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DROMEDARY AND HYBRID CAMELS' MILK COMPOSITION

Last centenary there is an increasing attention for camel dairy products, which create an attractiveness for camel breeding with high dairy productivity. Camel physiology and adaption ability on the background of climatic changes push for interest for these animals as an important livestock species at international level, therefore, high productive camels could become an important milk source in arid zones. In this article the difference in camel milk composition, milk productivity and udder morphology of Aruana breed and hybrids from three regions of Kazakhstan was determined. According to camel milk composition the percentage of well-classed was 83.8 %: 93.3% of the Aruana were well classed vs 77.9% of the Kospak and 68.2% of the Nar-Maya. The main discriminating factors were in the order, the density and fat content in camel milk. Studying milk composition of camel breeds and populations could give us an opportunity to improve milk quality and milk productivity of local camels.

Key words: camel milk, dromedary camels, hybrids, milk composition.

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Дромедар және гибридті түйелердің сүт құрамы

Соңғы онжылдықта түйе сүтінен жасалған өнімдерге қызығушылық артып келеді, бұл түйелерді сүт өнімділігі жоғары түйелерді өсіруге ынталандырады. Түйелердің ерекше физиологиясы мен климаттық өзгерістерге бейімделу қабілеті бұл жануарларға халықаралық деңгейде назар аудартады. Осылайша, жоғары өнімді түйелер құрғақ аймақтарда сүттің маңызды көзі бола алады. Осы мақалада Қазақстанның үш аймағынан алынған Аруана тұқымы мен будандарының түйе сүтінің құрамы, сүт өнімділігі және желін морфологиясындағы айырмашылықтар анықталды. Зерттеу нәтижелеріне сәйкес, түйе сүті құрамының жоғары деңгейде бағаланған үлесі 83,8% құрады: Аруана тұқымының 93,3%-ы жоғары бағаланған, ал Коспақ үшін 77,9% және Нар-Майя үшін 68,2% құрады. Айырмашылықтарды анықтайтын негізгі факторлар түйе сүтінің тығыздығы мен майлылығы болды. Сонымен қатар, желін өлшемі мен сүт мөлшері арасындағы байланыс анықталды, бұл өнімділікті арттыру үшін морфологиялық сипаттамаларды одан әрі зерттеу қажеттілігін көрсетеді. Түйе тұқымдары мен популяцияларының сүт құрамын зерттеу бізге

лікті түйелердің сүт сапасы мен сүт өнімділігін арттыруға үлкен мүмкіндік береді, бұл су ресурстары шектеулі және температурасы жоғары аймақтар үшін өте маңызды болып табылады.

Түйін сөздер: түйе сүті, дромедар түйелері, будандар, сүт құрамы.

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Состав молока одногорбых и гибридных верблюдов

В последние десятилетия наблюдается растущее внимание к продуктам из верблюжьего молока, что делает разведение верблюдов с высокой молочной продуктивностью всё более привлекательным. Специфическая физиология верблюдов и их способность адаптироваться к изменяющимся климатическим условиям усиливают интерес к этим животным на международном уровне. Благодаря этому высокопродуктивные верблюды могут стать важным источником молока в засушливых регионах. В данной статье рассмотрены различия в составе молока, молочной продуктивности и морфологии вымени верблюдов породы Аруана и гибридов из трёх регионов Казахстана. Согласно полученным данным, процент высококлассифицированного молока составил 83,8%: 93,3% для породы Аруана, 77,9% для Коспака и 68,2% для Нар-Майи. Основными дискриминационными факторами, определяющими различия, стали плотность и содержание жира в молоке. Кроме того, выявлена взаимосвязь между размером вымени и количеством молока, что указывает на необходимость дальнейшего изучения морфологических характеристик для улучшения продуктивности. Исследование состава молока различных пород и популяций верблюдов предоставляет возможность для улучшения качества молока и повышения молочной продуктивности местных верблюдов, что важно для регионов с ограниченными водными ресурсами и высокими температурами.

Ключевые слова: верблюжье молоко, одногорбые верблюды, гибриды, состав молока.

