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COMPARATIVE STUDY OF THE PHYSICOCHEMICAL CHARACTERISTICS OF MILK COLLECTED FROM CAMELS (*CAMELUS DROMEDARIUS*) CONDUCTED IN TWO BREEDING SYSTEMS (EXTENSIVE AND SEMI-INTENSIVE)

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Abstract

The camel milk sector is still little explored and especially the effect of the camel breeding system on certain properties and chemical compositions of camel milk. This study aims to assess the potential impact of the transition in the camel breeding system on milk productivity and the physicochemical composition of camel milk. To achieve this objective, a preliminary survey was conducted involving several breeders actively practicing the two targeted breeding systems (extensive and semi-intensive) in Algeria. This survey revealed milk production levels of 2 L/d and 3.5 L/d for the extensive and semi-intensive systems, respectively. Physicochemical analyses of these two types of camel milk (from extensive and semi-intensive breeding) were carried out. Various parameters were measured, including pH, acidity, density, total solids, solids-not-fat, ash levels, lactose, calcium, vitamin C, total proteins, whey proteins, and caseins. The results of these analyses indicate that the transition from extensive breeding system to the semi-intensive system significantly impacts the physicochemical quality of camel milk. Specifically, camel milk from the semi-intensive breeding system becomes less dense, more acidic and less rich in total dry matter particularly in solids-not-fat, which includes lactose, vitamin C, and minerals and notably calcium. Furthermore, this milk has become richer in proteins both total proteins and whey proteins, and more notably in caseins.

Key words: milk, *Camelus dromedarius,* breeding system, physicochemical quality, extensive, semi-intensive

INTRODUCTION

Generally, 16.9 % of milk consumed by humans comes from species other than cows. These species include sheep, horses, yaks, goats, camels, and buffalo (Ali et al., 2019). According to the FAO in 2019 the worldwide camel population number was estimated to be around 35 million (Al Abri and Faye, 2019; Faye, 2020; Kibebew et al., 2021) and they contribute to almost 0.4% of the world's non-cattle milk production (Ali et al., 2019).

Dromedary camels are known to produce more milk for a longer duration than any other milk-producing animal when subjected to similar

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challenging conditions (Gebremichael et al., 2019). The milk they produce has a physicochemical composition that is relatively similar to that of bovine milk. However, camel's milk stands out due to its numerous medicinal and therapeutic properties, which include anti-cancer, anti-hypertensive, antibacterial, and hypoglycemic effects (Abdel Gader and Alhaider, 2016; Kula, 2016). These beneficial properties are attributed to the high content of vitamin C and niacin in camel's milk, as well as the presence of a powerful protective system, including relatively high levels of lysozyme, lactoperoxidase, peptidoglycan recognition proteins, lactoferrin, and more (Siboukeur, 2007). These distinctive characteristics are often linked to the nature of the forage plants consumed by dromedary camels, particularly in Saharan rangelands.

In Algeria, the camel population was estimated at 379,094 heads according to FAO statistics in 2016 (Bensemaoune et al., 2018), with a milk production of 8,000 tons as reported by FAO in 2002 (Faye, 2004). For a long time, camel milk was not really valorised, but it served as a primary food source for nomadic populations in desert regions, who consumed it in its raw form or used it traditionally for treating certain diseases. However, in recent years, there has been a significant transformation in the camel dairy production systems. This transformation is characterized by a greater emphasis on milk production, with a focus on various health and nutritional aspects.

Additionally, some breeders have organized and structured the camel dairy sector around urban centers. This evolution has led to changes, particularly from a nutritional perspective. Consequently, a new breeding system, known as semi-intensive breeding, has emerged in the country. This system involves semi-stabling the camels and introducing a new diet for them.

The objective of this study is to assess the impact of transitioning from a natural (extensive) camel breeding system to a semi-intensive breeding system on specific physicochemical and biochemical parameters of the camel milk produced.

MATERIAL AND METHOD

Samples of milk

Two distinct sets of milk samples were gathered for this study:

The first group of samples was collected from 13 she-camels reared under extensive conditions. These camels were located in the Douar El Ma region, situated at coordinates 33°35'22.6'' N, 7°31'24.8'' E, within the wilaya (province) of El Oued in the southeast of Algeria (Fig. 1). The second group of samples was collected from 13 she-camels reared under semi-intensive conditions. These camels were located in the Ouazitten region, situated at coordinates 33°20'43.6" N, 6°49'34.7" E, within the wilaya of El Oued in the southeast of Algeria (Fig. 2).

Fig. 1. Extensive breeding system in Douar El Ma. The camel walks and grazes plants in Sahara rangeland

Fig. 2. Semi-intensive breeding system in Ouazitten region. The dromedary is stabled for half a day and walks in the rangeland, with a pastor from the afternoon to sunset

All of the dromedaries from which the samples were collected were in their second parturition and in the same stage of lactation (the mid-lactation).

