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Morphological Study and Dairy Productivity of *Camelus bactrianus* in Eurasia

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Abstract: In Eurasia, a common species of camel is the double-humped (*Camelus bactrianus*), which has not been studied in detail so far on morphological features of the exterior and dairy productivity. The research was carried out in Alakol-Agro LLP in the Alakol district, the Zhetysu region of the Republic of Kazakhstan, and the Republic of Tyva of the Russian Federation. The object of the research was the breeding stock of camels of purebred Kazakh Bactrian and Mongolian Bactrian of the Tuvan population. The formation of experimental groups of female camels of the Kazakh Bactrian of the Kyzylorda and South Kazakhstan type, as well as Mongolian Bactrian, was carried out according to origin and typicality. The purpose of the study is to study the morphological parameters and milk productivity of *Camelus bactrianus* in Eurasia. The coefficient of reproductive ability in *Camelus bactrianus* camelids varies from 0.49-0.51. Full-aged *Camelus bactrianus* camelids have an average live weight of 495.7, 615.6, and 695.1 kg. The height between the humps of *Camelus bactrianus* is 163.5, 175.7, and 184.6 cm. The oblique body length of camelids was 149.3, 162.9, and 164.8 cm. The chest circumference ranged from 223.7-243.8 cm. The girth of the pastern ranged from 20.9-21.4 cm in camelids. The examined camels corresponded to the elite + I class. The highest milk yield for 275 days of lactation is characterized by camels of the Kazakh Bactrian breed of the South Kazakhstan type (1732.5 kg), in comparison with the peers of the Kazakh Bactrian of the Kyzylorda type (1408.6 kg) and the Mongolian bactrian of the Tuvan population (1154.8 kg). The rate of breast transfer varied from 0.95-1.52 kg/min. The lactation index was 97.0-162.8 kg. The caloric and energy value of 100 g of *Camelus bactrianus* camel milk ranged from 78.3 kcal or 2249.1-87.0 kcal or 2515.6 kJ.

Keywords: Body Measurements, Morphological Features, Camels, *Camelus bactrianus*, Live Weight, Milk Biochemistry, Milk Production

Introduction

Camels play an important role in human life, especially in arid regions, due to their multi-purpose significance and unique ability to adapt to harsh conditions and economic value in desert areas, where they are used primarily for transportation and trade and as a source of food (camel meat and milk) and technical raw materials (camel wool and

leather) (Ming *et al*., 2022, Faye, 2020).

Bactrian camels (*Camelus bactrianus*) in Eurasia are represented by the Kazakh Bactrian, Kalmyk Bactrian, and Mongolian Bactrian breeds (Baimukanov, 1989).

Dromedary camels (*Camelus dromedarius*) of the Turkmen Arvana breed are also bred in Eurasia (Nazhmeddinovich *et al*., 2020). When breeding dromedary camels (*Camelus dromedarius*) in Kazakhstan, attention is paid to selection for milk productivity (Baimukanov *et al*., 2021).

Bactrian camels are predominantly found in the desert steppes of Central Asia, namely China, Mongolia, Russia, Kazakhstan, and Iran. Moreover, different habitat conditions, breeding controls, and food sources have resulted in domestic Bactrian camels evolving into many unique populations, each with local and morphological characteristics. However, due to the continuous development of modern transportation, improved mechanization of agriculture, and the production of camel milk products, the number of purebred Bactrian camels is rapidly declining due to the increase in the marketable population of hybrid camels, which leads to the depletion of the genetic resources of Bactrian camels (Yi *et al*., 2017, Jirimutu *et al*., 2012, Ali *et al*., 2019).

Currently, camels are more often used as dairy animals to meet the needs of the local dairy industry, in the production of various types of camel milk products. This direction is relevant in India. Indian Bactrian camel breeds are currently being evaluated for their dairy potential and efforts are being made to breed dairy-type camels. To this end, it is proposed to increase attention to the assessment and selection of the udder shape of breeding stock (Liu *et al*., 2019).