Introduction

In Kazakhstan, the historical nomadic lifestyle was associated mainly with camels and horses. These animals were the main nomadic logistical reserve for the migration process of entire families or villages. The strongest and hardiest animals were selected for logistics. Bactrians or their hybrids with dromedaries were mainly used. Due to which, on the territory of modern Kazakhstan cohabiting double-humped, single-humped camels and their hybrids, currently the main goal of hybridization is to improve productive qualities, such as milk, meat, wool productivity and working capacity [1,2]. According to Burger [3], Kazakhstan is the country where the practice of anthropogenic hybridization is well developed. This is a country that has the most sophisticated hybridization techniques with well-established breeding strategies. Currently, these camels populations are an important productive livestock resource in several regions of the country. Camel is one of the most ecologically harmless domestic animals in the dry regions of camel breeding countries in the world [4,5]. Using camels as a draught animal and valuable camel breeding products showing the economic importance of these animals [6]. Compared to other dairy animals camels can produce an important amount of milk from poor feed [7].

Nowadays, camel milk is under high demand at both markets on domestic and foreign level. The potential value of camel milk is on average 3.6% of the total national milk production, and this proportion increased by 30% since its independence. In the last 20 years, the production of camel products increased 5 times [8,9]. There is an upward trend in prices for camel dairy products, which create an attractiveness for breeding camels with high dairy productivity in the country. Specific physiology and adaptive capacity and increased interest for these animals as livestock species worldwide could lead to high productive camels becoming an important milk source for humans [10]. In this article the dif-

ference in camel milk composition of Aruana breed and hybrids from different regions of Kazakhstan was determined.

The milk composition is highly variable according to genetics, feeding, or physiological status [11-13]. If those factors were investigated previously in Kazakhstan [14-16], up to now the relationships between morphological characteristics of the udder, the milk productivity and its composition were not investigated. During lactation period the shape, the teat diameter, the udder length and depth, teat length and other parameters could change [16,17]. Thus, the present paper focused on the assessment of the links between these parameters and on their relationships withcamel milk composition, udder morphology and milk productivity.

Materials and methods

Milk sampling procedure

Kazakhstan having the particularity to possess dromedary (*Camelus dromedarius*) and Bactrian camels (*Camelus bactrianus*), the animals (4-18 years old; lactation stage 4-5 months) sampled in our study belong to three types, i.e., Aruana (dromedary), Nar-Maya (Crossbreed F1 between Bactrian female and Dromedary male) and Kospak (crossbreed F2 between Nar-Maya female and Bactrian male). The animals were originated from three camel farms located in (1) Atyrau region (24 Kospak hybrids), (2) Kyzylorda region (19 Nar Maya hybrids), and (3) Mangystau region (7 Kospak and 1 Nar Maya). Farming extensive management system was similar in all the cases (natural pasture, hand milking, type of housing). The milk was sampled individually (n=50) in one time, in a specific clean recipient.

Milk analyses and udder measurements

The analyses were performed immediately after collection in the farm. The following parameters were measured: milk production (Pmilk), solid non-fat (SNF), fat matter (Fat), density (Dens) and total proteins (Prot). The physico-chemical parameters were determined by using milk analyzer Lactan 1-4. The samples were identified by the breed of the camel (Aruana, Kospak or Nar-Maya), their age, parity and farm origin. Milk production (in kg) was determined by measuring milk quantity produced for the last 12 hours.Size and shape (udder length, udder depth and teat length) were evaluated . The measurements retained in the present investigation (Fig. 1) were achieved immediately after milk collection[2]

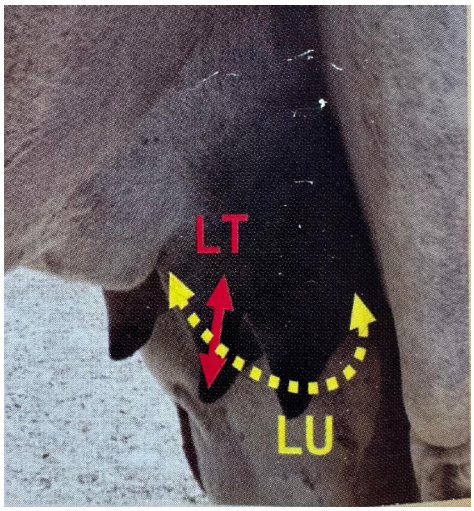

Figure 1 – Measurements of the morphology of udders and teats of dairy camels. LU: length of the udder. LT: length of the teat [18]

Statistical analyses

The objectives of the statistical strategy was the following: (i) To identify the parameters significantly different between breed and farms, or between types of udder shape; (ii) to identify the types of milk composition patterns; and (iii) to identify the links between udder morphology and milk composition and production. To achieve such objectives, the following statistical procedure was achieved: (i) variance analysis (ANOVA) after homogenization of the variances (assessment of the breed, farm effect or udder shape) , (ii) Principal Components analysis (PCA) of the milk composition parameters with farm and breed as illustrative variables, following by Ascending Hierarchical Classification (AHC) to identify the homogenous groups of camels according to their milk composition, (iii) Discriminant Factorial analyse to identify the more discriminant parameters.

