Comparative fatty acid gross composition of milk in Bactrian camel, and dromedary

B. Faye[1], G. Konuspayeva[2], M. Narmuratova[3], G. Loiseau[4]

[1]CIRAD-EMVT, Campus International de Baillarguet, 34398, Montpellier cedex, France

[2]Kazakh National University Al-Farabi, 050078, Almaty, Kazakhstan

[3]Kazakh National University Al-Farabi, 050078, Almaty, Kazakhstan

[4]CIRAD-AMIS, Avenue du Val de Montferrand, 34398, Montpellier cedex, France

Abstract

Samples of camel milk both from Bactrian and dromedary were collected in 4 regions from Kazakhstan at different seasons. The fatty acid composition of those milk samples from different species of camel was compared by taking in account the proportion of the major part of the saturated, mono-unsaturated and poly-unsaturated fatty acids and compared with literature data. The results showed a higher part of saturated fatty acids in cow (78.6%) and goat (75.3%) compared to camel (68.6 for Bactrian and 69.7% for dromedary) and mare (50.6 % only) milk fat. The mono-unsaturated fatty acids are in highest proportion in camel (29.3 % for Bactrian and 27.6% for dromedary) compared to mare (25.8%), goat and cow (20.7 and 20.8% respectively) milk fat. At reverse, camel milk fat is the lower in poly-unsaturated fatty acids in our sample (2.0 and 2.5% respectively for camel and dromedary) compared to goat and cow (3.4 and 3.8 % respectively). Mare milk is particularly rich in linoleic and linolenic acid (11.3 and 11.9% respectively). In camel, the mono-unsaturated fatty acids are in lower proportion in autumn and higher quantity in summer. No differences were observed according the regions.

1. Introduction

The genus *Camelus* includes the one-humped camel (*C. dromedarius*) and the Bactrian two-humped camel (*C. bactrianus*). In Kazakhstan, these two species cohabit in the same areas and even in the same farms (Konuspayeva & Faye, 2004). This particularity allows comparing the milk composition of those animals reared in similar environment. Elsewhere, crude camel milk and fermented product (named *shubat*) were always an important food of Kazakh peoples. Especially shubat is renowned and used for some medicinal purpose (Djanbakilov *et al*., 2000; Konuspayeva *et al*., 2004). The fatty acid composition of milk is one of the aspects linked to the discussion on the health effect of milk and milk products (Wahle & Heys, 2002). However, the fatty acid composition of camel milk and comparison with other species have not documented extensively (Chilliard, 1989; Farah, 1996), especially in Bactrian camel (Zhang *et al*., 2005). No recent data are available in Kazakhstan. The present study aimed to obtain results on fatty acid composition in dromedary and Bactrian camel living in the same areas of Kazakhstan, to compare the results with some references concerning

camels in other countries and to compare with other main dairy species.

2. Material and methods

2.1. Animals and milk samples

In order to have a high variability in fatty acid composition, the healthy animals have been randomly selected in four different regions of Kazakhstan and at the four different seasons where the whole 31 milk samples were collected. The samples came from 4 farms : Daulet-Beket (Almaty region, n = 8), Sary-Arka (Shimkent region, n = 11), Kulandy (Aralsk region, n = 4) and Tendik (Atyrau region, n = 8).

The number of milk samples was balanced between winter (n = 8), spring (n = 7), summer (n = 10) and autumn (n = 6). The 31 milk samples included 9 Bactrian camels, 11 dromedaries, 3 hybrids, and finally 3 mixed crude milks (Bactrian and dromedary) and 5 fermented milks (got from mixed milk also). Milks were collected at milking time at the end of milking. The milks were stored in ice-box up to the lab then frozen at -20°C up to the analyses.

