from camel milk. *International Dairy Journal, 31*(2), 51–54. http://doi.org/10.1016/j.idairyj.2013.02.008.

Bránayik, T., Silva, D. P., Baszczyński, M., Lehnert, R., & Almeida E Silva, J. B. (2012). A review of methods of low alcohol and alcohol-free beer production. *Journal of Food Engineering, 108*(4), 493–506. http://doi.org/10.1016/j.jfoodeng.2011.09.020.

Ebaid, H. (2014). Promotion of immune and glycaemic functions in streptozotocin-induced diabetic rats treated with un-denatured camel milk whey proteins. *Nutrition & Metabolism, 11*(1), 31. http://doi.org/10.1186/1743-7075-11-31.

Ebaid, H., Abdel-Salam, B., Hassan, I., Al-Tamimi, J., Metwalli, A., & Alhazza, I. (2015). Camel milk peptide improves wound healing in diabetic rats by orchestrating the redox status and immune response. *Lipids in Health and Disease, 14*(1), 132. http://doi.org/10.1186/s12944-015-0136-9.

Ejtahed, H. S., Niasari Naslaji, A., Mirmiran, P., Zraif Yeganeh, M., Hedayati, M., Azizi, F., et al. (2015). Effect of camel milk on blood sugar and lipid profile of patients with type 2 diabetes: A pilot clinical trial. *International Journal of Endocrinology and Metabolism, 13*(1), e21160. http://doi.org/10.5812/ijem.21160.

El Zubeir, I. E. M., & Jabreel, S. O. (2008). Fresh cheese from camel milk coagulated with Camifloc. *International Journal of Dairy Technology, 61*(1), 90–95. http://doi.org/10.1111/j.1471-0307.2008.00360.x.

El-agamy, E. I., Nawar, M., Shamsia, S. M., Awad, S., & Haenlein, G. F. W. (2009). Are camel milk proteins convenient to the nutrition of cow milk. *Small Ruminant Research*. http://doi.org/10.1016/j.smallrumres.2008.12.016.

El-Fakharany, E. M., Serour, E. A., Abdelrahman, A. M., Haroun, B. M., & Redwan, E.-R. M. (2009). Purification and characterization of camel (*Camelus dromedarius*) milk amylase. *Preparative Biochemistry and Biotechnology, 39*(2), 105–123. http://doi.org/10.1080/10826060902800288.

Elayan, A. A., Sulieman, A. M. E., & Salah, F. A. (2010). The hypocholesterolemic effect of gariss and gariss containing bifidobacteria in rats fed on a cholesterol-enriched diet. *Asian Journal of Biochemistry, 5*(3), 205–209.

Elhadi, Y. A., Nyariki, D. M., & Wasonga, O. V. (2015). Role of camel milk in pastoral livelihoods in Kenya: Contribution to household diet and income. *Pastoralism, 5*(1), 8. http://doi.org/10.1186/s13570-015-0028-7.

Ereifej, K. I., Alu'datt, M. H., Alkhalidy, H. A., Alli, I., & Rababah, T. (2011). Comparison and characterisation of fat and protein composition for camel milk from eight Jordanian locations. *Food Chemistry, 127*(1), 282–289. http://doi.org/10.1016/j.foodchem.2010.12.112.

Esmaili, M., Ghaffari, S. M., Moosavi-Movahedi, Z., Atri, M. S., Sharifizadeh, A., Farhadi, M., et al. (2011). Beta casein-micelle as a nano vehicle for solubility enhancement of curcumin; food industry application. *LWT - Food Science and Technology, 44*(10), 2166–2172. http://doi.org/10.1016/j.lwt.2011.05.023.

Farah, Z., Streiff, T., & Bachmann, M. R. (1989). Manufacture and characterization of camel milk butter. *Milchwissenschaft, 44*(7), 412–414.

Faye, B., Konuspayeva, G., & Loiseau, G. (2010). Variability of urea concentration in camel milk in Kazakhstan. *Dairy Science & Technology, 90*(6), 707–713. http://doi.org/10.1051/dst/2010025.