The software used was XLstat (Addinsoft©, 2022).

Results and discussion

Milk composition

The individual mean volume of milk produced by camels over the past 12 hours was 4.6 ±1.2 liters for Aruana breed and 3.6 ±0.5L only for hybrids. The mean values of the physico-chemical parameters of the milk samples, were determined in the different breed/species (Table 1).

Table 1 – Physico-chemical parameters of camel milk samples

Animals	SNF, %	Fat Content, %	Density, kg/m3	Protein, %
Aruana	9,71	3,63	34,13	3,13
Kospak	9,31	3,52	33,39	2,99
Nar Maya	9,26	4,28	33,35	2,98

There was no significant difference in the milk composition between breed, or farms except slightly for density ($P<0.05$). All the parameters were highly correlated, notably fat and protein contents (Figure 2).

However, despite the lack of significant differences, the factorial discriminant analysis which is taking in account, the whole componentsshowed a certain separation between the breeds, with Aruana in one side (right side of the factorial plan and hybrids in the left side along the first factor of the analysis (Figure 3).

The percentage of well-classed was 83.8 %: 93.3% of the Aruana were well classed vs 77.9% of the Kospak and 68.2% of the *Nar-Maya*. It is interesting to note that the incorrect-classed Aruana camel milk samples all belong to the same Farm suggesting unreliable data, the "aruana camels" being probably not pure dromedary, but hybrids of 4 or 5th generation.

The discriminating analysis using stepwise method allows to give the more discriminating parameters which were in the order, the density and the fat content.

Udder morphology and milk production

The milk composition was estimated according to the size of the udder and of the teat. Thus, the following types were investigated:

- Small udder (<40cm), medium udder (40-49cm) and large udder (>50cm);
- Very short teat (<3cm), short teat (3-4cm), medium teat (4-6cm) and long (>6cm).

A non-significant tendency to have more milk when the size of udder and teat increased was observed (Figure 4).

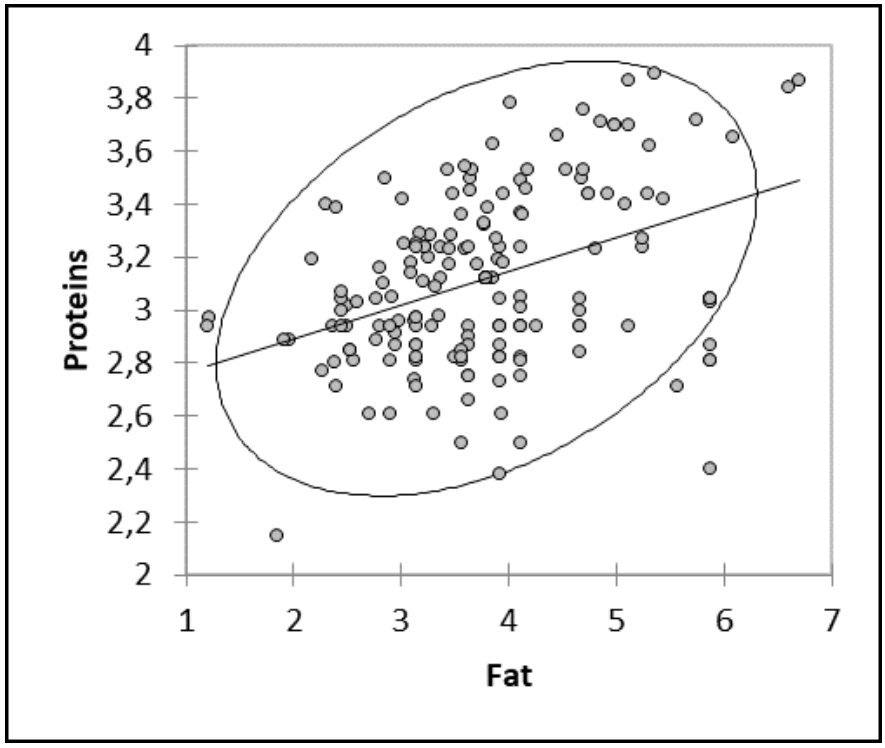

Figure 2 – Correlation between fat and protein content in camel milk (n=50)

