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SHORT COMMUNICATION
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Milking Frequency Optimization for Health and Productivity in Lactating Bactrian Camels

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ABSTRACT

This study evaluated the effect of different milking routines on the milk productivity of Kazakh Bactrian camels in the West Kazakhstan region. Sixty female camels were divided into four groups, each having three replicates, with milking intervals every 2, 3, 4, and 6 hours. Milk yields and physicochemical parameters of milk (fat content, density, protein content, sugar, and ash substances) were measured. The results showed that the highest productivity, 1,498.5L per period was observed when milking every 2 hours, especially during the first 3 months of lactation (57.26% of the total milk yield). However, under this routine, milk density and fat content decreased. The optimal milk quality (fat content: 5.82%, density: 1.031g/cm^3) was achieved at an interval of 4 hours. The most effective routine in terms of productivity is milking every 2-3 hours; however, for a balance between milk quality and animal health, milking once every 3 to 4 hours is preferable. Excessively frequent milking requires strict monitoring and proper feeding, while less frequent milking reduces overall productivity.

Keywords: Bactrian camel; Milk; Productivity; Lactation; Physicochemical parameters.

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INTRODUCTION

Camel breeding in Kazakhstan is a traditionally established branch of productive livestock farming (Bolaev, 2012; Akhmetsadykova et al., 2022). Camel breeding is of great economic importance in the economic development of vast territories in Kazakhstan, half of which are in desert and semi-desert zones (Koptileuov et al., 2024; Aidarbayeva et al., 2025; Nazarova et al., 2025). Zootechnical research and practice at the present stage is to preserve and improve the variety of economically valuable and biologically significant traits of Kazakh Bactrian camels (Bozymov et al., 2013; Doshanov et al., 2013; Abutalip et al., 2024; Tariq et al., 2024). Preserving genetic diversity within the existing gene pool while enhancing their productivity and reproductive ability remains a pressing issue when breeding Kazakh Bactrian camels (Baimukanov et al., 2017). Kazakh Bactrian camels are also reared for meat, but they are used as dairy animals in routine practices (Bekenov et al., 2023).

Camel milk is a basic need for sustaining of the people and they achieve multiple products from the milk (Tariq et al., 2024). The milk economics chiefly depends upon the quality and quantity of milk. Camel rearing people have to achieve a sufficient quantity of milk to fulfill their needs, simultaneously a low-quality milk has low demand in the market (Alhassani, 2024). Milk quality and quantity depends upon multiple factors, including nutrition, management diseases and environmental conditions (Tanimoun et al., 2021). Because of frequent observations of these factors, they are maintained, but multiple other factors, i.e., milking techniques, frequency, and duration, are not reported (Bai & Zhao, 2015). Research states that the interval in milking has a strong association with the quality and quantity of milk in dairy animals. For quality and quantity, an optimum interval is necessitated, which needs experimentation.

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This research has been designed to assess the effect of varying intervals during milking span of Kazakh Bactrian camels to check the effects of interval of milking on quantity and quality of the milk. This is a pioneer study on Kazakh Bactrian camels and provides a helpful insight on the milking of camels.

The study's purpose is to analyze the effect of the frequency of milking on the milk productivity of camels, evaluate the dynamics of milk yield and changes in the physicochemical characteristics of milk depending on the interval between milking, and determine the optimal milking routine to increase milk productivity and ensure animal health in the West Kazakhstan region.

MATERIALS & METHODS

Location

The study on milk productivity in Kazakh Bactrian camels was conducted at the Khanskaya Orda LLP in the Bokey Orda district of the West Kazakhstan region (Fig. 1).

Fig. 1: Location Map.

Experiment Design

The experiment involved 60 camels, which were divided into 4 groups, each having 3 replicates, with 5 female lactating camels in each group. All the camels were maintained at standard feeding and keeping. The groups were based on the interval of milking. In group 1, the camels were milked every 2 hours, while groups 2, 3, and 4 were milked every 3, 4, and 6 hours, respectively. The milk productivity of the experimental groups of female camels was studied through monthly control milking, starting from the third month of lactation, over one year. The female camels were milked from three udder lobes, and the baby camels were allowed to suck on the fourth one.

Management of Camels

Four groups of Bactrian camels were selected for the study, utilizing the analog principle. The feeding and keeping conditions for all groups of animals were the same. All camels were kept in standard condition, corresponding to the recommendations for animal care during the lactation period. Feeding was performed with balanced diets, considering the animals' needs for proteins, fats, carbohydrates, vitamins, and minerals to ensure normal growth and milk production (Kalashnikov et al., 2003; Koptileuov et al., 2024).