Faye, B., Konuspayeva, G., Messad, S., & Loiseau, G. (2008). Discriminant milk components of Bactrian camel (*Camelus bactrianus*), dromedary (*Camelus dromedarius*) and hybrids. *Dairy Science & Technology, 88*(6), 607–617. http://doi.org/10.1051/dst.

Faye, B., Konuspayeva, G., Narmuratova, M., Serikbaeva, A., Musaad, A. M., & Mehri, H. (2013). Effect of crude olive cake supplementation on camel milk production and fatty acid composition. *Dairy Science and Technology, 93*(3), 225–239. http://doi.org/10.1007/s13594-013-0117-6.

Felfoul, I., Jardin, J., Gaucheron, F., Attia, H., & Ayadi, M. A. (2017). Proteomic profiling of camel and cow milk proteins under heat treatment. *Food Chemistry, 216*, 161–169.

Felfoul, I., Lopez, C., Gaucheron, F., & Attia, H. (2015). A laboratory investigation of cow and camel whey proteins deposition under different heat treatments. *Food and Bioproducts Processing, 96*, 256–263.

Felfoul, I., Lopez, C., Gaucheron, F., Attia, H., & Ayadi, M. A. (2015). Fouling behavior of camel and cow milks under different heat treatments. *Food and Bioprocess Technology*, 1771–1778. http://doi.org/10.1007/s11947-015-1529-5.

Fguiri, I., Ziadi, M., Atigui, M., Ayeb, N., Arroum, S., Assadi, M., et al. (2015). Isolation and characterisation of lactic acid bacteria strains from raw camel milk for potential use in the production of fermented Tunisian dairy products. *International Journal of Dairy Technology, 68*, 1–11. http://doi.org/10.1111/1471-0307.12226.

Garcell, H. G., Garcia, E. G., Pueyo, P. V., Martín, I. R., Arias, A. V., & Alfonso Serrano, R. N. (2016). Outbreaks of brucellosis related to the consumption of unpasteurized camel milk. *Journal of Infection and Public Health, 9*, 523–527.

Ghamari, F., Ghaffari, S. M., Salami, M., Moosavi-Movahedi, F., Farivar, F., Johari, A., et al. (2013). Synergic study of -glucosidase inhibitory action of aloin and its antioxidant activity with and without camel and its peptides. *Protein and Peptide Letters*. http://doi.org/10.2174/0929866511320050015.

Gorban, A. M. S., & Izzeldin, O. M. (1999). Study on cholesteryl ester fatty acids in camel and cow milk lipid. *International Journal of Food Science and Technology, 34*, 229–234. http://doi.org/10.1046/j.1365-2621.1999.00254.x.

Gorban, A. M. S., & Izzeldin, O. M. (2001). Fatty acids and lipids of camel milk and colostrum. *International Journal of Food Sciences and Nutrition, 52*(3), 283–287. http://doi.org/10.1080/09637480020027000-3-5.

Habib, H. M., Ibrahim, W. H., Schneider-Stock, R., & Hassan, H. M. (2013). Camel milk lactoferrin reduces the proliferation of colorectal cancer cells and exerts antioxidant and DNA damage inhibitory activities. *Food Chemistry, 141*(1), 148–152. http://doi.org/10.1016/j.foodchem.2013.03.039.

Haddad, I., Mozzon, M., Strabbioli, R., & Frega, N. G. (2011). Electrospray ionization tandem mass spectrometry analysis of triacylglycerols molecular species in camel milk (*Camelus dromedarius*). *International Dairy Journal, 21*(2), 119–127. http://doi.org/10.1016/j.idairyj.2010.09.003.

Hailu, Y., Bech, E., Seifu, E., Eshetu, M., & Ipsen, R. (2016). Factors in fl uencing the gelation and rennetability of camel milk using camel chymosin. *Nternational Dairy Journal, 60*, 62–69.

Homayouni-Tabrizi, M., Shabestarin, H., Asoodeh, A., & Soltani, M. (2016). *Identification of two novel antioxidant peptides from camel milk using digestive Proteases: Impact on expression gene of superoxide dismutase (SOD) in hepatocellular carcinoma cell line*. http://doi.org/10.1007/s10989-015-9497-1.