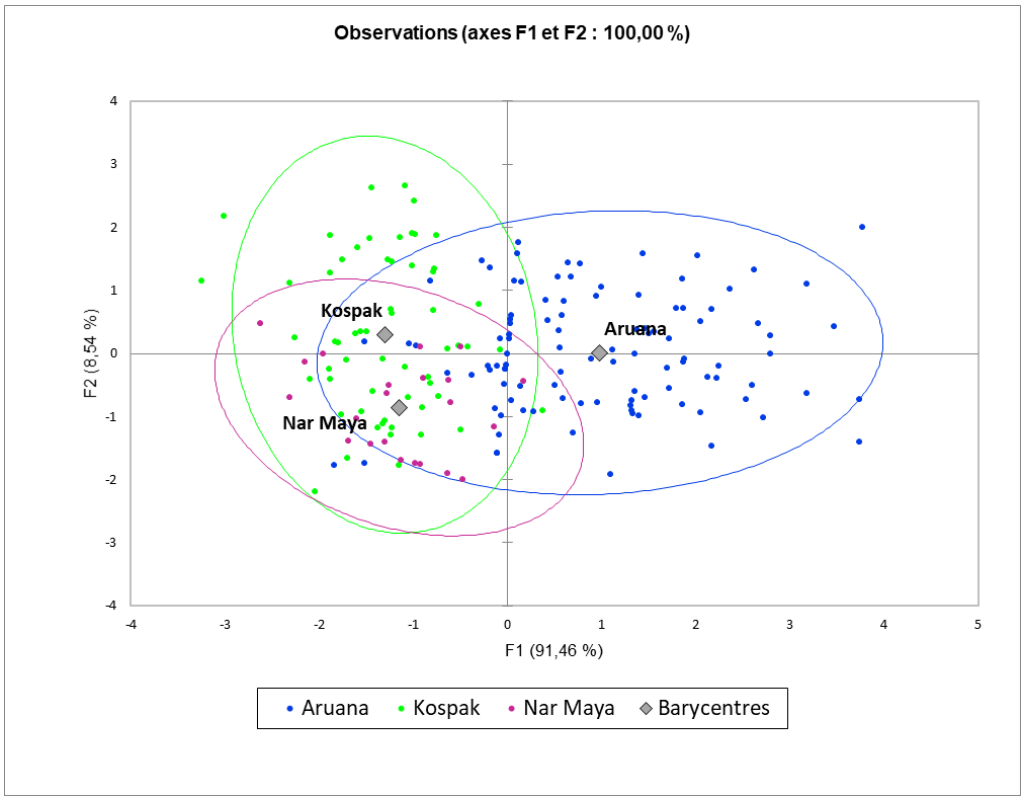

Figure 3 – Main factorial plan of the Discriminant analysis applied to milk composition data