Parameters

Macro- and microelements in milk were analyzed, and the relationship between the milking method and these indicators was demonstrated. Milk Fat, protein, and lactose, were also measured.

Milk productivity of the dairy herd was studied based on controlling milk yield and determining fat content, protein content, and milk density using a Lactane-3 analyzer once a month (Shidlovskaya et al., 2003; Shidlovskaya, 2004).

Statistical Analysis

Statistical analysis was performed using a one-way Anova in Minitab and Tukey's test was used afterwards.

RESULTS

Table 1 presents the results of milk yield measurements in four groups, according to the experimental design. As shown in Table 1, the total milk productivity of group 1 significantly exceeds that of similar Bactrian camels with any other milking routine. The average milk productivity was 1,498.5L of milk, and the average daily milk yield was 5.5L. When milking camels with an interval of 2 hours, there was an increase in the amount of milk released, especially at the beginning of lactation, when physiological processes were actively restored. The greatest increase in milk production occurred during the peak phase of lactation. This milking routine, with an interval of 2 hours, proves to be the most effective for achieving high milk productivity, but requires careful monitoring of the animals' condition and ensuring their proper nutrition.

Table 1: Milk production (L) of camels among the various groups of Kazakh Bactrian camels

Animal groups	Milk consumption	Milk sucked	Average milk productivity	Average daily milk yields
1	474.6	1,023.9	1,498.5	5.5
2	458.6	976.0	1,434.6	5.3
3	433.9	925.0	1,358.9	5.0
4	435.0	905.0	1,340.0	5.0

In group 2, where milking was done every 3 hours, the average milk productivity was 1,434.6L and the average daily milk yield was 5.3L. This routine involves intensive stimulation of the mammary gland, which can contribute to increased milk production, especially during the initial lactation period. However, it is essential to consider that such a routine necessitates careful monitoring of the animals' condition, as frequent milking without proper nutrition and recovery can lead to stress and exhaustion.

In group 3, with a milking frequency of every 4 hours, the average milk productivity was 1,358.9L, and the average daily milk yield was 5.0L. This milking routine helps to maintain a stable level of milk production, providing an optimal balance between the mammary gland stimulation and time for the animal to recover.

In group 4, with a milking frequency of every 6 hours,

the average milk productivity was 1,340.0L, and the average daily milk yield was 5.0L. This less intense milking routine reduces the load on the camel's body. However, to maintain high milk productivity, it is essential to monitor the health of the animals and ensure their proper nutrition.

Thus, a comparative study has found that the optimal frequency of milking to achieve the highest milk productivity is an interval of 2 hours. This interval allows for the maximum total milk yield and maintains a high level of productivity, especially at the beginning of lactation. However, milking every 4 hours is also an effective and balanced approach for sustainable results and minimizing animal stress.

The milking frequency significantly affects milk yield dynamics during lactation, as it regulates the stimulation of the mammary gland. Increasing the interval between milking sessions can reduce overall milk productivity, while more frequent milking sessions increase it, especially in the early stages of lactation.

However, the optimal milking routine should be balanced, considering the animals' health and physiological needs. Fig. 2 shows the dynamics of the daily milk yield of Bactrian camels.

The maximum milk yield from camels in the Khanskaya Orda LLP is observed in the first three months of lactation. In group 1, the first three months of the lactation period account for 57.26% of the total milk yield for the entire lactation period. In group 2, this indicator is 56.49%, indicating a similar dynamic of milk production, but with a slight decrease compared to group 1. In group 3, the first three months of lactation account for 54.77% of the total milk yield, which is slightly lower, indicating less intensive productivity in the early stages of lactation. This indicator is 52.74% in group 4, marking the most significant decrease in milk yield during the first months of lactation compared to the other groups.

Such indicators suggest that the highest milk productivity occurs during the initial months of lactation, and as the interval between milking increases, there is a corresponding decrease in milk yield. This may indicate that more frequent milking contributes to better preservation and increases milk production in the first months when physiological processes are established. The frequency of milking directly impacts the physiological state of camels. More frequent milking (for example, once every 2-3 hours) promotes better removal of milk from the mammary gland, which helps prevent lactostasis and stimulates milk production. However, an excessive milking frequency without proper nutrition and recovery can lead to stress, fatigue, and even exhaustion in the body, negatively impacting long-term milk productivity.