Ibrahem, S. A., & Zubeir, I. E. M. El (2016). Processing, composition and sensory characteristic of yoghurt made from camel milk and camel – sheep milk mixtures. *Small Ruminant Research, 136*(April 2012), 109–112.

Jans, C., Bugnard, J., Njage, P. M. K., Lacroix, C., & Meile, L. (2012). Lactic acid bacteria diversity of African raw and fermented camel milk products reveals a highly competitive, potentially health-threatening predominant microflora. *LWT - Food Science and Technology, 47*(2), 371–379. http://doi.org/10.1016/j.lwt.2012.01.034.

Jans, C., Follador, R., Hochstrasser, M., Lacroix, C., Meile, L., & Stevens, M. J. A. (2013). Comparative genome analysis of *Streptococcus infantarius* subsp. *infantarius* CJ18, an African fermented camel milk isolate with adaptations to dairy environment. *BMC Genomics, 14*(1), 200. http://doi.org/10.1186/1471-2164-14-200.

Jrad, Z., El Hatmi, H., Adt, I., Girardet, J.-M., Cakir-Kiefer, C., Jardin, J., et al. (2014). Effect of digestive enzymes on antimicrobial, radical scavenging and angiotensin I-converting enzyme inhibitory activities of camel colostrum and milk proteins. *Dairy Science & Technology, 94*(3), 205–224. http://doi.org/10.1007/s13594-013-0154-1.

Kadri, Z., Spitaels, F., Cnockaert, M., Praet, J., Farricha, O. E., Swings, J., et al. (2015). *Enterococcus bulliens* sp. nov., a novel lactic acid bacterium isolated from camel milk. *Antonie van Leeuwenhoek, 108*(5), 1257–1265. http://doi.org/10.1007/s10482-015-0579-z.

Kadri, Z., Vandamme, P., Ouadghiri, M., Cnockaert, M., Aerts, M., Farricha, O. E., et al. (2014). *Streptococcus tangierensis* sp. nov. and *Streptococcus cameli* sp. nov., two novel Streptococcus species isolated from raw camel milk in Morocco. *International Journal of Systematic and Evolutionary Microbiology, 64*(PART 7), 2480–2485. http://doi.org/10.1099/ijs.0.062893-0.

Kamal, M., & Karoui, R. (2016). Monitoring of mild heat treatment of camel milk by front-face fluorescence spectroscopy. *LWT - Food Science and Technology*. http://doi.org/. http://dx.doi.org/10.1016/j.lwt.2016.11.013.

Kappeler, S. R., Van Den Brink, H. M., Rahbek-Nielsen, H., Farah, Z., Puhan, Z., Hansen, E. B., et al. (2006). Characterization of recombinant camel chymosin reveals superior properties for the coagulation of bovine and camel milk. *Biochemical and Biophysical Research Communications, 342*(2), 647–654. http://doi.org/10.1016/j.bbrc.2006.02.014.

Kersting, S., Hüttel, S., & Odening, M. (2016). Industry dynamics under production constraints — the case of the EU dairy sector. *Economic Modelling, 55*, 135–151. http://doi.org/10.1016/j.econmod.2016.02.006.

Khalesi, M., Jahanbani, R., Riveros-Galan, D., Sheikh-Hassani, V., Sheikh-Zeinoddin, M., Sahihi, M., et al. (2016). Antioxidant activity and ACE-inhibitory of Class II hydrophobin from wild strain *Trichoderma reesei*. *International Journal of Biological Macromolecules, 91*, 174–179. http://doi.org/10.1016/j.ijbiomac.2016.05.068.

Khay, E. O., Idaomar, M., El Moussaoui, N., & Abrini, J. (2014). Application of a bacteriocin-like inhibitory substance producing *Enterococcus durans* E204 strain, isolated from camel milk, to control *Listeria monocytogenes* CECT 4032 in goat jben. *Annals of Microbiology, 64*(1), 313–319. http://doi.org/10.1007/s13213-013-0666-1.