2.2. Lipid analysis

The milk fat was extracted from milk in liquid form by hexane. One gram of fat was dissolved in 5 mL hexane. Fatty acids were determined after methylation by gas chromatography and were confirmed by mass spectrometry for each milk sample. A Varian 3400 gas chromatograph was equipped with a non polar DB-Wax capillary column (molten silica) of 60 m length, 0.32 mm diameter and 0.25 µm film thickness. All other conditions were those described by Collomb and Bühler (2000).

The analysis gave the next composition of fatty acids:

- Major saturated acids: butyric (C4), caproic (C6), caprilic (C8), capric (C10), lauric (C12), miristic (C14), palmitic (C16), stearic (C18), arachidic (C20).
- Major Mono-unsaturated acids: palmitoleic (C16:1), oleic omega 9 (C18:1/9), vaccenic omega 7 (C18:1/7).
- Major Poly-unsaturated acids: linoleic omega 6 (C18:2/6), linolenoic acid (C18:3).

In order to compare the different species, the results were expressed by the class of major fatty acids: saturated, mono-unsaturated or poly-unsaturated.

2.3. Statistical analysis

As the objective was to have an idea of the variability of fatty acid composition with only at least one sample in each cell region*species*season, the variance analysis was not applicable. In order to compare the present results to those of the literature on camel milk, a principal components analysis was also achieved (meta-analysis) using the Winstat software (CIRAD ©).

3. Results and Discussion

3.1. Species effect

The proportion of the different classes of major fatty acids was similar between dromedary and Bactrian camel. However a slight lower proportion of mono-unsaturated FA was observed in our samples. The hybrid milk composition was not really intermediate between Bactrian and Dromedary as we could expect. The shubat samples seemed to be different with a higher quantity of unsaturated FA (table 1).

Table 1. Proportion (in %) of the major saturated (SAT), mono-unsaturated (MUSAT) and Poly-unsaturated (PUSAT) fatty acids in the milk from different species in Kazakhstan

	SAT	*MUSAT*	*PUSAT*
Bactrian	68.4 ± 12.3	29.2 ± 12.9	2.0 ± 1.3
Dromedary	67.4 ± 11.4	26.8 ± 9.8	2.5 ± 1.4
Hybrid	78.9 ± 13.0	19.0 ± 12.0	2.0 ± 1.1
Mixte	70.2 ± 4.9	23.7 ± 8.5	2.8 ± 3.3
Shubat	60.9 ± 10.9	36.3 ± 7.5	2.9 ± 1.4

Few data were available in the literature for the shubat fat composition. The main feature is the disappearing of short chain fatty acid as butyric acid and sometimes caproic and caprilic acid, and the presence of linoleic acid which was not observed in crude milk. In addition, the relative high quantity of oleic acid could support the idea of the health effect attributed to shubat fat (Narmuratova et al., 2006).

3.2. Season effect

The main feature concerning the season effect was the important decrease of the mono-unsaturated acids at autumn and a slight increase of poly-unsaturated fatty acids in the same time table 2). The content of unsaturated fatty acids decreased in winter and in spring. That is certainly due to the animal feed which is quite poor and composed mainly of cellulose at that time. Such results were already described in other species (Lucas, 2005 and 2007). As the camels were reared in extensive area, the season effect is quite linked to the dietary status which changed according the season.

Table 2. Proportion (in %) of the major saturated (SAT), mono-unsaturated (MUSAT) and Poly-unsaturated (PUSAT) fatty acids in the milk at different seasons in Kazakhstan

	SAT	*MUSAT*	*PUSAT*
Winter	69.2 ± 13.0	28.0 ± 12.3	2.4 ± 1.0
Spring	68.7 ± 14.5	28.7 ± 13.1	2.4 ± 1.6
Summer	65.2 ± 3.4	31.9 ± 5.1	2.3 ± 1.4
Autumn	73.6 ± 12.6	16.2 ± 6.3	2.6 ± 1.8

3.3. Region effect

For each region (Almaty, Atyrau, Aralsk and Shymkent), some differences were observed and can be explained by a heterogeneous distribution of farms and different climatic conditions, but as the animal types (Dromedary, Bactrian and their hybrids) were not present in each region, the variation part can be due to species also (Table 3).