The milk samples were obtained by hand milking. A 500 ml sample was taken from each camel. Once the samples were obtained, they were cooled and brought to the laboratory aseptically. All information about samples is given in Table 1.

Table 1

Samples of collected camel milk

Samples	Camel population name's	Breeding system	Nutrition
13	Sahraoui	Extensive	- Natural plants of the Saharan rangelands only. - Water is available once a day (in the morning).
13	Sahraoui	Semi-intensive	- Natural plants of the Saharan rangelands. - Maize, soybeans, barley with a ratio of 10 % - 12 % / 10 % -12 % / 76 % - 80 %, respectively (all as bran) - Poor quality dates - Water is available all the time.

Investigation

An estimation of the potential dairy population of Sahraoui dromedary camels has been conducted, considering two distinct breeding systems: "extensive" and "semi-intensive." This investigation was conducted in close proximity to breeders who actively practice both of these breeding systems. Several breeders were surveyed as part of this study, and it's important to note that all participants were well-informed about the significance of this research and understood the importance of providing accurate information.

Physicochemical analysis

pH

The pH measurement should be taken as soon as possible after taking the milk samples. The pH measurement was carried out at a milk temperature of 20 °C with a Jenway 3510 pH meter.

Dornic acidity

To 10 mL of sample was added 3 to 5 drops of phenolphthalein solution (prepared at 1% in 96% ethanol). The mixture was titrated with standardized 0.111 N NaOH until the first color change (to pink) persisted for 30 s. The Dornic degree number corresponds to the tenth of a mL of NaOH (0.111 N) poured in (Konuspayeva, 2007).

Density

The density determination was carried out using a lactodensimeter (Siboukeur, 2007) model "Quevenne" (aerometer specially adapted for milk). The analysis involved immersing the instrument into a cylindrical tube filled with milk at a temperature of 20 °C.

The density of the milk was then directly read from the scale of the lactodensimeter. This method provides a rapid measurement of milk density.

Total solids content

The determination of the total solids content in the milk samples was carried out using the standard method (ISO 6731 / IDF 21 2010). A test portion is predried on a boiling water bath and the remaining water subsequently evaporated in a drying oven at a temperature of 102 °C ± 2 °C for about 3 hours (Until constant mass).

Solid not fat

A portion of the milk was first skimmed using centrifugation at 3500 x g for 20 minutes at a temperature of 4 °C (Siboukeur, 2007). After skimming, the milk was further processed according to the standard method (ISO 6731 / IDF 21 2010). The mass of solid obtained represents the solids content of the milk sample, excluding the fat content. The result is typically expressed in grams per liter (g/L).

Ash

The ash determination was carried out by complete incineration of a milk test portion of at a temperature of ≤ 550 °C until C-free. The method used was the standard method (AOAC 930.30).

Lactose content

We used the oxidation and reduction method by Fehling's solution to determine the amount of lactose in each sample (Fox and McSweeney, 1998). The milk was defecated by zinc hexacyanoferrate (II); a cupro-alkaline solution was reduced in hot with the filtrate obtained; The precipitate of cuprous oxide formed was underneath by a solution of ferric sulphate and the ferrous sulphate formed was determined by manganimetry in the presence of ferrous orthophenantroline as an indicator (Konuspayeva, 2007).

Vitamin C

Vitamin C content in milk samples was determined by the 2,6-dichlorphenolindophenol method (Konuspayeva, 2007; Chang et al., 2016). The principle followed was as indicated by the standard method (AOAC 985.33 1988) with a very slight modification as described by (Konuspayeva, 2007).

The principle Ascorbic acid is estimated by titration with colored oxidation-reduction indicator, 2,6, dichloroindophenol. EDTA is added as chelating agent to remove Fe and Cu interferences.

Total proteins content

The protein content was determined using the Lowry method (Lowry et al., 1951). This method is based on the Biuret reaction, in which the peptide bonds of proteins react with copper under alkaline conditions, producing Cu^+. Cu^+ then reacts with the Folin reagent, leading to the reduction of phosphomolybdotungstate to heteropoly molybdenum blue, which is facilitated by the copper-catalyzed oxidation of aromatic amino acids. These reactions result in a strong blue color, which is partly dependent on the tyrosine and tryptophan content of the sample. The Lowry method is sensitive and can detect protein concentrations as low as 0.01 mg of protein/ml. It is most effective when used on solutions with protein concentrations ranging from 0.01 to 1 mg/mL (Waterborg and Matthews, 1994).

Caseins and whey proteins content

The milk was skimmed, as described in the (solid not fat) section above. the caseins from the whey proteins, the pH of camel skimmed milk was reduced to 4.3 using a 4N hydrochloric acid solution (Wangoh et al., 1998).

Once the milk reached its isoelectric point at pH 4.3, the caseins were completely precipitated through centrifugation at 3500 x g for 15 minutes (Siboukeur, 2007).