Konuspayeva, G., Faye, B., Loiseau, G., Narmuratova, M., Ivashchenko, A., Meldebekova, A., et al. (2010). Physiological change in camel milk composition (*Camelus dromedarius*) 1. Effect of lactation stage. *Tropical Animal Health and Production, 42*(3), 495–499. http://doi.org/10.1007/s11250-009-9449-x.

Konuspayeva, G., Faye, B., Pauw, E. D., & Focant, J. F. (2011). Levels and trends of PCDD/Fs and PCBs in camel milk (*Camelus bactrianus* and *Camelus dromedarius*) from Kazakhstan. *Chemosphere, 85*(3), 351–360. http://doi.org/10.1016/j.chemosphere.2011.06.097.

Konuspayeva, G., Lemarie, E., Faye, B., Loiseau, G., & Montet, D. (2008). Fatty acid and cholesterol composition of camel's (*Camelus bactrianus*, *Camelus dromedarius* and hybrids) milk in Kazakhstan. *Dairy Science & Technology, 88*(3), 327–340. http://doi.org/10.1051/dst:2008005.

Korish, A. A., Abdel Gader, A. G. M., & Alhaider, A. A. (2015). Camel milk ameliorates the coagulopathy in streptozotocin diabetic rat model. *International Journal of Dairy Technology, 68*(1), 79–87. http://doi.org/10.1111/1471-0307.12168.

Korish, A. A., Abdel Gader, A. G., Korashy, H. M., Al-Drees, A. M., Alhaider, A. A., & Arafah, M. M. (2015). Camel milk attenuates the biochemical and morphological features of diabetic nephropathy: Inhibition of Smad1 and collagen type IV synthesis. *Chemico-Biological Interactions, 229*, 100–108. http://doi.org/10.1016/j.cbi.2015.01.013.

Kumar, D., Chatli, M. K., Singh, R., Mehta, N., & Kumar, P. (2016). Enzymatic hydrolysis of camel milk casein and its antioxidant properties. *Dairy Sci. & Technol., 96*(7), 391–404. http://doi.org/10.1007/s13594-015-0275-9.

Lacou, L., Leonil, J., & Gagnaire, V. (2016). Food Hydrocolloids Functional properties of peptides: From single peptide solutions to a mixture of peptides in food products. *Food Hydrocolloids, 57*, 187–199.

Langholm Jensen, J., Mølgaard, A., Navarro Poulsen, J. C., Harboe, M. K., Simonsen, J. B., Lorentzen, A. M., et al. (2013). Camel and bovine chymosin: The relationship between their structures and cheese-making properties. *Acta Crystallographica Section D: Biological Crystallography, 69*(5), 901–913. http://doi.org/10.1107/S0907444913003260.

Limon, A., Gallegos-Perez, J. L., Reyes-Ruiz, J. M., Aljohi, M. A., Alshanqeeti, A. S., & Miledi, R. (2014). The endogenous GABA bioactivity of camel, bovine, goat and human milks. *Food Chemistry, 145*, 481–487. http://doi.org/10.1016/j.foodchem.2013.08.058.

Li, N., Zheng, F. P., Chen, H. T., Liu, S. Y., Gu, C., Song, Z. Y., et al. (2011). Identification of volatile components in Chinese Sinkiang fermented camel milk using SAFE, SDE, and HS-SPME-GC/MS. *Food Chemistry, 129*(3), 1242–1252. http://doi.org/10.1016/j.foodchem.2011.03.115.

Lorenzen, P. C., Wernery, R., Johnson, B., Jose, S., & Wernery, U. (2011). Evaluation of indigenous enzyme activities in raw and pasteurised camel milk. *Small Ruminant Research, 97*(1–3), 79–82. http://doi.org/10.1016/j.smallrumres.2011.01.014.

Lü, X., Hu, P., Dang, Y., & Liu, B. (2014). Purification and partial characterization of a novel bacteriocin produced by Lactobacillus casei TN-2 isolated from fermented camel milk (Shubat) of Xinjiang Uygur Autonomous region, China. *Food Control, 43*, 276–283. http://doi.org/10.1016/j.foodcont.2014.03.020.