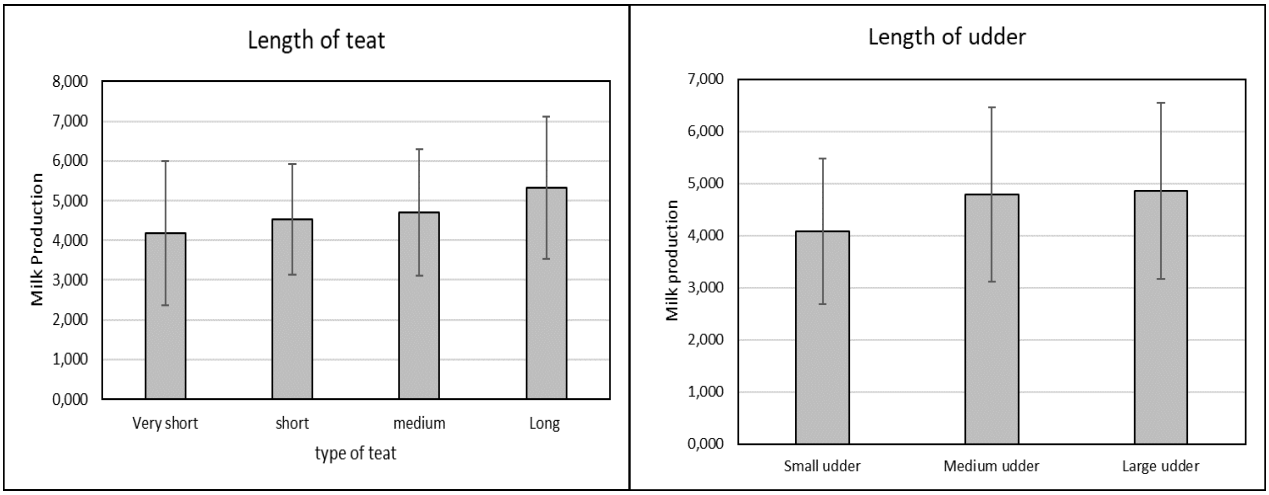

Figure 4 – Changes in milk production according to the size of udder and teats

Variability in milk composition

In a study achieved in Sudan [13] on 60 she-camels (*Camelus dromedarius*) of different breed (Anafi, Kenana, Dali and Arabi) randomly collected to investigate the effect of parity and breed on the milk production, it was reported that milk yield, fat, solid not fat (SNF) and protein were affected by parity number ($P<0.05$). Significant breed differences ($P<0.05$) were also observed on freezing point, conductivity, milk yield, fat, lactose, ash, SNF and protein. High positive correlations ($P<0.001$) were observed also between the physico-chemical parameters as density, freezing point, fat, SNF, lactose, ash and protein. Negative and significant ($p<0.001$) cor-

relations were observed also between each parameter and added water and conductivity. Globally, as for other species, physico-chemical components of camel milk could vary according to parity and breed [13,19].

In a meta-analysis including 7298 camel milk samples from 23 countries [20], the mean composition was reported as follows: protein, 3.17%; fat, 3.47%; lactose, 4.28%; ash, 0.78%; and total solids, 11.31%; calcium, 112.93 mg/100 g; iron, 0.45 mg/100 g; potassium, 116.13 mg/100 g; magnesium, 9.65 mg/100 g; sodium, 53.10 mg/100 g; zinc, 1.68 mg/100 g; vitamin C, 5.38 mg/100 g; vitamin A, 0.36 mg/100 g; vitamin B1 ,0.05 mg/100 g; vitamin B2 , 0.13 mg/100 g; vitamin B3 , 0.51 mg/100 g; vitamin B6 , 0.09 mg/100 g; and vitamin B12 , 0.0039 mg/100 g. Other factors than those investigated in our present studies could play a role to explain the variability ion the milk composition such as the number of samples, the different analytical techniques, the feeding patterns, the camel's breeds, the geographical locations, and the seasonal variations [20].

Camel milk composition from both dromedary and Bactrian species was described in several publications both in Kazakhstan [21-23] and elsewhere, notably in the Middle-East [24]. In another meta-analysis including eighty-two references from scientific journals or grey literature relative to the gross composition of camel milk (fat matter, total protein, lactose, ash and dry matter) [23] have shown that the references from Asia (notably involving Bactrian milk) gave higher values in all the milk components (except ash content) than in samples originate from Middle-East or Africa. Indeed, it was reported that , the Bactrian camel milk has higher fat, lactose and proteins than dromedary milk [25,26]. Within African continent, milk samples from East African were richer in fat matter content compared to other samples in North or Western Africa [27-29]. The chronicle since one century showed in the meta-analysis cited above, made it possible to distinguish four periods according to fat matter and total protein values. Personal data from Kazakhstan showed significantly higher fat matter and total protein contents, but a lower lactose content compared to other references from Central Asia [23].

Conclusion

The present results are a preliminary investigation regarding the variability in milk composition of various camel breeds and populations. It could give an opportunity to pursue these investigations for improving milk quality and productivity of local camels. Research to detect the influence of external factors on the composition of camel milk needs to be continued and studied in more depth. Also need to add some other factors to determine interaction between factors and determine which profile will be more suitable for industrialization of camel milk.

Conflict of interest

All authors have read and are familiar with the contents of the article and have no conflicts of interest.

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References

1. Dioli M. Dromedary (Camelus dromedarius) and Bactrian camel (Camelus bactrianus) crossbreeding husbandry practices in Turkey and Kazakhstan: An in-depth review //Pastoralism. – 2020. – Т. 10. – №. 1. – С. 6.

2. Akhmetsadykova S. H., Konuspayeva G., Akhmetsadykov N. Camel breeding in Kazakhstan and future perspectives //Animal Frontiers. – 2022. – Т. 12. – №. 4. – С. 71-77.

3. Burger P. A., Ciani E., Faye B. Old World camels in a modern world–a balancing act between conservation and genetic improvement //Animal Genetics. – 2019. – Т. 50. – №. 6. – С. 598-612.

4. Ashour G., Abdel-Rahman S. M. Camels as a miracle key for animal production sustainability in Egypt //Egyptian Journal of Animal Production. – 2022. – Т. 59. – №. 4. – С. 33-43.