In camel breeding, current trends are the study of genome polymorphism of Bactrian camels of dairy productivity (Ming *et al*., 2016; 2017).

Due to the growing world population and increasing demand for animal products, camel milk, and meat is no exception. Therefore, to meet the population's needs for

meat and milk, it is necessary to pay attention to targeted selection for milk and meat types (Dioli, 2020, Nagy *et al*., 2022).

One of the advantages of camels is that they are well adapted to arid conditions, where breeding other types of dairy cattle is ineffective (Gilbert *et al*., 2021).

In turn, Kazakhstan has huge areas of semi-desert, desert, and steppe pastures, where camel farming is intensively developing. In Kazakhstan, the demand for camels is rapidly increasing as productive animals, from which milk, wool, and meat are obtained. The Republic of Kazakhstan is traditionally one of the world's leading producers of camel milk. However, one of the pressing problems of productive camel farming is the sustainable development of dairy camel farming, caused by the excess demand for camel milk over the real possibility of its production. The factors limiting the increase in camel milk production to fully meet the needs of the domestic and foreign markets are, firstly, the low milk productivity of animals; secondly, the small number of specialized dairy farms in relation to the total population (Abdullayev *et al*., 2022). Milk productivity can be influenced by the following factors: animal age, breed, milking technology, feeding, and maintenance (Elmira *et al*., 2020, Nazhmeddinovich *et al*., 2020).

The aim of the study is to study the morphological features of the exterior and milk productivity of female camels of double-humped camels (*Camelus bactrianus*) in Eurasia.

Materials and Methods

The object of the research was the breeding stock of purebred Kazakh Bactrian and Mongolian Bactrian of the Tuvan population camels.

The research was carried out in the agricultural production complex "Alakol-Agro" of the Alakol district of the Zhetysu region of the Republic of Kazakhstan and the Republic of Tyva of the Russian Federation.

The research was conducted in compliance with the basic norms of bioethics. The methodology used for conducting research on camels of the studied breeds meets the requirements of biological safety and ethical principles of experimentation on animals (Protocol No. 3 of October 01, 2023).

The formation of experimental groups of female camels of the Kazakh Bactrian of the Kyzylorda and South Kazakhstan types, as well as Mongolian Bactrian, was carried out according to the common method (Baimukanov *et al.*, 2024).

The yield of colts per 100 female camels was determined by the formula (1):

$$YC = \frac{365 \text{ x } 100}{ICP} \quad (1)$$

where, *YC* is the yield of colts per 100 females, %, 365 Average length of the calendar year, days, 100 Constant coefficient, *ICP* Intercolting period, days.

The reproductive capacity coefficient was calculated using the following formula (2):

$$RCC = \frac{365}{ICP} \quad (2)$$

where, *RCC* is the reproductive capacity coefficient, 365 is the average length of the calendar year, days, and *ICP* Intercolting period, days.

The process of milk formation in camels is uniform throughout the day, both with double and triple milking (Abdullayev *et al*., 2022; Ermakhanov *et al*., 2022).

The daily productivity of camels is determined by the method of control milking, taking into account the milk sucked by the colts at night according to the I.A. Saygin formula:

$$Mp = \frac{ADM}{t}\ x\ 24 \quad (3)$$

where, *Mp* is the milk productivity of female camel per day, kg; *ADM* is the actual daily milk yield, determined by the control milking method, kg; *t* is the time of participation of female in the milking process from the moment of foaling to the end of the last milking, hours; "24" is the number of hours in a day.

The milk production of females that are not milked in the first month of lactation can be judged by the young camel's growth since its main food is the mother's milk. It has been established that for 1 kg of young camel growth in the first month of life, an average of 10 kg of mother's milk is consumed.

Firstly, the difference between month-aged and newborn colts is used to determine the growth rate per month and per day. Then the average daily gain is multiplied by 10. For example, if a colt weighed 40 kg at birth and 85 kg at one month of age, then the average daily milk production of its female will be:

$$\frac{(85-40)}{30}\times 10 = 15 kg\ milk \quad (4)$$

The processing of digital data was carried out according to the formula with further processing and analysis (The Basics of Biometrics, 2011).