Maaroufi, S. H., Rezaei, K., Raftaniamiri, Z., & Mirzaei, F. (2015). Evaluating the effects of herbal essences from spearmint and wild thyme on the quality of camel's milk. *International Journal of Food Science and Technology, 50*(10), 2168–2174. http://doi.org/10.1111/ijfs.12855.

Mahmoudi, I., Ben, O., El, T., Khaldi, M., Kebouchi, M., Soligot, C., et al. (2016). Functional in vitro screening of Lactobacillus strains isolated from Tunisian camel raw milk toward their selection as probiotic. *Small Ruminant Research, 137*, 91–98.

Malik, A., Al-Senaidy, A., Skrzypczak-Jankun, E., & Jankun, J. (2012). A study of the anti-diabetic agents of camel milk. *International Journal of Molecular Medicine,*

30(3), 585–592. http://doi.org/10.3892/ijmm.2012.1051.
Meena, S., Rajput, Y. S., & Sharma, R. (2014). Comparative fat digestibility of goat, camel, cow and buffalo milk. *International Dairy Journal, 35*(2), 153–156. http://doi.org/10.1016/j.idairyj.2013.11.009.
Mohamed, H. E., Mousa, H. M., & Beynen, A. C. (2005). Ascorbic acid concentrations in milk from Sudanese camels. *Journal of Animal Physiology and Animal Nutrition, 89*(1–2), 35–37. http://doi.org/10.1111/j.1439-0396.2004.00507.x.
Moslehishad, M., Ehsani, M. R., Salami, M., Mirdamadi, S., Ezzatpanah, H., Naslaji, A. N., et al. (2013). The comparative assessment of ACE-inhibitory and antioxidant activities of peptide fractions obtained from fermented camel and bovine milk by *Lactobacillus rhamnosus* PTCC 1637. *International Dairy Journal, 29*(2), 82–87. http://doi.org/10.1016/j.idairyj.2012.10.015.
Moslehishad, M., Mirdamadi, S., Ehsani, M. R., Ezzatpanah, H., & Moosavi-Movahedi, A. A. (2013). The proteolytic activity of selected lactic acid bacteria in fermenting cow's and camel's milk and the resultant sensory characteristics of the products. *International Journal of Dairy Technology, 66*(2), 279–285. http://doi.org/10.1111/1471-0307.12017.
Mwangi, L. W., Matofari, J. W., Muliro, P. S., & Bebe, B. O. (2016). Hygienic assessment of spontaneously fermented raw camel milk (suusa) along the informal value chain in Kenya. *International Journal of Food Contamination, 3*(18). http://doi.org/10.1186/s40550-016-0040-8.
Nagy, P., Faye, B., Marko, O., Thomas, S., Wernery, U., & Juhasz, J. (2013). Microbiological quality and somatic cell count in bulk milk of dromedary camels (*Camelus dromedarius*): Descriptive statistics, correlations, and factors of variation. *Journal of Dairy Science, 96*(9), 5625–5640. http://doi.org/10.3168/jds.2013-6990.
Nagy, P., & Juhasz, J. (2016). Review of present knowledge on machine milking and intensive milk production in dromedary camels and future challenges. *Tropical Animal Health and Production, 48*, 915–926. http://doi.org/10.1007/s11250-016-1036-3.
Nagy, P., Skidmore, J., & Juhasz, J. (2013). Use of assisted reproduction for the improvement of milk production in dairy camels (*Camelus dromedarius*). *Animal Reproduction Science, 136*(3), 205–210.
Nanda, D. K., Tomar, S. K., Singh, R., Mal, G., Singh, P., Arora, D. K., et al. (2011). Phenotypic and genotypic characterisation of *Lactobacilli* isolated from camel cheese produced in India. *International Journal of Dairy Technology, 64*(3), 437–443. http://doi.org/10.1111/j.1471-0307.2011.00695.x.
Omar, A., Harbourne, N., & Oruna-concha, M. J. (2016). Quantification of major camel milk proteins by capillary electrophoresis. *International Dairy Journal, 58*, 31–35. http://doi.org/10.1016/j.idairyj.2016.01.015.