5. Faraz A. Younas, M.; Lateef, M.; Muhammad, G. Effect of intensive and semi-intensive management systems on growth performance and economics of Marecha (Camelus dromedarius) calves reared under desert conditions //Pak. J. Agric. Sci. – 2018. – Т. 55. – С. 625-632.

6. El-Agamy E. S. I. Camel milk //Handbook of milk of non-bovine mammals. – 2006. – С. 297-344.

7. Rahmeh R., Alomirah, H.; Akbar, A.; Sidhu, J. Composition and properties of camel milk //Milk production, processing and marketing. – 2019.

8. Mehta S. C., Bissa, U. K., Patil, N. V., Pathak, K. M. L. Importance of camel milk and production potential of dromedary breeds. – 2011.

9. Faye B., Madani H., El-Rouili S. A. H. Camel milk value chain in Northern Saudi Arabia //Emirates Journal of Food and Agriculture. – 2014. – С. 359-365.

10. Brezovečki A. Čagalj, M.; Dermit, Z. F.; Mikulec, N.; Ljoljić, D. B.; Antunac, N. Camel milk and milk products //Dairy/Mljekarstvo. – 2015. – Т. 65. – №. 2.

11. Cherifa B., Oumelkheir S., Amar E. Influence of feeding on some physicochemical and biochemical characteristics of camel milk (Camelus dromadarius) //Emirates Journal of Food and Agriculture. – 2018. – С. 251-255.

12. Ghude M. I., Maigandi, S. A., Muhammad, I. R., Alkali, H. A. Chemical composition of camel (Camelus dromedarius) milk as affected by parity and seasons under pastoral production systems in north-west, Nigeria //Nigerian Journal of Animal Production. – 2016. – Т. 43. – №. 2. – С. 202-210.

13. Elobied A. A., Osman, A. M., Kashwa, S. M. A., Ali, A. S., Ibrahim, M. T., Salih, M. M. Effect of parity and breed on some physico-chemical components of Sudanese camel milk. – 2015.

14. Konuspayeva G., Baubekova, A., Akhmetsadykova, S., Faye, B. Traditional dairy fermented products in Central Asia // International Dairy Journal. – 2023. – Т. 137. – С. 105514.

15. Конуспаева Г. С., Фай, Б., Мелдебекова, А. А., Нармуратова, М. Х., Серикбаева, А. Д. Типология верблюжьего молока различных регионов Казахстана //Вестник. Серия биологическая. №. – 2018. – Т. 1. – №. 74. – С. 124.

16. Ayadi M., Aljumaah, R. S., Musaad, A., Samara, E. M., Abdelrahman, M. M., Alshaikh, M. A., Saleh, S. K., Faye, B. Relationship between udder morphology traits, alveolar and cisternal milk compartments and machine milking performances of dairy camels (Camelus dromedarius) //Spanish Journal of Agricultural Research. – 2013. – Т. 11. – №. 3. – С. 790-797.

17. Akhmetsadykova S., Shertay, E., Konuspayeva, G., Torekhanov, A., Faye, B. Phenotypic biodiversity characterization of dromedary camels and hybrids in Kazakhstan //Tropical Animal Health and Production. – 2023. – Т. 55. – №. 2. – С. 79.

18. Faye, B., H. Abdallah, F. Almathen, B. Harzallah, S. Al-Mutairi. 2011. Camel biodiversity. Camel phenotypes in the Kingdom of Saudi Arabia, Camel Breeding, Protection and Improvement Center, project UTF/SAU/021/SAU, FAO Publ., Riyadh (Saudi Arabia), pp.78.

19. Elhassan S. M. B. M., Dowelmadina I. M. M., Ibtisam E. M. Effect of management system, parity orders and stages of lactation on chemical composition of camel milk //Journal of Veterinary Medicine and Animal Production. – 2015. – Т. 6. – №. 2.

20. Alhaj O. A., Altooq, N. J., Alenezi, A. F., Janahi, A. I., Janahi, M. I., Humood, A. M., AlRasheed, M. M., Bragazzi, N. L., Jahrami, H. A., Faye, B. Camel milk composition by breed, season, publication year, and country: A global systematic review, meta-analysis, and meta-regression //Comprehensive Reviews in Food Science and Food Safety. – 2022. – Т. 21. – №. 3. – С. 2520-2559.

