Journal of Advanced Research in Science and Technology
ISSN: 2352-9989

Comparison of physico-chemical properties and protein profile of cow's milk and camel milk

Nili Mohamed seghir[1*] and Katarzyna Czyz [2]

[1] University of El oued , laboratory BABDA University of El Oued 39000, Algeria
[2] faculty of Biologie and Animal Science Wroclaw University of Environmental and life science, Poland

Abstract. Milk is one of the main food raw materials. Most often it is obtained from cows and to lesser extent from sheep, or goats. In recent years, due to health-promoting properties, interest in camel milk also increases. The aim of the study was to compare the physicochemical properties and protein profile of cow's milk and camel milk. It was shown that camel milk was characterized by lower protein and dry matter content ($p < 0.01$) compared to cow's milk.However, there were no significant differences in the protein fraction profile. Only the content of α-casein was four times higher ($P < 0.01$) in camel milk.

Keywords: *cow's milk; camel milk; physicochemical properties.*

1. Introduction

The composition and properties of mammalian milk are still an important research topic for many researchers. However, the emerging publications concern mainly cow's milk, which accounts for 85% of milk consumed all over the world (Sabahelkhier, Faten and Omer 2012, Pecka, Zachwieja and Tumanowicz 2013),and to a lesser extent, goat or sheep (Park et al 2007, Sabahelkhier, Faten and Omer 2012).In recent years, the number of publications on milk from camels has also increased,characterized by high nutritional values (Konuspayeva et al. 2009, Gul et al 2015, Kumar Yadav et al. 2015, Mohamed et al. 2016, Tache Kula and Tegegne 2016, Elhosseny et al. 2018).

Camel milk is a valuable source of protein for people living in a desert climate.In comparison to other species' milk, it has the closest composition to human milk.It has anti-cancer properties,hypoallergenic and antidiabetic (Kumar Yadav et al. 2015, Tache Kula and Tegegne 2016).It is also characterized by high content of long-chain unsaturated fatty acids (Faye et al. 2008, Gul et al. 2015, Kumar Yadav et al. 2015, Mohamed and Mustafa 2016).

* Corresponding author.
E-mail: Nili @yahoo.fr (Nili M. S.).
Address: University of El Oued 39000, Algeria

The physicochemical properties of the obtained dairy raw material influence changes in technological properties of milk and the quality of dairy products (Barłowska et al., 2012).There is a linear relationship between the fat and protein content and the yield in cheese production (Verdier-Metz et al. 2001, Shook et al. 2003).The pH and κ-casein levels have a significant influence on cheese production (Verdier-Metz et al. 2001).These factors affect the clotting time of cheese, clot moisture, cheese yield, which is consequently related to production costs.The production of particular types of cheese is associated with a strictly developed recipe and technology for each of them, and the production efficiency depends on the quality of the dairy raw material.(Król et al. 2011; Pecka, Zachwieja and Tumanowicz 2013).

A thorough analysis of the physicochemical properties of camel milk and comparison with cow's milk may be a valuable source of knowledge in order to obtain camel milk for the production of cheeses with refined health qualities.Therefore, the aim of the study was to compare the physico-chemical properties and the profile of protein fractions in the milk of cows and camels.

2. Material and methods

Milk was taken from 12 Polish Holstein-Friesian black and white cows during the trial milking in2 and 3 lactation. The animals were kept in a free-standing system. The basis for cow nutrition was the complete TMR blend. Their diet was formulated according to the French INRA standard (INS.tion 4.01).

Samples of camel milk were collected from camels from the Sahraoui population (Algeria) with 380 mothers. Camels from whom milk was taken were aged 7-8.During the experiment the diversity of milk characteristics was analyzed depending on the species of animal.