The determination of whey protein content was conducted using the Lowry method (Lowry et al., 1951). For the caseins, their quantity was calculated by subtracting the quantity of whey proteins from the quantity of total proteins.

Statistical analysis

The values from these experiments were determined in triplicate, and the resulting data were presented as the mean ± standard deviation. To assess differences between different means, an independent-samples t-test was performed using SPSS statistical software package version 27.0.1 (2020). A significance level of 0.05 ($p < 0.05$) was employed to determine statistical significance.

RESULTS AND DISCUSSION

Estimated dairy potential

The survey, which included breeders practicing both semi-intensive and extensive farming, was conducted to assess the milk production potential. According to the breeders' responses, it was evident that milk production in semi-intensive breeding exceeded that of extensive breeding. Specifically, in semi-intensive breeding, the average milk production was found to be 3.5 ± 1.4 L/d, whereas in extensive breeding, it averaged 2 ± 0.7 L/d.

Comparable milk production levels were reported for Sahraoui camels raised under semi-intensive conditions in the Souf region of Algeria, specifically averaging (2.48 L/d) according to Adamou and Boudjenah (2012). However, for the same population and geographic area, a broader range of milk production, spanning from (1 to 5 liters per camel per day), was reported under extensive breeding system, as documented by Titaouine et al. (2011).

The literature supports the notion that semi-intensive breeding systems tend to be more productive compared to extensive systems, as indicated by various authors and studies. For instance, Faye et al. (2011), reported similar findings with Sudanese camels, where they observed significantly higher milk production of (2633 L per lactation) in the semi-intensive system compared to (1204 L) in the traditional extensive system. This difference in production is likely attributed to factors such as veterinary care and food supplementation, including concentrates, vitamins, and minerals.

Similarly, Bakheit et al. (2008) reported consistent results, showing a milk production of (6.9 L/d) in the semi-intensive system compared to (3.1 L/d) in the extensive system. Additional studies by Khanna et al. (2004) and Ould Soule (2003) also reported milk production levels ranging from (5 L/d) to (3-14 L/d) in semi-intensive breeding system.

In Pakistan (4-8 kg) and (5-9) kg of milk are produced by hand and day respectively for Marecha and Barela camels under extensive pastoral conditions (Faraz et al., 2021).

Considering the collective evidence from the literature and the obtained results, it appears that the semi-intensive breeding system tends to be more productive than the extensive system in terms of camel milk production.

Physicochemical and biochemical quality

All results can be visualized in Table 2.

Table 2

Comparison of physicochemical and biochemical parameters between camel milk samples from the extensive breeding system and those from the semi-intensive breeding system

Camel milk Samples	**Extensive**	**Semi-intensive**	***p* value**
Physicochemical and biochemical parameters			
Density	1.031 ± 0.001	1.029 ± 0.0005	0.0061**
pH	6.39 ± 0.006	6.46 ± 0.006	0.0001**
Dornic acidity (D°)	18 ± 0.5	20.17 ± 1.26	0.0502^ns
Total Solids (g/L)	169.67 ± 6.03	106.50 ± 0.50	0.0029**
Solids-not-fat (g/L)	88.33 ± 0.58	76.67 ± 0.58	<0.0001**
Ash (g/L)	8.05 ± 0.07	6.98 ± 0.40	0.0029**
Lactose (g/L)	49.2 ± 106	41.28 ± 0.26	0.0002**
Calcium (g/L)	1.56 ± 0.03	1.24 ± 0.16	0.0077**
Vitamin C (mg/L)	44 ± 1.41	24.1 ± 0.28	<0.0001**
Total proteins (g/L)	34.28 ± 0.68	43.1 ± 1.07	<0.0001**
Casein (g/L)	24.16 ± 1.64	32.12 ± 1.58	<0.0001**
Whey proteins (g/L)	10.12 ± 1.58	10.98 ± 2.52	0.0141*

*: (Significant difference) P ≤ 0,05; **: (highly significant difference) P ≤ 0.01; ns: (non-significant difference) (P > 0,05).

pH

The first pH value (6.39) closely resembled the pH reported by Sboui et al. (2009), in Tunisia for extensive breeding, which was (6.41). However, it appeared to be lower than the pH values reported by other authors for the same breeding system For instance, Khaskheli et al. (2005) in Pakistan reported a pH of (6.77); Faye et al. (2008) in Kazakhstan reported values of (6.46) and (6.57), and Omer and Eltinay (2009) reported a pH of (6.57). On the other hand, in the semi-intensive breeding system, the average pH value of (6.46) observed in this study closely matched the pH of (6.51) reported by Bornaz et al. (2009).