Osman, K. M., Samir, A., Orabi, A., & Zolnikov, T. R. (2014). Confirmed low prevalence of *Listeria mastitis* in she-camel milk delivers a safe, alternative milk for human consumption. *Acta Tropica, 130*(1), 1–6. http://doi.org/10.1016/j.actatropica.2013.10.001.
Park, Y. W. (2009). *Bioactive components in camel milk*. Retrieved from http://books.google.com/books?hl=en%26lr=%26id=VFpG2doYN7IC%26oi=fnd%26pg=PR5%26dq=Bioactive+Components+in+Milk+and+Dairy+Products%26ots=YSTfjeXxRw%26sig=UNF8eU19JIzsfXFhZR2LJ2X_ls8.
Raei, M., Rajabzadeh, G., Zibaei, S., Jafari, S. M., & Sani, A. M. (2015). Nano-encapsulation of isolated lactoferrin from camel milk by calcium alginate and evaluation of its release. *International Journal of Biological Macromolecules, 79*, 669–673. http://doi.org/10.1016/j.ijbiomac.2015.05.048.
Rahimi, M., Ghaffari, S. M., Salami, M., Mousavy, S. J., Niasari-Naslaji, A., Jahanban, R., et al. (2016). ACE- inhibitory and radical scavenging activities of bioactive peptides obtained from camel milk casein hydrolysis with proteinase K. *Dairy Sci. & Technol.*, 489–499. http://doi.org/10.1007/s13594-016-0283-4.
Rahman, M. S., Al-hakmani, H., Al-alawi, A., & Al-marhubi, I. (2012). Thermochimica Acta Thermal characteristics of freeze-dried camel milk and its major components. *Thermochimica Acta, 549*, 116–123. http://doi.org/10.1016/j.tca.2012.09.005.
Rahman, N., Xiaohong, C., Meiqin, F., & Mingsheng, D. (2009). Characterization of the dominant microflora in naturally fermented camel milk Shubat. *World Journal of Microbiology and Biotechnology, 25*(11), 1941–1946. http://doi.org/10.1007/s11274-009-0092-5.
Rutella, G. S., Tagliazucchi, D., & Solieri, L. (2016). Survival and bioactivities of selected probiotic lactobacilli in yogurt fermentation and cold storage: New insights for developing a bio-functional dairy food. *Food Microbiology, 60*, 54–61.
Salami, M., Moosavi-Movahedi, A. A., Ehsani, M. R., Yousefi, R., Haertlé, T., Chobert, J.-M., et al. (2010). Improvement of the antimicrobial and antioxidant activities of camel and bovine whey proteins by limited proteolysis. *Journal of Agricultural and Food Chemistry, 58*(6), 3297–3302. http://doi.org/10.1021/jf9033283.
Salami, M., Yousefi, R., Ehsani, M. R., Dalgalarrondo, M., Chobert, J. M., & Haertl, T. (2008). Kinetic characterization of hydrolysis of camel and bovine milk proteins by pancreatic enzymes. *International Dairy Journal, 18*(12), 1097–1102. http://doi.org/10.1016/j.idairyj.2008.06.003.
Salami, M., Yousefi, R., Ehsani, M. R., Razavi, S. H., Chobert, J. M., Haertl, T., et al. (2009). Enzymatic digestion and antioxidant activity of the native and molten globule states of camelβ-lactalbumin: Possible significance for use in infant formula. *International Dairy Journal, 19*(9), 518–523. http://doi.org/10.1016/j.idairyj.2009.02.007.
Salmen, S. H., Abu-Tarboush, H. M., Al-Saleh, A. A., & Metwalli, A. A. (2012). Amino acids content and electrophoretic profile of camel milk casein from different camel breeds in Saudi Arabia. *Saudi Journal of Biological Sciences, 19*(2), 177–183. http://doi.org/10.1016/j.sjbs.2011.12.002.
Salwa, M. Q., & Lina, A. F. K. (2010). Antigenotoxic and anticytotoxic effect of camel milk in mice treated with cisplatin. *Saudi Journal of Biological Sciences, 17*(2), 159–166. http://doi.org/10.1016/j.sjbs.2010.02.010.