Farms regularly keep a log of control milkings, taking into consideration the number of milking camels and milk produced. Based on the results of the accounting, the most productive animals are selected, through which the breeding core is formed.

Results and Discussion

Results of the studies of reproductive traits of *Camelus bactrianus* showed that the Mongolian Bactrian of the Tuvan population is late-ripening (Table 1).

The age of the first coating in the Mongolian Bactrian is 18,243.2 days, which is significantly higher in comparison with the mates of the Kazakh Bactrian of the Kyzylorda type (14,554.8 days) and the Kazakh Bactrian of the South Kazakhstan type (14,618.1 days).

The intercolting period was 715.8 days for Kazakh Bactrian of the Kyzylorda type, 730.5 days for the Kazakh Bactrian of the South Kazakhstan type, and 745.6 days for the Mongolian Bactrian of the Tuvan population.

The reproductive capacity coefficient of Camelus camels bactrianus varies from 0.49-0.51. A good zootechnical indicator is the yield of colts per 100 females of 41-43%, in exceptional cases for a highly valuable gene pool of 46-50%. That is, *Camelus bactrianus* are considered highly valuable individuals.

The largest representatives of *Camelus bactrianus* are female camels of the Kazakh Bactrian breed of the Kyzylorda type, in comparison with the mates of the Kazakh Bactrian of the South Kazakhstan type and the Mongolian Bactrian of the Tuvan population.

The camelids of the first group turned out to be the largest in terms of live weight, surpassing the peers of the second group by 79.5 kg and the third group by 199.4 kg. The examined camel mothers corresponded to the elite class + class I (Table 2).

The coefficient of variation in live weight of *Camelus bactrianus* was 11.4-19.2%, metacarpus girth was 1.8-2.3%, chest girth 3.7-5.8%, oblique body length 2.6-3.3% and height between humps 3.1-4.2%.

The average standard deviation for live weight is for Camelus camels bactrianus 7.6-11.4 kg, height between humps 0.8-1.1 cm, oblique body length 1.-2.1 cm, chest girth 2.2-2.6 cm and metacarpus girth 0.09- 0.12 cm.

The highest yield of marketable milk over 275 days of lactation is characterized by camels of the Kazakh Bactrian breed of the South Kazakhstan type (1732.5 kg), in comparison with the mates of the Kazakh Bactrian of Kyzylorda type (1408.6 kg) and Mongolian Bactrian of the Tuvan population (1154.8 kg). The milk production coefficient was 510 kg for the Kazakh Bactrian of the Kyzylorda type, 600 kg of the Kazakh Bactrian of the South Kazakhstan type, and 460 kg of the Mongolian Bactrian of the Tuvan population (Table 3).

Table 1: Reproductive traits of *Camelus bactrianus* females

	Breed		
Indicators	Kazakh Bactrian of Kyzylorda type (n = 29)	Kazakh Bactrian of south Kazakhstan type (n = 28)	Mongolian Bactrian of the Tuvan population (n = 26)
Age of first colting, days	14554.8±18.2	14618.1±12.7	18243.2±27.3
Intercolting period, days	715.8±22.1	730.5±25.9	745.6±31.4
Yield of camels per 100 females, animals	51.2±0.5	49.9±0.6	49.0±1.1
Reproductive Capacity coefficient (RCC)	0.51±0.01	0.50±0.02	0.49±0.02