21. Faye B., Konuspayeva, G., Messad, S., Loiseau, G. Discriminant milk components of Bactrian camel (Camelus bactrianus), dromedary (Camelus dromedarius) and hybrids //Dairy Science and Technology. – 2008. – Т. 88. – №. 6. – С. 607-617.

22. Konuspayeva G., Faye, B., Loiseau, G., Narmuratova, M., Ivashchenko, A., Meldebekova, A., Davletov, S. Physiological change in camel milk composition (Camelus dromedarius) 1. Effect of lactation stage //Tropical animal health and production. – 2010. – Т. 42. – С. 495-499.

23. Konuspayeva G., Faye B., Loiseau G. The composition of camel milk: a meta-analysis of the literature data //Journal of food composition and analysis. – 2009. – Т. 22. – №. 2. – С. 95-101.

24. Musaad A., Faye B., Al-Mutairi S. Seasonal and physiological variation of gross composition of camel milk in Saudi Arabia. Emir. J. Food Agric. – 2013, – 25(8) – 618-624

25. He J., Xiao, Y., Orgoldol, K., Ming, L., Yi, L., Ji, R. Effects of geographic region on the composition of Bactrian camel milk in Mongolia //Animals. – 2019. – Т. 9. – №. 11. – С. 890.

26. Liu C., Chen, H., Yang, X., Zhang, C., Ren, Z. Exploring the genomic resources of seven domestic Bactrian camel populations in China through restriction site-associated DNA sequencing //Plos one. – 2021. – Т. 16. – №. 4. – С. e0250168.

27. Ming L., Yuan, L., Yi, L., Ding, G., Hasi, S., Chen, G., Jambl, T., Hedayat-Evright, N., Batmunkh, M., Badmaevna, G. K. Whole-genome sequencing of 128 camels across Asia provides insights into origin and migration of domestic Bactrian camels // bioRxiv. – 2019. – С. 656231.

28. Zahran K., Mounir N., Tabarek J. Compositional aspects and bacteriological quality of camel milk from Tunisian oasis. – 2021.

29. Birhan M., Mekuriaw, Y., Tassew, A., Tegegne, F. Multi-source monitoring of dairy farm management practices and milk quality analysis in Amhara region, Ethiopia. – 2022.

References

1. Конуспаева, Г. С., Фай, Б., Мелдебекова, А. А., Нармуратова, М. Х., & Серикбаева, А. Д. (2018). Типология верблюжьего молока различных регионов Казахстана. Вестник. Серия биологическая. №, 1(74), 124.

2. Akhmetsadykova, S. H., Konuspayeva, G., & Akhmetsadykov, N. (2022). Camel breeding in Kazakhstan and future perspectives. *Animal Frontiers*, *12*(4), 71-77.

3. Akhmetsadykova, S., Shertay, E., Konuspayeva, G., Torekhanov, A., & Faye, B. (2023). Phenotypic biodiversity characterization of dromedary camels and hybrids in Kazakhstan. *Tropical Animal Health and Production*, *55*(2), 79.

4. Alhaj, O. A., Altooq, N. J., Alenezi, A. F., Janahi, A. I., Janahi, M. I., Humood, A. M., ... & Faye, B. (2022). Camel milk composition by breed, season, publication year, and country: A global systematic review, meta-analysis, and meta-regression. *Comprehensive Reviews in Food Science and Food Safety*, *21*(3), 2520-2559.

5. Ashour, G., & Abdel-Rahman, S. M. (2022). Camels as a miracle key for animal production sustainability in Egypt. *Egyptian Journal of Animal Production*, *59*(4), 33-43.

6. Ayadi, M., Aljumaah, R. S., Musaad, A., Samara, E. M., Abdelrahman, M. M., Alshaikh, M. A., ... & Faye, B. (2013). Relationship between udder morphology traits, alveolar and cisternal milk compartments and machine milking performances of dairy camels (Camelus dromedarius). *Spanish Journal of Agricultural Research*, *11*(3), 790-797.

7. Birhan, M., Mekuriaw, Y., Tassew, A., & Tegegne, F. (2022). Multi-source monitoring of dairy farm management practices and milk quality analysis in Amhara region, Ethiopia.

8. Brezovečki, A., Čagalj, M., Dermit, Z. F., Mikulec, N., Ljoljić, D. B., & Antunac, N. (2015). Camel milk and milk products. *Dairy/Mljekarstvo*, *65*(2).

9. Burger, P. A., Ciani, E., & Faye, B. (2019). Old World camels in a modern world–a balancing act between conservation and genetic improvement. *Animal Genetics*, *50*(6), 598-612.