Table 3. Proportion (in %) of the major saturated (SAT), mono-unsaturated (MUSAT) and Poly-unsaturated (PUSAT) fatty acids in the milk from different regions in Kazakhstan

	SAT	*MUSAT*	*PUSAT*
Almaty	68.9 ± 7.0	28.5 ± 6.5	2.4 ± 1.0
Atyrau	68.8 ± 8.8	26.7 ± 11.1	2.4 ± 1.0
Aralsk	65.7 ± 21.5	31.9 ± 19.7	2.5 ± 1.9
Shimkent	69.4 ± 11.3	24.8 ± 10.1	2.4 ± 1.4

The milk samples from Aralsk were the richest in unsaturated fatty acids. In this area, the floristic composition of pasture are little bit different than in other places

(Konuspayeva, 2007) and supplementation with fresh fish can occur in some occasion.

So, as the whole, it was clear that the general composition in fatty acids was mainly under the influence of environmental conditions (the region was the reflection of feeding conditions) more than genetic factors. It was notable for example that Bactrian milk was not very different than dromedary milk.

3.4. Comparison with other species

The fatty acid composition of milk was described in many other dairy species. However the between-species comparison have to be taken with caution because respective FA have different technological and nutritional properties.

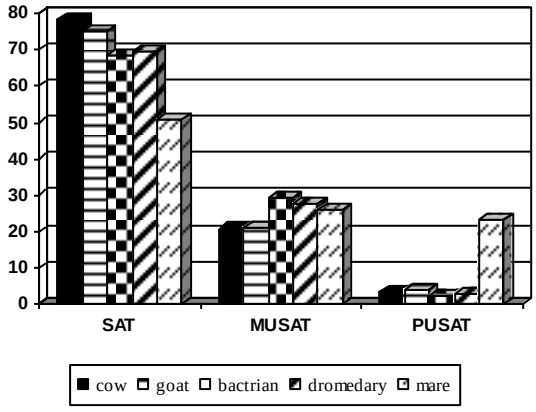


Figure 1. Proportion (in %) of the major saturated (SAT), mono-unsaturated (MUSAT) and Poly-unsaturated (PUSAT) fatty acids in the milk from different species (Chilliard et al., 2006; Doreau and Boulot, 1989; Jensen et al., 1990; Lucas, 2007; Sollberger et al., 2004).

Nevertheless, according to the reviews of Doreau and Boulot (1989), Jensen at al., (1990), Chilliard et al. (2006) and Lucas (2005) concerning mare, cow, and goat's milk, respectively, our results confirmed the intermediate place of camels between cow and goat from one hand (milk rich in saturated fatty acids) and mare from another hand (milk rich in poly-unsaturated fatty acids). This gross composition (fig. 1) give a good interest to the camel milk especially when it is consumed under shubat form (table 1).

3.5. Meta-analysis (camel fatty acid composition)

The comparison of the current results with others concerning camel milk was difficult because the analytical methods were generally different and the variability due to environmental factors (feeding system, climate) or to physiological factors (stage of lactation, genetic differences) was rarely described (Zhang *et al*., 2005). However the comparison of our results with those of the literature can be approached by a meta-analysis using principal components analysis. Unfortunatly, in most of these references, the sampling conditions were not reported. So, only results in gross composition could be compared.

The general fatty acid compositions given by Abu-Lehia (1989), Cardak *et al*. (2003), Farah *et al.* (1989), Jardali (1988), Mohamed (1990), Sharmanov *et al.*, (1978), Gnan and Sheriha (1986) were closed to our results and only main fatty acids contributed to the variability of the facteur F1 (fig. 2). But a very slight difference seemed to be observed between samples from Kazakhstan (where both dromedaries and Bactrian were sampled) and other countries (where dromedaries only where sampled).