It's worth noting that Gorban and Izzeldin (1999) suggested that pH and the taste of milk could be influenced by factors such as the nature of forage and water availability. Furthermore, the high concentration of volatile fatty acids (Yagil, 1982) and the relatively high vitamin C content of camel milk lower the pH (Farah et al., 1992; Haddadin et al., 2008; Yagil, 1982).

Vignola in 2002 reported that the pH of the milk is mainly dependent on the presence of casein and phosphoric and citric anions.

Dornic acidity

The values of the Dornic acidity obtained in this study were within the range of work reported by some authors (18.2 °D) (Siboukeur, 2007), (18 °D) by (Khaskheli et al., 2005) in India. Other authors reported higher or lower values. Konuspayeva (2007) and Faye et al. (2008) in Kazakhstan reported higher values (26 °D and 24.04 °D, respectively). In contrast, some studies reported lower Dornic acidity values.

Sboui et al. (2009) found a value of (17.2 °D), Meiloud et al. (2011) in Mauritania reported (16 °D), and in Saudi Arabia, Elamin and Wilcox (1992) reported (15 °D), while Abu-Lehia (1987) in Saudi Arabia and Kamoun (1994) in Tunisia reported values of (15 °D) and (15.6 °D), respectively.

It is important to clarify that camel milk is characterized by a greater buffering effect compared to bovine milk (Kamoun and Ramet, 1989), which means that its pH tends to remain relatively stable despite variations in Dornic acidity.

However, it's significant to point out that the difference between the two Dornic acidity values observed in your study was statistically significant, suggesting variations in milk acidity.

Density

The measured densities for both extensive and semi-intensive breeding, as shown in Table 2, exhibited a significant difference ($P<0.05$).

These values are well within the range of values reported by the FAO (1995) based on a compilation of various sources (1.0250-1.0380).

Additionally, the values closely resembled those reported by Iqbal et al. (2001) and Alloui-lombarkia et al. (2007) in Algeria, which fell within the range of (1.029-1.030). However, they differed from the values reported by Sboui et al. (2009), who found a density of (1.020), and Siboukeur (2007), who reported a density of (1.023). It's important to note that the density of milk can vary based on the concentration of dissolved and suspended elements, including solids-not-fat, as mentioned by Mosbah et al. (2019). These variations in density may reflect differences in the composition and quality of the milk, which can be influenced by factors such as diet and management practices in different breeding systems.

Total Solids

The total solids content of the two analyzed camel milk samples showed a highly significant difference ($P < 0.001$), as indicated in Table 2. These results diverged from the findings reported by Haddadin et al. (2008) in Jordan, who observed a total solids content of (123 g/L) for an extensive breeding system, and Bornaz et al. (2009) in Tunisia, who reported values of (117.50 g/L) and (116.10 g/L) for a semi-intensive breeding system.

It's important to recognize that the variation in total solids content can be attributed to a variety of factors. For instance, Khaskheli et al. (2005) noted that factors such as water quality and quantity available to the animals can influence the total solids content of milk. In the summer, milk may have a higher water content, resulting in a lower total solids content, especially when animals experience water stress. Furthermore, Yagil and Etzion (1980) demonstrated that the passage of a regime hydrated to a diet low in water minimizes significantly the total solids' content of (14.3 % to 8.8 %). This is a natural adaptation that ensures the survival of camel calves and provides a product with sufficient nutritional value, along with a substantial water content, during times of drought.

Ash content

The ash content of the analyzed samples exhibited a significant difference ($P < 0.05$), as shown in Table 2. These values were similar to those reported by Sboui et al. (2009) in Tunisia with (7.5 g/L), and by Siboukeur (2007), with a value of (7.28 g/L). However, they were lower than the results obtained by Haddadin et al. (2008) in Jordan, with an ash content of (8.2 g/L), and the findings of Karue (1994) (8.6 g/l), Diallo (1989) in Mauritania, with values of (8.83 g/L). Kasiriyan (2016) also reported a higher value of 0.87%.

It's worth noting that the ash content, which represents the mineral content of camel milk, can be influenced by factors such as water deprivation (Yagil, 1985). It also varies depending on the stage of lactation (Siboukeur, 2007).

Calcium content

The results presented in Table 2 demonstrated a significant difference, which aligns with those reported by Haddadin et al. (2008), with (1.37 g/L) Similarly, Shamsia (2009) reported calcium concentration of (1.09 g/L) in a semi-intensive breeding system.

It's important to note that calcium concentrations in milk can be affected by various factors. For instance, Yagil (1982) observed that calcium concentrations tend to decrease in milk from dehydrated dromedaries. Additionally, Dell'orto et al. (2000) found that a diet rich in trace elements could significantly increase the calcium content in milk. Moreover, Neville (2005) suggested that changes in calcium levels are influenced by the rates of citrate and casein in milk, highlighting the intricate regulation of calcium in milk composition.

Lactose content

The study revealed a highly significant difference in the lactose content between the two samples ($P < 0.01$), as displayed in Table 2.