2.1 Analysis of physicochemical properties of milk

The content of: fat, total protein, lactose, dry matter was determined in each obtained sample using the Infrared Milk Analizer 150 (Bentley Instruments Inc.). The number of somatic cells was determined using the Somacount 150 (Bentley Instruments Inc.). The total number of microorganisms was determined by the cytometric method using the Bactocount 70 apparatus (Bentley Instruments Inc.).Active acidity was determined using the Level2 pH-meter according to the PN-A-86122 standard, the acidity potential of the Soxhlet-Henkel method and the milk resistance level by the Dramiński apparatus. Density of milk using the DMA 35N Density Meter.

2.2 The share of protein fractions

The proportion of protein fractions was determined in the obtained samples using Laemml electrophoresis (1970) on a polyacrylamide gel in the presence of sodium dodecyl sulphate (SDS) according to the methodology described (Pecka et al. 2012).

2.3. Statistical analysis

The results of the study were statistically analyzed using a one-way ANOVA variance analysis in the Statistic 10.0 program (StatSoft Poland, Krakow, Poland). Significance was declared at P <0.05 and P <0.01. Differences between means with 0.05 <P <0.10 were accepted into representing tendencies to differences.

3. Results

In the analyzed samples, a higher level (P <0.01) of protein and dry matter in milk of cows was observed compared to camel milk (Table 1). Camel milk trials were characterized by a lower (P <0.05) level of non-fat dry matter. There were no statistically significant differences between the species in the lactose level and fat in the analyzed milk samples. However, in the camel, the level of fat and lactose was lower than in cows by 0.69 and 0.40 g / 100g respectively. In the camel's milk, a lower (P <0.01) value of active acidity (pH) of about 0.61 was observed (Table 2).

In contrast, potential acidity (SH) was inversely shaped to the pH at the trend level. The milk of cows was characterized by a higher (P <0.01) resistance of approx. 219.69Ω compared to camel milk. Milk density was found for both species at a similar level (cow's milk 1.06 g / dm-3, camel 1.071.06 g / dm-3). A similar relationship was noted with the number of somatic cells.

The profile of protein fractions in the milk of cows and camel was slightly different (Table 3). The largest changes were observed in the percentage of α-casein. In camel milk, the proportion of this fraction was four times higher (P <0.01) than in cow's milk. The content of κ-casein and α-lactalbumin similarly developed, however, changes betweenspecies were statistically different at the trend level. A lower level of albumin serum in camel milk was found (16.86%) than in cow's milk (34.03%). Both species were observed to share a similar level of β-casein (12.68% in cow's milk and 13.97% in camel).

Table 1. The basic composition of cow's and camel's milk

Milk parameters	Cows	Camel	S.E.M.	P-value
Fat [%]	3.80	3.11	0.229	0.231
Protein [%]	3.28A	1.81B	0.191	<0.000
lactose [%]	4.60	4.20	0.132	0.233
Dry mass [%]	12.28A	9.13B	0.480	0.002
S. m. b. [%]	8.20a	6.01b	0.400	0.018

a,b p<0,05 inrows

A,B p<0,01 inrows

Table 2.Physico-chemical properties of milk of cow's milk and camel milk

Milk parameters	Cows	Camel	S.E.M.	P-value
pH	6.72a	6.11b	0.098	0.005
Resistance [Ω]	546.36a	326.67b	33.128	0.002
SH	6.95	12.67	1.382	0.089
Density [d]	1.06	1.07	0.024	0.876
LKS*tys./ml	176.25	173.00	198.10	0.368

a,b p<0,05 in rows

A,B p<0,01 in rows

Table 3. Share of selected protein fractions in cow's milk and camel milk

Milk parameters	Cows	Camel	S.E.M.	P-value
serum albumin [%]	34.03	16.86	4.891	0.157
α-casein [%]	4.48A	16.94B	2.045	0.006
β-casein [%]	12.69	13.97	1.241	0.689
κ-casein [%]	3.56	8.69	1.124	0.057
α-lactalbumin[%]	49.19	10.91	9.291	0.091

a,b p<0,05 in rows

A,B p<0,01 in rows

4. Discussion

The basic composition of camel milk (in g / 100ml) according to literature data is as follows: 1.2-5.2 fat; 2.15-5.57 proteins; 8,17-14,3 dry matter (Konuspayeva et al. 2009, Kumar Yadav et al. 2015,