As our study demonstrated, the optimal milking routine is to milk every 3-4 hours. This routine strikes a good balance between stimulating milk productivity and allowing the camel sufficient time to recover. As a result, camels can maintain a high milk yield during the first months of lactation, effectively utilizing their milk production without overloading the animal. The results of our control milkings confirm the high milk productivity of Kazakh Bactrian camels bred on the farm. The camel milk under study is characterized by a high density, attributed to its high content of dry substances (Table 2). An analysis of the physicochemical and organoleptic properties of camel milk obtained at various milking intervals revealed that the frequency of milking significantly impacted its composition and quality.

In group 1, where milking was carried out every 2 hours, the milk had the lowest density of 1,029g/cm^3 and a fat content of 5.5%, which is attributed to insufficient time for milk fat accumulation. The acidity of milk in this group was the highest at 19.1^{0}T, which may indicate increased mammary gland activity during frequent milking.

In group 2, where milking was performed every 3 hours, there was a slight increase in density (1,030g/cm^3) and fat content (5.7%) compared with group 1. This is because, as the interval between milking increases, the mammary gland becomes more efficient at accumulating milk components.

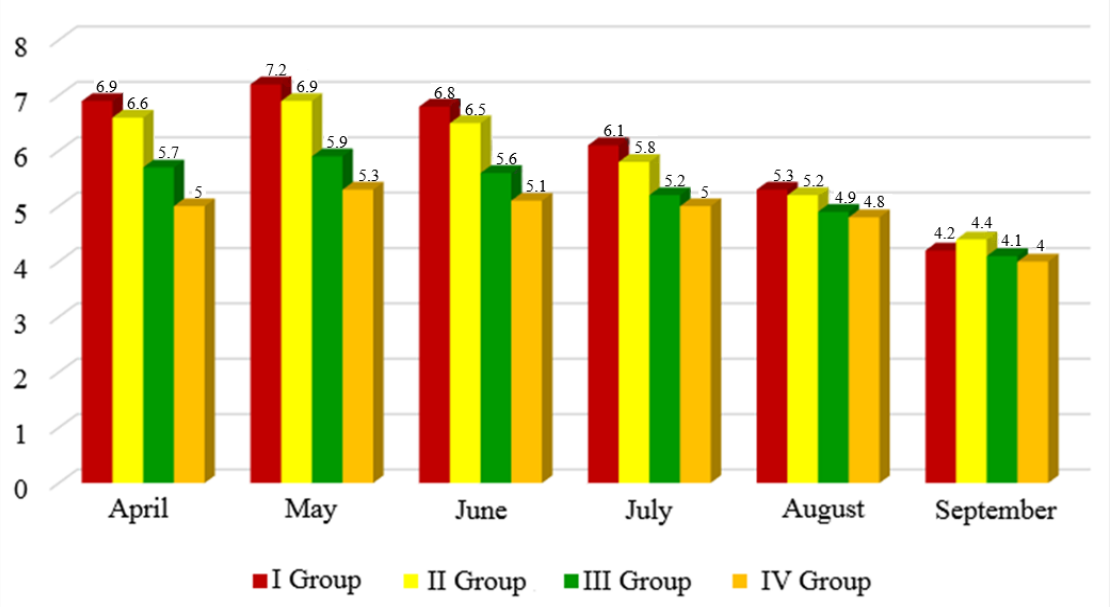

Fig. 2: Dynamics of daily milk yield of camels during lactation.

Table 2: Organoleptic and physicochemical parameters of Bactrian camel milk

Indicators	Group			
	Group 1	Group 2	Group 3	Group 4
Organoleptic studies				
Taste and smell	Neutral, odorless	Neutral, odorless	Neutral, odorless	Neutral, odorless
Consistency	Homogeneous, sediment-free, liquid	Homogeneous, sediment-free, liquid	Homogeneous, sediment-free, medium density	Homogeneous, sediment-free, thick
Color	White with a yellowish tinge	White with a yellowish tinge	White with a yellowish tinge	White with a yellowish tinge
Physicochemical study				
Acidity, ^{0}T	19.1	18.5	17.7	17.3
Density, g/cm^3	1.029	1.030	1.031	1.033
Fat, %	5.5±0.23	5.7±0.21	5.82±0.21	5.7±0.18
Protein, %	3.8±0.32	3.85±0.28	3.86±0.32	3.75±0.21
Sugar, %	4.5±0.13	4.6±0.11	4.8±0.11	4.7±0.09
Ash, %	0.95±0.31	0.93±0.22	0.92±0.21	0.91±0.13
Dry matter, %	14.5±0.29	14.6±0.32	14.78±0.36	14.58±0.28
Ca	0.22±0.15	0.23±0.19	0.24±0.18	0.23±0.14
P	0.09±0.05	0.10±0.07	0.10±0.09	0.09±0.09

In group 3, where milking took place every 4 hours, the milk was the fattiest, at 5.82%, and had an optimal density of 1,031g/cm³, indicating a better balance between the mammary gland stimulation and recovery time. The sugar content in the milk of this group was also the highest, 4.8%, which indicates a good ability of the mammary gland to produce carbohydrates.