Table 2: Measurements and live weight of full-age milking *Camelus bactrianus*

Indicators	Measurements, cm				Live weight, kg
	Height between humps	Oblique body length	Girth		
			Chest	Metacarpus	
Kazakh Bactrian of Kyzylorda type (n = 29)					
X ± m x	184.6±1.2	164.8±0.7	243.8±2.3	21.4±0.2	695.1±15.8
Lim	178-192	158-174	235-262	20.5-22.0	630-740
σ	0.9	1.5	2.5	0.11	8.9
C V	3.7	2.6	5.8	2.3	19.2
Kazakh Bactrian of South Kazakhstan type (n = 28)					
X ± m x	175.7±0.8	162.9±1.1	241.5±3.1	21.2±0.2	615.6±16.7
Lim	167-185	153-168	229-250	20.5-21.5	540-700
σ	0.8	1.9	2.2	0.12	7.6
C V	3.1	2.7	4.4	2.1	14.9
Mongolian Bactrian of Tuvan population (n = 26)					
X ± m x	163.5±1.5	149.3±0.8	223.7±2.8	20.9±0.2	495.7±22.1
Lim	157-167	145-155	216-228	19.5-21.0	430-520
σ	1.1	2.1	2.6	0.09	11.4
C V	4.2	3.3	3.7	1.8	24.4

Explanation of the symbols; X ± m x – The arithmetic mean and the error of the arithmetic mean; δ – The average standard deviation Cv – Coefficient of variability

Table 3: Milk production of full-aged *Camelus bactrianus*

Live weight of mares, kg	Actual milk yield, kg		Gross milk yield (including milk sucked by the baby camel), kg		Milk production speed, kg/min	Milk coefficient (per 100 kg live weight)
	Per day	For 275 days of lactation	Per day	For 275 days of lactation		
Kazakh Bactrian of Kyzylorda type (n = 15)						
630.9±22.9	5.12±0.32	1408.6±76.9	11.5±0.65	3162.5±111.7	1.35±0.05	510
Kazakh Bactrian of South Kazakhstan type (n = 15)						
589.7±17.4	6.3±0.44	1732.5±99.8	12.7±0.38	3492.5±183.5	1.52±0.04	600
Mongolian Bactrian of Tuvan populations (n = 15)						
478.7±18.3	4.2±0.26	1154.9±83.1	7.9±0.45	2172.5±141.3	0.95±0.02±	460

The lowest rate of milk production is observed in female camels of Mongolian Bactrians of the Tuvan population-0.95 kg/min, the highest in Kazakh Bactrians of the South Kazakhstan type 1.52 kg/min, in comparison with Kazakh Bactrians of the Kyzylorda type 1.35 kg/min.

There is a superiority of camels of the Kazakh Bactrian breed of the South Kazakhstan type in the yield of milk fat (97 kg) and milk protein (65.8 kg), in comparison with their mates of the Kyzylorda type (81.7 and 50.7 kg). The lactation indicator was 132.4 kg for camels of the Kazakh Bactrian of the Kyzylorda type, 162.8 kg for the Kazakh Bactrian of the South Kazakh type, and 97.0 kg for the Mongolian Bactrian of the Tuvan population (Table 4).

The results of studies of the biochemical parameters of milk from dairy camels made it possible to determine the fat content of Kazakh Bactrian camels of the Kyzylorda type, fat content 5.8%, protein 3.6%, lactose 5.1%, ash 0.93%, with a milk density of 32.8±0.37° A and acidity 17.3° T (Table 5).

In Kazakh Bactrian camels of the South Kazakhstan type, the fat content in milk was 5.6%, protein 3.8%, lactose 4.9%, ash 0.97%, density 32.5° A, acidity 16.9° T. In the mother camels of the Mongolian Bactrian of the Tuvan population, the milk content was 5.1%, protein 3.3%, lactose 4.4%, ash 0.89%, density 31.9° A, acidity 16.5° T.