Mohamed et al. 2016, Tache Kula and Tegegne 2016). It is characterized by lower levels of fat and dry matter as compared to milk of dairy cows (Sabahelkhier et al. 2012, Kumar Yadav et al. 2015). In our own research a similar relationship was observed.

Lactose is the basic carbohydrate found in milk, which is the main source of energy for newborn mammals. It consists of glucose and galactose that are involved in lactic fermentation at the formation of a casein clot (Adamczak and Bednarski 2008, Farah).The lactose content in camel milk varies from 4.8% to 5.8% and is relatively stable over the entire lactation period. Similar to dairy cows (Farah, Pollott et al. 2004, Konuspayeva et al. 2009). In lactating cows, the lactose content is 4.8% and correlates with the water level (r = 94) (Pollott et al. 2004). The results of our own research corresponded with literature data.

According to Sabahelkhier et al. (2012), the pH value in camel milk is 6.5 and in cows 6.6. Similar results were obtained by Rafiq et al. (2016). Also in our research, higher (P <0.001) pH in cow's milk was observed than in camel milk. The level of active acidity (pH) of the mammary gland secretion increases with the simultaneous decrease in the value of the acidity potential of oSH (Pecka et al.2012). What can be the resulting differences between the oSH values in the analyzed milk samples.

The number of somatic cells (LKS) is an exponent of inflammation of the udder in cattle, it is also the basis for intermediate tests in determining mastitis in camels (Nagy et al. 2013, Saeed et al. 2013).The obtained analyzing results it can be stated that the milk came from healthy cows and camel, hence the low number of somatic cells and the lack of differences between species. The flow of electricity in milk and what follows and the resistance depends mainly on the health of the mammary gland, that is on the level of somatic cells. A significant influence on milk resistance is also its composition and temperature (Bruckmaier et al. 2004).In order to obtain more information on the obtained results, Sabahelkhier et al. (2012) found no statistical difference between the density of camel milk (1,029 g / dm-3) and cow's milk 1,032 g / dm-3). The studies also did not affect the type of this value. In addition to the fact that milk density is associated with proteins and parks.

Caseins are coagulated in milk in the process of curd cheese formation and are the main camel milk protein (Verdier-Metz et al. 2001, Tache Kula and Tegegne 2016). They constitute from 52-87% of protein, and the remaining part is whey protein. In the whole casein, β-CN is 65%, and αs1-CN is 21% (Abbas et al 2013).The smallest share is κ-casein (Omar and in 2010). Genetic conditions indicate the presence of alleles that shape the following levels of casein fractions: α-> κ-> β-CN (Verdier-Metz et al. 2001). However, according to Al-Alawi and Laleye (2008) in the casein pool, the most is β-CN (65%) followed by α-CN (31.5%), the least κ-CN (3.5%), and in cows' milk the share is as follows: CN-48%, β-CN39%, κ-CN 13%. Other authors indicate that in milk from cows with no inflammatory changes in the glandThe lactic share of casein in the total protein is 38.3%, including the sum of β- and κ-casein 40.5% (Urech et al. 1999). Literature data do not indicate a clear participation of