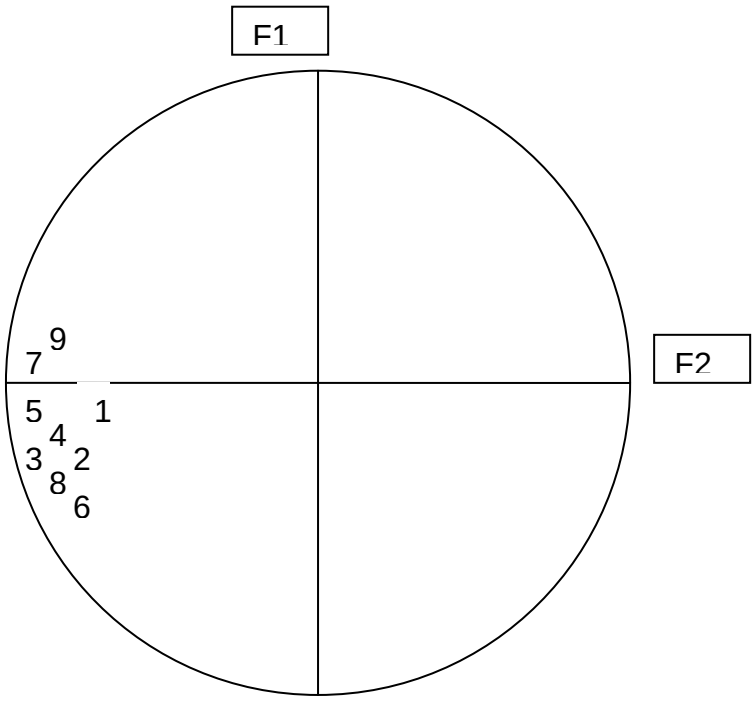


Figure 2. Correlation circle (F1, F2) obtained by the Principal Component Analysis of fatty acid composition of camel milk published by Abu-Lehia (1), Cardak (2), Farah (3), Gorban (4), Jardali (5), Mohamed (6), Sharmanov (7), Gnan and Sheriha (8) and our results (9).

4. Conclusion

Our results obtained on the fatty acid gross composition of camel milk fat from Kazakhstan are comparable to results of the literature, in particular the highest content of unsaturated fatty acids of these milks compared to cow milk. However, a high variability is observed between the animals, even if the variation factors like genetic (dromedary, Bactrian and hybrids), season or region seem to have a low effect in the context of the present study. Compared to cow or goat milk, these results confirmed the nutritional interest of camel milk even if it is less rich in poly-unsaturated fatty acids than horse milk.

5. Acknowledgement

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6. References

Abu-Lehia I.H., 1989. Physical and chemical characteristics of camel milk fat and its fractions. Food. Chem., 34, 261-271.

Cardak, A.D.; Yetismeyen, A.; Brückner, H., 2003. Quantitative comparison of free fatty acids in camel, goat and cow milk. Milchwissenschaft, 58, 127-130.

Chilliard Y., 1989. Particularités du métabolisme des lipides et du métabolisme énergétique chez le dromadaire. In "Digestion, Nutrition et Alimentation du Dromadaire"- Options Méditerranéennes, Série Séminaires, 2, 101-110.

Chilliard Y., Rouel J., Ferlay A., Bernard L., Gaborit P., Raynal-Ljutovac K., Lauret A., Leroux C. 2006. Optimising goat's milk and cheese fatty acid composition. Chapter 12 in "Improving the fat content of foods" (C.

Williams and J. Buttriss, Eds), Woodhead Publishing Ltd. (Cambridge, UK) . p.281-312.

Collomb M., Bühler T., 2000. Analyse de la composition en acides gras de la graisse de lait, Mitt. Lebebsem. Hyg., 91, 306-332.

Djangabilov A.K., Bekishev A.C., Mamirova T.N., 2000. Medicinal properties of camel milk and shubat. Proc. 2nd Intl. Camelid Conf., « Agroeconomics of camelid farming », Agromercur publ., Almaty, Kazakhstan, p.100.