Table 4: Lactation indicator of full-aged *Camelus bactrianus* dairy camels

Milk production indicators	Signs		
	Fat, kg	Protein, kg	Lactational indicator, kg
Kazakh Bactrian of Kyzylorda type (n = 15)			
X ± m x	81.7±1.4	50.7±0.8	132.4
δ	1.8	1.5	-
Cv	24.3	16.5	-
Kazakh Bactrian of South Kazakhstan type (n = 15)			
X ± m x	97.0±1.7	65.8±1.1	162.8
δ	1.2	0.9	-
C v	17.6	14.8	-
Mongolian Bactrian of Tuvan populations (n = 15)			
X ± m x	58.9±0.9	38.1±0.5	97.0
δ	2.1	1.1	-
Cv	25.1	18.4	-

Explanation of the symbols: X ± m x – The arithmetic mean and the error of the arithmetic mean; δ – The average standard deviation; Cv – Coefficient of variabilit

Table 5: Camelus dairy camels bactrianus

Milk production indicators	Biochemical characteristics					
	Fat, %	Protein, %	Lactose, %	Ash, %	Density,° A	Acidity,° T
Kazakh Bactrian of Kyzylorda type (n = 15)						
X ± m x	5.8±0.07	3.6±0.06	5.1±0.24	0.93±0.07	32.8±0.17	17.3±1.12
δ	0.17	0.11	0.19	0.05	1.25	1.17
C v	12.6	6.5	7.5	9.3	14.3	11.9
Lim	5.3-6.5	3.5-3.9	4.5-8.0	0.88-0.99	29.5-34.0	16-20
Kazakh Bactrian of South Kazakhstan type (n = 15)						
X ± m x	5.6±0.08	3.8±0.05	4.9±0.18	0.97±0.09	32.5±0.25	16.9±1.44
δ	0.12	0.09	0.25	0.06	1.21	1.08
C v	9.7	4.8	6.2	10.1	14.5	8.7
Lim	5.5-6.2	3.6-3.9	4.4-7.5	0.90-0.99	30.0-33.5	16-19
Mongolian Bactrian of Tuvan population (n = 15)						
X ± m x	5.1±0.06	3.3±0.04	4.8±0.19	0.89±0.08	31.9±0.19	16.5±1.58
δ	0.19	0.09	0.18	0.04	1.14	1.11
C v	14.1	7.4	8.5	7.9	12.6	9.4
Lim	4.8-5.8	2.8-3.8	4.2-6.5	0.82-0.95	29.0-33.0	15.5-17.5

Table 6: Correlation coefficient between milk productivity indicators (r)

Indicators	*Camelus bactrianus*		
	Kazakh Bactrian of Kyzylorda type	Kazakh Bactrian of South Kazakhstan type	Mongolian Bactrian of the Tuvan population
Milk yield, kg – Mass fraction of milk fat, %	-0.18	-0.25	-0.31
Milk yield, kg – Mass fraction of milk protein, %	-0.05	-0.09	-0.03
Mass fraction of milk fat, % – Mass fraction of milk protein, %	+0.24	+0.25	+0.23
Milk yield, kg – Amount of milk fat, kg	+0.91	+0.92	+0.86
Milk yield, kg – Amount of milk protein, kg	+0.93	+0.95	+0.89
Amount of milk fat, kg – Amount of milk protein, kg	+0.90	+0.91	+0.85

The caloric content and energy value of 100 g of camel milk from camel mothers of the Kazakh Bactrian of the Kyzylorda type was 87.0 kcal or 2515.6 kJ, the Kazakh Bactrian of the South Kazakhstan type was 85.2 kcal or 2456.4 kJ, the Mongolian Bactrian of the Tuvan population was 78.3 kcal or 2249.1 kJ.

With an increase in milk production in dairy *Camelus bactrianus* there is a significant decrease in the mass fraction of milk fat and milk protein in milk. The influence of breed on the correlation coefficient between milk yield and the mass fraction of milk fat, which varies from -0.18 to -0.31, has not been established. The correlation coefficient between milk yield and the mass fraction of protein in milk varies from -0.03 to -0.09 (Table 6).

A very high positive relationship was established between milk yield and the amount of milk fat (from 0.86-0.92) and protein (from 0.89-0.95).

Full-aged *Camelus bactrianus* is characterized by a strong constitutional type and high milk production. The resulting camel milk corresponds in biochemical composition to a highly nutritious dairy product.

The selection of *Camelus bactrianus* and the selection of camel sires for them (Borax sire) based on milk production will not lead to an improvement in the quality characteristics of milk.