10. Cherifa, B., Oumelkheir, S., & Amar, E. (2018). Influence of feeding on some physicochemical and biochemical characteristics of camel milk (Camelus dromadarius). *Emirates Journal of Food and Agriculture*, *30*(4), 251-255.

11. Dioli, M. (2020). Dromedary (Camelus dromedarius) and Bactrian camel (Camelus bactrianus) crossbreeding husbandry practices in Turkey and Kazakhstan: An in-depth review. *Pastoralism*, *10*(1), 6. El-Agamy, E. I. (2008). Camel Milk; Handbook of Milk of Non-Bovine Mammals, Edited by Young W. Park and George FW Haenlein.

12. Elhassan, S. M. M., Dowelmadina, I. M., & Ibtisam, E. M. (2015). Effect of management system, parity orders and stages of lactation on chemical composition of camel milk. *Journal of Veterinary Medicine and Animal Production*, *6*(2).

13. Elobied, A. A., Osman, A. M., Kashwa, S. A., Ali, A. S., Ibrahim, M. T., & Salih, M. M. (2015). Effect of parity and breed on some physico-chemical components of Sudanese camel milk.

14. Faraz, A., Younas, M., Lateef, M., & Muhammad, G. (2018). Effect of intensive and semi-intensive management systems on growth performance and economics of Marecha (Camelus dromedarius) calves reared under desert conditions. *Pak. J. Agric. Sci*, *55*, 625-632.

15. Faye, B., Konuspayeva, G., Messad, S., & Loiseau, G. (2008). Discriminant milk components of Bactrian camel (Camelus bactrianus), dromedary (Camelus dromedarius) and hybrids. *Dairy Science and Technology*, *88*(6), 607-617.

16. Faye, B., Madani, H., & El-Rouili, S. A. (2014). Camel milk value chain in Northern Saudi Arabia.

17. Faye, B., R Abdallah, H., S Almathen, F., Harzallah, B. D., & E Al-Mutairi, S. (2011). Camel biodiversity. Camel phenotypes in the Kingdom of Saudi Arabia.

18. Ghude, M. I., Maigandi, S. A., Muhammad, I. R., & Alkali, H. A. (2016). Chemical composition of camel (Camelus dromedarius) milk as affected by parity and seasons under pastoral production systems in north-west, Nigeria. *Nigerian Journal of Animal Production*, *43*(2), 202-210.

19. He, J., Xiao, Y., Orgoldol, K., Ming, L., Yi, L., & Ji, R. (2019). Effects of geographic region on the composition of Bactrian camel milk in Mongolia. *Animals*, *9*(11), 890.

20. Konuspayeva, G., Baubekova, A., Akhmetsadykova, S., & Faye, B. (2023). Traditional dairy fermented products in Central Asia. *International Dairy Journal*, *137*, 105514.

21. 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*(2), 95-101.

22. Konuspayeva, G., Faye, B., Loiseau, G., Narmuratova, M., Ivashchenko, A., Meldebekova, A., & Davletov, S. (2010). Physiological change in camel milk composition (Camelus dromedarius) 1. Effect of lactation stage. *Tropical Animal Health and Production*, *42*, 495-499.

23. Liu, C., Chen, H., Yang, X., Zhang, C., & Ren, Z. (2021). Exploring the genomic resources of seven domestic Bactrian camel populations in China through restriction site-associated DNA sequencing. *Plos one*, *16*(4), e0250168.

24. Mehta, S. C., Bissa, U. K., Patil, N. V., & Pathak, K. M. L. (2011). Importance of camel milk and production potential of dromedary breeds.

25. Ming, L., Yuan, L., Yi, L., Ding, G., Hasi, S., Chen, G., Jambl, T., Hedayat-Evright, N., Batmunkh, M., & Badmaevna, G. K. (2019). Whole-genome sequencing of 128 camels across Asia provides insights into origin and migration of domestic Bactrian camels. BioRxiv, 656231.

26. Musaad, A., Faye, B., & Al-Mutairi, S. E. (2013). Seasonal and physiological variation of gross composition of camel milk in Saudi Arabia.

27. Rahmeh, R., Alomirah, H., Akbar, A., & Sidhu, J. (2019). Composition and properties of camel milk. *Milk production, processing and marketing*.

28. Zahran, K., Mounir, N., & Tabarek, J. (2021). Compositional aspects and bacteriological quality of camel milk from Tunisian oasis.

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