Interestingly, it was observed that the milk from camels in semi-intensive breeding exhibited a lower lactose content, while the milk from camels fed on natural rangeland plants showed a higher lactose content. This finding is consistent with Karue's 1994 study in Saudi Arabia, which reported a lactose content of (36.5 g/L) in an intensive breeding system, compared to (44.4 g/L) reported by Mehaia et al. (1995) for an extensive system.

The variations in lactose levels could be attributed to factors such as camel breed. Kadim and Mahgoub (2004) noted that the Al-Dowasir race, elevated in Saudi Arabia under an intensive system, produced milk with higher lactose content, and it was the top milk-yielding race in the Gulf region.

Furthermore, the diet of camels plays a significant role in lactose variation. Camels often graze on halophyte plants like Atriplex and Acacia, as noted by Yagil (1982), which can impact the composition of their milk.

Squires (2010) suggested that changes in milk lactose content are typically challenging to manipulate through dietary interventions, emphasizing that lactose serves as the osmotic component of milk. Any significant changes in lactose synthesis can affect the volume of water in the milk and, consequently, the overall milk yield. Yagil and Etzion (1980) reported a (37%) decrease in lactose content in cases of camel dehydration.

Finally, the lactose varies depending on the stage of lactation (Bakheit, 1999). The study reported that the lactose content of Sudanese camels' milk is equal to (4.7 %) during the three months after calving and (3.2 %) in late lactation.

Vitamin C content

The study revealed that the vitamin C content in camel milk collected from the extensive system was significantly higher than that obtained from camel milk in the semi-intensive system ($p < 0.01$).

Camel milk is known for its richness in vitamin C. Its content of this vitamin is three times to five times higher than in bovine milk (Farah et al., 1992; Siboukeur, 2007; Stahl et al., 2006). The results we obtained in this study show that richness.

These results agreed with those reported by Siboukeur (2007) (43,87 mg/L) and Shamsia (2009), with (41.40 mg/L) and (46 mg/L) but they were lower than the number indicated by Khan and Iqbal (2001), with (58.2 mg/L). On the other hand, the rate reported by Mehaia (1994), which was (24.9 mg/L) for intensive breeding with Majaheem race in Saudi Arabia confirmed the results that we have saved with the semi-intensive system (24.1 mg/L).

The feeding of the camel seems to play a significant role, rations containing alfalfa for example are favourable to the concentration of ascorbic acid (Konuspayeva, 2007). Vitamin C concentrations also vary according to the animal race, lactation stage where they increase after 180 days in milk (Mohamed, 2002).

Total protein content

An average minimum characterizes the sample of milk from extensive breeding system which was (34.28 g/L), whereas; the maximum level was recorded for the semi-intensive's sample with (43.1 g/L). The recorded difference was highly significant ($P < 0.01$).

These results confirmed those obtained by: Sboui et al. (2009), (34.15 g/L); Kamoun (1994), (34.3g/L); Attia et al. (2000), (30.72 g/L); (30.8 and 33.1 g/L) by Wangoh (1997); (33 g/L), Kamal et al. (2007); (34.6 g/L), Shamsia (2009) and (35.6 g/L), Siboukeur (2007), on milk from camels in extensive breeding system.

In addition, numbers reported by Mehaia (1995) on the race Majaheim (41 g/L - 49 g/L) in Saudi Arabia conducted in intensive breeding confirmed our results for semi-intensive breeding. Numerous authors showed that a diet based on grass leads to lower rates of protein and milk fat. Delaby and Peyraud (1994) showed that a wheat-based diet induced a moderate increase in protein content of cow's milk compared to a diet based on conserved or grazed grass.

It specifies that the fat content has improved during intake of concentrates in larger quantities. It showed that feeding by corn silage, beet increased protein levels, while breeding by poor grass or silage leads to a lowering of protein levels. Finally, races and seasonal conditions in particular also would influence the protein content of camel milk (Al Haj and Al Kanhal, 2010).

Casein content

The levels of casein content were more important concerning the milk coming from camels in semi-intensive breeding. The recorded difference was highly significant ($P < 0.01$).

Levels comparable to those recorded for the milk sample coming from extensive system, were reported by Khaskheli et al. (2005), (22.1 g/L); Attia et al. (2000), (20.60 g/L) and by Alloui-lombarkia et al. (2007), (21.3 g/L). However, some authors have reported lower levels (19.7 g/L) by Kamoun (1995); (19.8 g/L) by Haddadin et al. (2008), and (19.8 g/L) by Alloui-Lombarkia et al. (2007).

It is recognized that in comparison with bovine milk, camel milk is poor in casein, proteins responsible for the consistency of clotted milk and mineral balance, which amplifies its ability to clot (Kamoun, 1995). In this context, camel milk in a semi-intensive system begins to resemble bovine milk with regard to its casein level.