The breeding group of *Camelus bactrianus* on breeding farms should have a milk yield coefficient for the Kazakh Bactrian of the Kyzylorda type of 510 kg, the Kazakh Bactrian of the South Kazakhstan type of 600 kg and the Mongolian Bactrian of the Tuvan population of 460 kg.

Conclusion

The Kazakh Bactrian camel is the main planned breed, specializing in the production of milk, meat, and wool. The common method of increasing the dairy productivity of Kazakh Bactrian camels is purebred breeding. According to A. Baimukanov, the most promising animals are those that meet the following selection parameters: Live weight -600-650 kg, dairy productivity over 12 months of lactation of 1000-1200 liters of commercial milk with a fat content of 5.0-6.0%. Kazakh Bactrian camels of improved type have a commercial milk yield for six months of lactation of 426.0 kg. Kazakh Bactrians of the desired type are superior to the improved type in terms of marketable milk yield by 164.7 kg. According to D.A. Baimukanov, Kazakh Bactrian camels have a high repeatability of milk yield -0.84-0.92. Therefore, based on the first lactation, it is possible to

predict the milk yield of the second and subsequent lactations. According to A. Baimukanov, camel breeding in Kazakhstan should develop by increasing the number of purebred Kazakh Bactrian camels, which differ in their appearance and productivity depending on their belonging to a certain zonal type (Baimukanov *et al*., 2020; 2023). When conducting the study, special attention is paid to the body measurements, live weight, and milk yield of purebred Kazakh and Mongolian Bactrian camels.

Camels of the Mongolian Bactrian breed are perfectly adapted to the natural and climatic conditions of semi-deserts and dry steppes. This breed produces wool with a high fluff content, and high-quality meat and is also used under saddle and as a pack animal (He *et al*., 2019; Chuluunbat *et al*., 2014).

The Republic of Tyva is one of the unique regions in Russia where productive camel breeding, which is a traditional branch of agricultural production, is successfully developing. In terms of their economic, biological, and productive characteristics, Mongolian camels are noticeably superior to all types of farm animals in terms of resistance to the extreme conditions of the sharply continental climate of the Republic of Tyva (Kungaevna and Darzhaaevna, 2014). The relatively low milk production of camels bred in the Republic of Tyva can be explained by unsatisfactory feeding and maintenance conditions. Camels are kept on pasture all year round and no reserves are created for them. The low milking capacity is also explained by the fact that selection has not been carried out in the direction of increasing dairy productivity for a long time; the main attention was paid to the packing and riding qualities of camels.

Maintenance and breeding camels do not require large expenditures on-premises, feed, labor, energy, transportation costs, etc. Camels provide highly nutritious meat, wool, which has high heat capacity and softness, and milk, valuable for its nutritional and medicinal qualities. The need for camels as working animals has remained (Kungaevna and Darzhaaevna, 2016). Increasing the production of camel products is possible with a high level of selection and breeding work and improving the system for assessing the breeding and productive traits of animals.

It is recommended to use the obtained research results as a criterion for evaluating, selecting, and selecting camels *Camelus bactrianus*.

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Author's Contributions

Dastanbek Asylbekovich Baimukanov: Conceptualization, data analysis, and generalization of findings. Contributed to the implementation and preparation of the article.

Anuarbek Temirbekovich Bissembayev, Amangeldi Turabayevich Turabayev, Sayana Darzhaevna Mongush; Principal investigators responsible for the experimental research. Contributed to the implementation and preparation of the article.

Yusupzhan Artykovich Yuldashbayev: Conducted experimental research. Contributed to the implementation and preparation of the article.

Dauren Maratovich Bekenov, Khamit Ablgazinovich Aubakirov: Analyzed experimental data. Contributed to the implementation and preparation of the article.

Makpal Temirkhanovna Kargaeyeva: Assisted in the implementation and preparation of the article contributed.

Ethics

When conducting the research work, all the principles of scientific ethics are observed.

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