Sboui, A., Khorchani, T., Djegham, M., Agrebi, A., Elhatmi, H., & Belhadj, O. (2010). Anti-diabetic effect of camel milk in alloxan-induced diabetic dogs: A dose-response experiment. *Journal of Animal Physiology and Animal Nutrition, 94*(4), 540–546. http://doi.org/10.1111/j.1439-0396.2009.00941.x.
Shori, A. B. (2012). Comparative study of chemical composition, isolation and identification of micro-flora in traditional fermented camel milk products: Gariss, Suusac, and Shubat. *Journal of the Saudi Society of Agricultural Sciences, 11*(2), 79–88. http://doi.org/10.1016/j.jssas.2011.12.001.
Shori, A. B. (2015). Camel milk as a potential therapy for controlling diabetes and its complications: A review of in vivo studies. *Journal of Food and Drug Analysis, 23*(4), 609–618. http://doi.org/10.1016/j.jfda.2015.02.007.
Shuangquan, Tsuda, H., & Miyamoto, T. (2008). Angiotensin I-converting enzyme inhibitory peptides in skim milk fermented with *Lactobacillus helveticus* 130B4 from camel milk in Inner Mongolia, China. *Journal of the Science of Food and Agriculture, 88*(2), 2688–2692, 88 http://doi.org/10.1002/jsfa.
Shuiep, E. T. S., Giambra, I. J., El Zubeir, I. E. Y. M., & Erhardt, G. (2013). Biochemical and molecular characterization of polymorphisms of??s1-casein in Sudanese camel (*Camelus dromedarius*) milk. *International Dairy Journal, 28*(2), 88–93. http://doi.org/10.1016/j.idairyj.2012.09.002.
Shuiep, E. S., Kanbar, T., Eissa, N., Alber, J., Lämmler, C., Zschöck, M., et al. (2009). Phenotypic and genotypic characterization of Staphylococcus aureus isolated from raw camel milk samples. *Research in Veterinary Science, 86*(2), 211–215. http://doi.org/10.1016/j.rvsc.2008.07.011.
Soleymanzadeh, N., Mirdamadi, S., & Kianirad, M. (2016). Antioxidant activity of camel and bovine milk fermented by *lactic acid bacteria* isolated from traditional fermented camel milk (Chal). *Dairy Science & Technology, 96*, 443–457. http://doi.org/10.1007/s13594-016-0278-1.
Tayefi-Nasrabadi, H., Hoseinpour-fayzi, M. A., & Mohasseli, M. (2011). Effect of heat treatment on lactoperoxidase activity in camel milk: A comparison with bovine lactoperoxidase. *Small Ruminant Research, 99*(2–3), 187–190. http://doi.org/10.1016/j.smallrumres.2011.04.007.
Vieira da Silva, B., Barreira, J. C. M., & Oliveira, M. B. P. P. (2016). Natural phytochemicals and probiotics as bioactive ingredients for functional foods: Extraction, biochemistry and protected-delivery technologies. *Trends in Food Science & Technology, 50*, 144–158.
Yaqoob, M., & Nawaz, H. (2007). Potential of Pakistani camel for dairy and other uses. *Animal Science Journal, 78*(5), 467–475. http://doi.org/10.1111/j.1740-0929.2007.00464.x.
Zhang, L., Boeren, S., Smits, M., Hooijdonk, T. V., Vervoort, J., & Hettinga, K. (2016). Proteomic study on the stability of proteins in bovine, camel, and caprine milk sera after processing. *Food Research International, 82*, 104–111.
Zhao, D., Bai, Y., & Niu, Y. (2015). Composition and characteristics of Chinese Bactrian camel milk. *Small Ruminant Research, 127*(4), 58–67. http://doi.org/10.1016/j.smallrumres.2015.04.008.
Ziane, M., Couvert, O., Le, P., Moussa-boudjemaa, B., & Leguerinel, I. (2016). Identification and characterization of aerobic spore forming bacteria isolated from commercial camel's milk in south of Algeria. *Small Ruminant Research, 137*, 59–64.