individual protein fractions in camels' milk and cows' milk.In the own research in camel milk, the lowest content of κ-casein was found, and the highest α-casein compared to the other casein fractions. There are differences in the molecular weight of the casein fractions in the milk of camels and cows. Molecular weights of αs, β- and κ-caseins of camel casein were estimated at 27.6, 23.8 and 22.4 kDa, compared to cows: 25.3, 22 and 20.5, respectively. Thus, by doing electrophoresis a slight shift of protein fractions on the gel in camel milk may occur with reference to cow milk (Saleh et al. 2012). A similar relationshipfound during the analysis. Small differences in molecular weight may affect the properties of the analyzed fractions. According to Omar et al. (2010).camel milk proteins slower to hydrolyse and coagulate faster by rennet as compared to cow milk proteins. Among the whey proteins in a camel, β-lactoglobulin is found in trace amounts, and α-lactalbumin is contained in the main part.In bovine milk, α-lactalbumin is only 25% t, and β-lactoglobulin is 50% of the total whey protein (Abbas et al 2013). In camel milk proteins, a higher level of albumin serum is formed compared to bovine whey, and the molecular weights of both albumin and α-lactalbumin serum are similar in both species (Merin et al. 2001). The milk of a healthy cow contains about 0.1-0.4 g / l albumin and 0.47 g / l α-lactalbumin (Urech et al. 1999). In our study, both the lower level of albumin serum and α-lactalbumin in camel milk was found in comparison to cow milk.

5. Summary

Analyzing the comparison of physicochemical properties of camel milk and cow's milk, it can be concluded that camel milk, despite the lower protein level in milk, is characterized by a higher content of casein proteins with a reduced level of whey proteins, which may cause allergies to a lesser extent. Also other analyzed physico-chemical parameters indicate good milk quality. The collected literature data on the share of protein fractions in camel milk are contradictory and it is not possible to discuss the obtained results, which is the basis for further research.

1. Abbas S., Ashraf H., Nazir A., Sarfraz L. (2013).Physico-chemical analysis and composition of camel milk. The International Research Journal “International Reseachers”, 2(2), 83-98.
2. Adamczak M., Bednarski W. (2008). Enzymatyczna synteza galaktooligosacharydów i laktulozy w permeacie po ultrafiltracji serwatki**.***Żywność. Nauka. Technologia. Jakość*, 6 (61), 105-117.
3. Al-Alawi A.A., Laleye L.C. (2008). Characterization of CamelMilk Protein Isolates as Nutraceutical and Functional IngredientsCollaborative Research Project SQU/UAEU CL/SQU-UAEU/01/08 SQU/UAEU 01-06-60/08 1-97
4. Barłowska J., Litwińczuk Z., Brodziak A., Chabuz W. (2012) Effect of the production season on nutritional value and technological suitability of milk obtained from intensive (tmr) and

traditional feeding system of cows. *Journal of Microbiology Biotechnology and Food Sciences*, 1 (5), 1205-1220.