Whey protein content

Whey protein contents of the samples analysed appeared close to each other for the two samples (Table 2). However, a significant difference was recorded between the two types of samples. These rates seemed higher than those reported by: Kihal et al. (1999), (8.59 g/L) and Farah (1993), (7 g/L).

In addition, some authors showed values close: (9 g/L) according to Abu-lehia (1987); (10 g/L) according to Bayoumi (1990) and (11.2 g/L) for Majaheem race by Abu-Lehia (1994).

This high rate of serum proteins in camel milk is of great interest because it is in this fraction we find particularly powerful antibacterial factors (lysozyme, lactoferrin and immunoglobulins) (Elagamy, 2000).

CONCLUSIONS

The transition from traditional camel breeding system in semi-intensive system by some breeders aimed to increase milk production, what has been achieved, since the quantities of milk collected have increased (3.5 ± 1.41 L/d in semi-intensive against 2 ± 0.71 L/d in extensive, respectively).

In parallel, the physicochemical and biochemical quality of camel milk used in this study seems to be affected by the non-traditional breeding system (Semi-intensive system). So: Milk from this type of breeding becomes more acidic, its density become less important, its total solids content is reduced and also the rate of minerals (calcium in particular). The lactose concentration also becomes less important, as well as the level of vitamin C.

In the other hand, camel milk from the semi-intensive breeding system has a higher protein content, in particular for casein concentration. This suggests that, the transition from an extensive breeding system to a semi-intensive one may improve the coagulation ability for this type of milk and thus increase its cheese yield, which can provide a solution for this problem, because it is known that the cheese processing of camel milk is very difficult as well as its cheese yield is very low.

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REFERENCES

1. Abdel Gader A.G.M., Alhaider A.A., 2016, The unique medicinal properties of camel products: A review of the scientific evidence. J. Taibah Univ. Med. Sci., 11, pp. 98-103;
2. Abu-Lehia I.H., 1987, Composition of camel milk. Milchwissenschaft, 42, pp. 368-371;
3. Abu-Lehia I.H., 1994, Recombined camel's powder. Actes du Colloque: Dromadaires et chameaux animaux laitiers, 24-26-octobre, Nouakchott, Mauritanie;
4. Adamou A., Boudjenah S.H., 2012, Potentialités laitières chez la chamelle Sahraoui dans la région du Souf. Ann. des Sci. Technol., 4, pp. 108-114;
5. Al Abri M.A., Faye B., 2019, Genetic improvement in dromedary camels: Challenges and opportunities. Front. Genet., 10, pp. 2014-2018;
6. Al Haj O.A., Al Kanhal H.A., 2010, Compositional, technological and nutritional aspects of dromedary camel milk. Int. Dairy J., 20, pp. 811-821;
7. Ali W., Akyol E., Ceyhan A., Dilawar S., Firdous A., 2019, Milk Production and Composition in Camel and Its Beneficial Uses : A Review. Turkish Journal of Agriculture - Food Science and Technology, 7, pp. 2142-2147;
8. Alloui-Lombarkia O., Hennam E., Bacha A., Abededdaim M., 2007, Physico-chemical and biochemical properties of camel milk and separation of its proteins by polyacrylamide gel electrophoresis. Renc. Rech. Ruminants, 22, 108;
9. Attia H., Kherouatou N., Fakhfakh N., Khorchani T., Trigui N., 2000, Dromedary milk fat: Biochemical, microscopic and rheological characteristics. J. Food Lipids, 7, pp. 95-112;
10. Bakheit S.A., 1999, Studies on Milk Production and Composition of Camels (Camelus dromedarius) under nomadic system. PhD Thesis, Faculty of Animal Production, University of Khartoum, Sudan;
11. Bakheit S.A., Majid A.M.A., Nikhala A.M., 2008, Camels (Camelus dromedarius) under pastoral systems in North Kordofan, Sudan: seasonal and parity effects on milk composition. Journal of Camelid Sciences, 1, pp. 32-36;
12. Bayoumi S., 1990, Studies on composition and rennet coagulation of camel milk. Milchwirtschaftlische Forschung, pp. 42, 3-8;
13. Bensemaoune Y., Beziou S.A.S.A.C., 2018, Le systeme d'elevage camelin dans la region de ghardaïa: situation et perspectives, 8, pp. 21-33;
14. Bornaz S., Sahli A., Attalah A., Attia H., 2009, Physicochemical characteristics and renneting properties of camels' milk: A comparison with goats', ewes' and cows' milks. Int. J. Dairy Technol., 62, pp. 505-513;