Doreau M., Boulot S., 1989. Recent knowledge on mare milk production: a review. Liv. Prod. Sci., 22, 213-235.

Farah Z., Streiff T., Bachmann M.R., 1989. Manufacture and characterisation of camel milk butter. Milchwissenschaft, 44, 412-414

Farah Z., 1993. Composition and characteristics of camel milk. Review article. J. dairy res., 60, 603-626.

Farah Z., 1996. Camel milk: properties and products, SKAT-Verlag, St Gallen, Switzerland.

Gnan S.O., Sheriha A.M., 1986. Composition of lybian camel's milk. Aust. J. Dairy Technol., 41, 33-35.

Gorban A.M.S., Izzeldin O.M., 2001. Fatty acids and lipids of camel milk and colostrum. Int. J. Food Sci. Nut., 52, 283-287.

Jardali Z., 1988. Contribution à l'étude de la composition du lait de dromadaire. Dipl. Etude Approf., 1–88, Inst. National Polytech., Vandoeuvre-lès-Nancy, F.

Jensen R., Ferris A., Lammi-Keefe C., Henderson R., 1990. Lipids of bovine and human milks: a comparison. J. Dairy Sci., 73, 223-240.

Konuspayeva G., Loiseau G., Faye B**.,** 2004. La plus-value « santé » du lait de chamelle cru et fermenté : l'expérience du Kazakhstan. Renc. Rech. Ruminants, 11, 47-50.

Konuspayeva G., Faye B., 2004. A better knowledge of milk quality parameters: A preliminary step for improving the camel milk market opportunity in a transition economy – The case of Kazakhstan. Intl. Conf. on « Saving the camel and peoples' livelihood », Sadri (Inde), 23-25/11/04, 28-36.

Konuspayeva G., 2007. Variabilité physico-chimique et biochimique du lait des grands camélidés (Camelus bactrianus, Camelus dromedarius et hybrides) au Kazakhstan. Thèse en Sciences des aliments. Université de Montpellier II (France).

Lucas A., 2005. *Relations entre les conditions de production du lait et les teneurs en composés d'intérêt nutritionnel dans le fromage.* Thèse en nutrition et sciences des aliments. Université Blaise Pascal, Clermont-Ferrand (France).

Lucas A., Rock E., Agabriel J., Chilliard Y., Coulon J.B. 2007. Relationships between the animal species and the contents of components of nutritionnal interest in raw milk farmhouse cheese. Small Ruminant Research. (in press).

Mohamed M.A., 1990. Camel milk: chemical composition, characterisation of casein and preliminary trial of cheese-making. PhD. Diss. Sveriges Lantbrukunibersitet, Uppsala, Sweden.

Narmuratova M., Konuspayeva G., Loiseau G. Serikbaeva A., Barouh N., Montet D., Faye B., 2006. The fatty acids composition of dromedary and Bactrian camel milk in Kazakhstan. J. Camel Pract. Res. (submitted).

Sharmanov, T. Sh., Kadyrova, R.Kh., Shlygina, O.E., Zhaksylykova, R.D., 1978. Changes in the indicators of radioactive isotope studies of the liver of patients with chronic hepatitis during treatment with whole camels' and mares' milk. Voprosy Pitaniya 1: 9–13.

Sollberger H., Schaeren W., Collomb M., Badertscher R., Büdikofer U., Sieber R., 2004. Beitrag zur kenntnis der zusammensetzung von ziegenmilch schweizerisher herkunft. ALP Sci., 473, 1-16.

Wahle K.W., Heys S.D., 2002. Cell signal mechanisms, conjugated linoleic acids (CLAs) and anti-tumorigenesis. Prostaglandins Leukot Essent Fatty Acids, 67, 183-186.

Zhang H., Yao J., Zhao D., Liu H., Guo M., 2005. Changes in chemical composition of Alxa Bactrian camel milk during lactation. J. Dairy Sci., 88, 3402-3410.