5. Bruckmaier R.M., Ontsouka C.E., Blum J.W. (2004). Fractionized milk composition in dairy cows with subclinical mastitis. *VeterynàrnìMedicìna -Czech,* 49(8), 283-290.
6. Elhosseny M., Gwida M., Elsherbini M., Abu Samra R., Al Ashmawy M. (2018). Evaluation of physicochemical properties and microbiological quality of camel milk from Egypt. *Journal of Dairy, Veterinary & Animal Research,* 7(3), 92-97.
7. Farah Z. Milk - Camelgate s 25-28*www.camelgate.com/pdf/milk.pdf*
8. Faye B., Konuspayeva G., Narmaturatova M., Loiseau G. (2008). Comparative fatty acid gross composition of milk in Bactrian camel, and dromedary, *Journal of Camelid Sciences.* 1, 48- 53.
9. Gul W., Farooq N., Anees D., Khan U., Rehan F. (2015). Camel Milk: A Boon to Mankind. *International Journal of Research Studies in Biosciences,* 3 (11), 23- 29.
10. Konuspayeva G., Faye B., Loiseau G. (2009). The composition of camel milk: A meta-analysis of the literature data.*Journal of Food Composition and Analysis,* 22, 95–101.
11. Król J., Brodziak A., Litwińczuk A. (2011). Basic chemical composition and content of chosen whey proteins in milk of different cows' breeds and rennet whey. *Żywność - Nauka, Technologia, Jakość*, 4, (77), 74-83.
12. Kumar Yadav A., Kumar R., Priyadarshini L., Singh J. (2015). Composition and medicinal properties of camel milk: A Review. *Asian Journal of Dairy and Food Research,* 34(2), 83-91.
13. Laemml U.K. (1970). Cleavage of structural proteins during the assembly of the head of bacteriophage T4. *Nature*, 227, 680-689.
14. Merin U. , Bernsteina S., Bloch-DamtiA., Yagil R., van Creveld C., Lindner P., Gollop N. (2001). A comparative study of milk serum proteins in camel (*Camelusdromedarius*) and bovine colostrums. *Livestock Production Science,* 67, 297–301.
15. Mohamed E., Mustafa A. (2016). Fatty Acids Content in Milk of Dromedary Camel (*Camelusdromedarius*) from Farming and Pastoral Systems in Sudan. *International Journal of Science and Research,* 5(6), 570- 573.
16. Mohamed E.H.A., Mustafa A.B., Atti K.A.A. (2016). Milk composition of the udder quarters of she-camel (*Camelusdromedarius*) raised under intensive farming system. *International Journal of Science and Knowledge*, 5(1), 9- 12.
17. 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 (Camelusdromedarius): descriptive statistics, correlations, and factors of variation.Journal of Dairy Science, 96(9), 5625-40.
18. Park Y.W., Juárez M., Ramos M., Haenlein G.F.W. (2007). Physico-chemical characteristics of goat and sheep milk. *Small Ruminant Research*, 68, 88–113.

19. Pecka E., Dobrzański Z., Zachwieja A., Szulc T., Czyż K. (2012). Studies of composition and major protein level in milk and colostrum of mares. *Animal Science Journal*, (83), 162-168
20. Pecka E., Zachwieja A., Tumanowicz J. (2013). Parametry technologiczne mleka w zależności od systemu utrzymania krów, czynników fizjologicznych oraz liczby komórek somatycznych. Przemysł Chemiczny, 92/6, 1087-1091.
21. Pollott G.E. (2004). Deconstructing Milk Yield and Composition During Lactation Using Biologically Based Lactation Models. Journalof Dairy Science, 87, 2375–2387.
22. Rafiq S., Huma N., Pasha I., Sameen A., Mukhtar O., Issa Khan M. (2016). Chemical Composition, Nitrogen Fractions and Amino Acids Profile of Milk from Different Animal Species. Asian-Australasian Journal of Animal Sciences, 29(7), 1022-1028.
23. Sabahelkhier M.K., Faten M.M., Omer F.I. (2012). Comparative Determination of Biochemical Constituents between Animals (Goat, Sheep, Cow and Camel) Milk with Human Milk. Research Journal of Recent Sciences, 1(5), 69-71.
24. Saleh S.K., Al- Ramadhan G., Faye B. (2013). Monitoring of monthly SCC in she-camel in relation to milking practice, udder status and microbiological contamination of milk. Emirates Journal of Food and Agriculture, 25 (5), 403-408
25. Shook G.E., Shaver R.D., Ruegg P.L., Wendorff W.L. (2003). Rethinking dairyland: milk composition, quality and production efficiency: Where does Wisconsin stand? Marketing and Policy Briefing Paper, 78(2), 1-33.
26. Tache Kula J., Tegegne D. (2016). Chemical Composition and Medicinal Values of Camel Milk. International Journal of Research Studies in Biosciences, 4(4), 13-25.
27. Urech E., Puhan Z., Schallibaum M. (1999). Changes in Milk Protein Fraction as Affected by Subclinical Mastitis. Journal of Dairy Science, 82, 2402-2411.
28. Verdier-Metz I., Coulon J.B., Pradel P. (2001). Relationship between milk fat and protein contents and cheese yield. Animal Research, 50, 365–371