In group 4, where milking was carried out every 6 hours, milk had the highest density of 1,033g/cm³ and a fat content of 5.7%. However, there was a slight decrease in protein content, at 3.75%, compared to the other groups. This is due to the longer interval between milking, which promotes fat accumulation, but may limit protein synthesis. Thus, the optimal frequency for obtaining milk with the best physicochemical and organoleptic characteristics is milking every 4 hours, as it ensures a balanced content of fat, protein, and sugar and preserves the high quality of the milk.

DISCUSSION

When analyzing milk productivity, it is essential to consider the impact of milking frequency on the quantity of milk and its qualitative characteristics (Boujenane, 2019). Important indicators of milk quality include the content of macro- and microelements, such as fat, protein, and lactose, directly related to the animal's physiological state, milking routine, and the impact of the milking routine on the mammary gland (Azwai et al., 2024; Khateeb et al., 2025).

The results on the effect of milking frequency on camel milk production are consistent with the work of other authors but also reveal some unique aspects that require a more in-depth analysis.

Our data indicates that the highest milk productivity is observed when milking occurs every 2-3 hours, particularly during the initial lactation period. These results have been confirmed in multiple studies (Baimukanov et al., 2023b). These studies indicate that regular and frequent milking stimulates the mammary gland, resulting in a higher milk yield during the early stages of lactation. Additionally, the work suggests that increasing the frequency of milking during active lactation improves total milk yield and enhances milk quality, a finding confirmed by our results for the group with a milking frequency of every 2-3 hours (Baimukanov et al., 2017).

Berezkina et al. (2022) and Nokusheva et al. (2023) emphasized that excessive milking frequency without proper care and balanced feeding can lead to stress and exhaustion in animals, which reduces their productivity. Al-Fayad (2023) and Tharwat et al. (2024) also support findings of this study regarding the need to monitor the condition of animals with frequent milking, noting that a lack of time for mammary gland recovery can negatively impact total milk yield and milk quality.

However, at longer intervals (4-6 hours), there is a decrease in milk productivity, which is also consistent with the previous work (Baymukanov, 2002). They explained that an increase in the interval between milking can lead to a decrease in mammary gland stimulation and, as a result, total milk yield, which is confirmed by our data. Studies have shown that milk obtained with an interval of 4 hours exhibits higher physicochemical parameters, such as fat content and density, which is also confirmed by our results (Baimukanov et al., 2023a). Our results indicate that milk from the group with this interval yielded the best results in these characteristics (Bekenov et al., 2023).

One of the main indicators of milk quality is its density (Al-Sobayil et al., 2024; Butar-Butar et al., 2024). The dynamics of milk productivity observed during lactation in our study coincide with the results presented in many works (Gnezdilova et al., 2023), which indicate that the highest milk yield occurs in the first three months of lactation. A decrease in milk production in subsequent months is associated with a reduction in mammary gland stimulation resulting from an increase in the interval between milking sessions. Our data on high milk yield in the first three months (57.26% of the total) confirm this trend.

Thus, our results confirm many of the conclusions reached by other authors and emphasize the importance of adopting a balanced approach to organizing the milking routine, considering the animals' physiological state. Excessively frequent milking or excessively long intervals can negatively affect the productivity and health of animals, necessitating further research to optimize milking routines under various conditions.

Conclusion

This research states that the interval of milking in the

Bactrian camel has a strong association with the quality and quantity of milk yield. Decrease in milking interval increases the quality of milk but the quantity is decreased. Optimum milking intervals lead to improved quality and quantity of milk. 4 hours milking interval is suitable for the optimum milk yield of animals.

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Author's Contribution: IZh, BK conceptualized the study and drafted the manuscript. FZ, AA and GK contributed to methodology and field survey design. SZh, MSh and BS performed laboratory analyses. BYe and DG assisted in data collection and validation. BS carried out statistical analysis and data interpretation. AA and GK provided technical support for molecular diagnostics. All authors critically revised the manuscript and approved the final version.

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