15. Chang S.K., Ismail A., Daud Z.A.M., 2016, Ascorbic Acid: Properties, Determination and Uses. Encyclopedia of Food and Health. Food science, pp. 275-284;
16. Delaby L., Peyraud J.L., 1994, Influence de la nature du concentre énergétique sur les performances des vaches laitières au pâturage. Rencontre Recherche Ruminants, 1, pp. 113-116;
17. Dell'Orto V., Cattaneo D., Beretta E., Baldi A., Savoini E.G., 2000, Effects of trace element supplementation on milk yield and composition in camels. Int. Dairy J. ,10, pp. 873-879;
18. Diallo B.C., 1989, L'élevage du dromadaire en Mauritanie. pp. 29-31;
19. Elagamy E.I., 2000, Physicochemical, molecular and immunological characterization of camel calf rennet: A comparison with buffalo rennet. J. Dairy Res., pp. 67, 73-81;
20. Elamin F.M., Wilcox C.J., 1992, Milk Composition of Majaheim Camels. J. Dairy Sci., 75, pp. 3155-3157;
21. Farah Z., 1993, Composition and characteristics of camel milk. J. Dairy Res., 60, pp. 603-626;
22. Farah Z., Rettenmaier R., Atkins D., 1992, Vitamin Content of Camel Milk Internat. J. Vit. Nutr. Res, 62, pp. 30-33;
23. Faraz A., Younas M., Pastrana C.I., Waheed A., Tauqir N.A., Nabeel M.S., 2021, Socio-economic constraints on camel production in Pakistan's extensive pastoral farming. Pastoralism, 11;
24. Faye B, 2004, Performances et productivité laitière de la chamelle: les données de la littérature. Lait chamelle pour l'Afrique Atelier sur la filière laitière caméline en Afrique Niamey, 5-8 novembre 2003, 93;
25. Faye B., 2020, How many large camelids in the world? A synthetic analysis of the world camel demographic changes. Pastoralism, 10;
26. Faye B., Konuspayeva G., Messad S., Loiseau G., 2008, Discriminant milk components of Bactrian camel (Camelus bactrianus), dromedary (Camelus dromedarius) and hybrids. Dairy Sci. Technol., 88, pp. 607-617;
27. Faye B., Abdelhadi O.M.A., Ahmed A.I., Bakheit S.A., 2011, Camel in Sudan: future prospects. Livestock Research for Rural Development, 23, Article 219;
28. Fox P.F., McSweeney P.L.H., 1998, Dairy Chemistry and Biochemistry. Blackie Academic Professional, London 478 p.;
29. Gebremichael B., Girmay S., Gebru M., 2019, Camel milk production and marketing: Pastoral areas of Afar, Ethiopia. Pastoralism, 9, pp. 0-10;
30. Gorban A.M.S., Izzeldin O.M., 1999, Study on cholesteryl ester fatty acids in camel and cow milk lipid. Int. J. Food Sci. Technol., 34, pp. 229-234;
31. Haddadin M.S.Y., Gammoh S.I., Robinson R.K., 2008, Seasonal variations in the chemical composition of camel milk in Jordan. J. Dairy Res., 75, pp. 8-12;
32. Iqbal A., Gill R.A., Younas M., 2001, Milk composition of Pakistani camel (Camelus dromedaries) kept under station/farmer's conditions. Emirates J. Food Agric., 13, pp. 7-10;
33. Kadim I.T., Mahgoub O., 2004, Camelid genetic resources. A repport on three Arabian Gulf countries. ICAR Technical Series, 11, pp. 81-92;
34. Kamal A.M., Salama O.A., Al-Saied K.M., 2007, Changes in amino acid profile of camel milk protein during the early lactation. International Dairy Journal, 2, pp. 226-234;
35. Kamoun M., 1994, Evolution de la composition du lait de dromadaire durant la lactation: conséquences technologiques. Actes du Colloque: Dromadaires et chameaux animaux laitiers, 24-26-octobre, Nouakchott, Mauritanie;

36. Kamoun M., 1995, Le lait de dromadaire: production, aspects qualitatifs et aptitude à la transformation. Elev. Aliment. du dromadaire, 103, pp. 81-103;
37. Kamoun M., Ramet, 1989, Conservation et transformation du lait de dromadaire. CIHEAM-Options Méditerranéenes, 6, pp. 229-231;
38. Karue C.N., 1994, The dairy characteristics of the Kenyan camel. Conference Chameaux et dromedaires, Animaux Laitiers, Nouakchott, Mauritannie, 24-26 October;
39. Kasiriyan M.M., 2016, Evaluation of the nutritional composition of camel milk and human milk. 4, pp. 25-31;
40. Khan B.B., Iqbal A., 2001, Production and Composition of Camel Milk, Review. Pak. j. Agri. Sci, 38, pp. 3-4;
41. Khanna N.D., Rai A.K., Tandon S.N., 2004, Camel Breeds of India. J. Camel Sci., 1, pp. 8-15;
42. Khaskheli M., Arain M.A., Chaudhry S., Soomro A.H., Qureshi T.A., 2005, Physico-Chemical Quality of Camel Milk. J. Agric. Soc. Sci., 1, pp. 164-166;
43. Kibebew B., Sale W., Latamo L., 2021, Potential of camel production and management Practices in Ethiopia: Review. J. Dryl. Agric., 7, pp. 67-76;
44. Kihal M., Chekroun A., Bensoltane A., Kheroua O., Saidu D., 1999, Characterization of Algeria raw camels'milk: proteins content and native lactic acid bacteria. 1ères Journées sur la Recherche Cameline, 25-27 May, ITAS, Ouargla;
45. Konuspayeva G., 2007, Variabilité physico-chimique et biochimique du lait des grands camélidés (Camelus bactrianus, Camelus dromedarius et hybrides) au Kazakhstan. pp. 255;
46. Kula J., 2016, Medicinal Values of Camel Milk. Int. J. Vet. Sci. Res., 2, pp. 18-25;
47. Lowry O.H., Rosebrough N.J., Farr A.L., Randall R.J., 1951, Protein measurement with the Folin phenol reagent. J. Biol. Chem., 193, pp. 265-275;
48. Mehaia M.A., 1994, Vitamin C and riboflavin content in camels milk: effects of heat treatments. Food Chem., 50, pp. 153-155;
49. Mehaia M.A., 1995, The fat globule size distribution in camel, goat, ewe and cow milk. Milchwisenschaft, 50, pp. 260-263;
50. Mehaia M.A., Hablas M.A., Abdel-Rahman K.M., El-Mougy S.A., 1995, Milk composition of Majaheim, Wadah and Hamra camels in Saudi Arabia. Food Chem., 52, pp. 115-122;
51. Meiloud G.M., Ould Bouraya I.N., Samb A., Houmeida A., 2011, Composition of Mauritanian camel milk: Results of first study. Int. J. Agric. Biol., 13, pp. 145-147;
52. Mohamed H.E., 2002, Vitamin C status in Sudanese camels. PhD thesis, Khartoum University, Soudan;
53. Mosbah S., Mekkaoui S., Dahia M., Boual Z., Boudjenah S.H., 2019, Variation des paramètres physico-chimiques et biochimiques au cours de la préparation du Raib à partir du lait de chamelle. Rev. des BioRessources, 9, pp. 66-77;
54. Neville M.C., 2005, Calcium secretion into milk. J. Mammary Gland Biol. Neoplasia, 10, pp. 119-128;
55. Omer R.H., Eltinay A.H., 2009, Changes in chemical composition of camel's raw milk during storage. Pakistan J. Nutr., 8, pp. 607-610;
56. Ould Soule A., 2003, Profil fourrager Mauritanie, FAO;
57. Sboui A., Khorchani T., Djegham M., Belhadj O., 2009, Comparaison de la composition physicochimique du lait camelin et bovin du Sud tunisien; variation du pH et de l'acidité à différentes températures. Afrique Sci. Rev. Int. des Sci. Technol., 5, pp. 293-304;
58. Shamsia S.M., 2009, Nutritional and therapeutic properties of camel and human milks. Int. J. Genet. Mol. Biol., 1, pp. 052-058;

59. Siboukeur O., 2007, Etude du lait camelin collecté localement: caractéristiques physico-chimiques et microbiologiques; aptitudes à la coagulation. Doctoral thesis in agronomic sciences. University of Ina El-Harrach Algers, Algeria, 135 p.;
60. Squires E.J., 2010, Applied Animal Endocrinology. 2nd Edition, 312 p. CABI Biblisher;
61. Stahl T., Sallmann H., Duehlmeier R.U.W., 2006, Selected vitamins and fatty acid patterns in dromedary milk and colostruim. J. Camel Pract. Res., 13, pp. 53-57;
62. Titaouine M., Mohamdi H., Meziane T., 2011, Considérations zootechniques sur l'élevage du dromadaire dans le sud-est Algérien. Rencontres et Recherches Ruminants, 18, 251;
63. Vignola C.L., 2002, Science et technologie du lait, transformation du lait. Canada, 600 p.;
64. Wangoh J., 1997, Chemical and Technological Properties of Camel (Camelus dromedarius) Milk. PhD thesis in technical sciences, Zurich, Switzerland;
65. Wangoh J., Farah Z., Puhan Z., 1998, Iso-electric focusing of camel milk proteins. Int. Dairy J., 8, pp. 617-621;
66. Waterborg J.H., Matthews H.R., 1994, The Lowry method for protein quantitation. Methods Mol. Biol., 32, pp. 1-4;
67. Yagil R., 1982, Camels and camel milk. In Animal production and health. 26 pp 1-69, Publication FAO, Rome;
68. Yagil R., 1985, The Desert camel: comparative physiological adaptation. Ed. KARGER, pp. 109-120;
69. Yagil R., Etzion Z., 1980, Milk yield of camels (Camelus dromedarius) in drought areas. Comp. Biochem. Physiol. - Part A Physiol., 67, pp. 207-209.

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