RESEARCH ON THE INFLUENCE OF DAILY MILKING FREQUENCY ON MILK PRODUCTION IN CARPATHIAN GOATS

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Abstract

Milking frequency is an important technological factor influencing the productive performance of dairy goats. This study evaluated its effect on milk production in 90 Carpathian females divided into three equal groups: females milked once daily (L1), twice daily (L2) or three times daily (L3). All animals were maintained under similar feeding and management conditions. Mean milk production was 176.84 ± 21.42 kg/female in L1, 214.93 ± 24.67 kg/female in L2 and 229.41 ± 22.83 kg/female in L3, with highly significant differences among groups ($P < 0.001$). Compared with once-daily milking, milk production increased by 21.54% in L2 and 29.73% in L3, whereas the additional gain from two to three daily milkings was 6.74%. The results demonstrate the positive effect of increased milking frequency and provide original data for establishing appropriate milking practices in Carpathian goats.

Key words: *Carpathian goat, milking frequency, milk production, lactation, milking management*

INTRODUCTION

Milk production represents one of the main productive traits of goats, and its level is influenced by both the genetic potential of the animals and the technological factors specific to the production system [1].

Within milk production technology, milking represents an essential stage, as its management and frequency can influence the secretory activity of the mammary gland, the amount of milk obtained, and the evolution of milk production throughout lactation [2].

Daily milking frequency is an important technological factor, and its effect on milk production may be influenced by the productive potential of the animals and the production conditions [1]. At the physiological level, milk production depends on the number of mammary secretory cells and their metabolic activity, both of which can be influenced by milking frequency [2].

Increasing the number of daily milkings results in more frequent removal of the milk accumulated in the mammary gland, whereas extending the interval between milkings may alter the functional response of the mammary gland and the mechanisms involved in the regulation of milk secretion [3].

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The effect of milking frequency on productive performance has been investigated in different goat breeds, with reported results indicating different responses depending on the biological and productive characteristics of the animals. Salama et al. (2003), in a study conducted on Murciano-Granadina goats, found that once-daily milking resulted in an 18% reduction in 4% fat-corrected milk yield compared with twice-daily milking, with reported values of 1.61 and 1.95 L/day, respectively. The authors also highlighted that the magnitude of the response to changes in milking frequency was influenced by the stage of lactation and parity [4].

A reduction in milking frequency has also been associated with lower milk production in goats with high productive potential. Komara et al. (2009), in a study conducted on Alpine goats, found that once-daily milking resulted in lower milk production compared with twice-daily milking [5].

The results reported in the literature highlight the importance of milking frequency for the expression of the productive potential of goats. However, increasing the number of daily milkings does not always result in a proportional increase in milk production. Torres et al. (2014), comparing once-, twice-, and three-times-daily milking in goats, reported a 26% increase in milk production when milking frequency was increased from once to twice daily, with no significant differences when the frequency was further increased from two to three milkings per day [6]. These findings highlight the need to evaluate the productive response associated with each level of milking frequency in order to establish a strategy adapted to the productive and technological characteristics of the herd.

At the same time, daily milking frequency should also be considered from the perspective of farm management, as changes in the number of daily milkings influence the labour requirements associated with this operation. Salama et al. (2003) pointed out that reducing milking frequency may contribute to increased labour productivity; however, this benefit should be considered in relation to the reduction in milk production associated with once-daily milking [4].

In Romania, the Carpathian breed represents one of the main indigenous goat populations and is raised under different production systems. Răducuță et al. (2015), analysing milk production in Carpathian goats raised under extensive and semi-intensive systems, reported differences in productive performance according to the production system [7]. However, information regarding the productive response of Carpathian goats to changes in daily milking frequency remains limited. Therefore, evaluating this technological factor may contribute to expanding the scientific information available for this breed and to establishing milking practices adapted to its productive characteristics.

The aim of this study was to evaluate the influence of daily milking frequency on milk production in Carpathian goats by comparing the productive performance of females milked once, twice, and three times daily. The working hypothesis was that increasing milking frequency would increase milk production and that the magnitude of the productive response would differ according to the number of daily milkings.

MATERIAL AND METHOD

The biological material used in this study consisted of 90 Carpathian female goats in their third lactation, with body weights ranging from 45 to 50 kg, monitored within the official milk performance recording system. The females were allocated to three experimental groups, each consisting of 30 animals. Throughout the experimental period, the goats were maintained under the

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same management and feeding conditions, with daily milking frequency being the only factor differentiating the experimental groups.

According to the number of daily milkings, Group I (L1) included 30 females milked once daily, Group II (L2) consisted of 30 females milked twice daily, at 07:00 and 17:00, while Group III (L3) included 30 females milked three times daily, at 06:00, 14:00 and 22:00.

The effect of milking frequency on milk production was evaluated over three consecutive months, corresponding to the official milk recording period. The first milk recording was performed approximately 40 days after kidding, while the following two recordings were carried out at intervals of 28–34 days. Milk production recording was performed according to the standard A4 method, in accordance with ICAR guidelines and the provisions of Order No. 22/2006.

Total milk production per lactation was determined using the Fleischmann method, which allows total production to be estimated based on the amounts of milk recorded at successive recording sessions and the time intervals between them, according to the following equation [8]:

$$MS = I_0\frac{(M1+M2)}{2} + I_1\frac{(M2+M3)}{2} + \ldots + I_{n-1}\frac{(Mn-1+Mn)}{2} + InMn$$

where:

MS – milk production per lactation;
M_1, M_2, M_n – amount of milk recorded during the 24-hour recording period;
I_0 – number of days between the beginning of milking and the first recording;
I_1, I_2, I_{n-1} – number of days between two consecutive recordings;
I_n – number of days between the last recording and the end of lactation.

To characterize milk production, the arithmetic mean, standard deviation (SD), coefficient of variation (CV%), and minimum and maximum values were calculated.

The statistical significance of the differences in milk production among the three experimental groups was evaluated using one-way analysis of variance (One-Way ANOVA), performed with the statistical analysis tools available in Microsoft Excel 2007.

The experimental factor analysed was daily milking frequency, represented by the three levels corresponding to groups L1, L2, and L3. The threshold for statistical significance was set at $p < 0.05$.

RESULTS

The results obtained revealed differences in milk production according to daily milking frequency. The lowest mean milk production was recorded in females from group L1, which were milked once daily, whereas increasing the milking frequency to twice and three times daily, respectively, was associated with an increase in mean milk production.

Table 1. Milk production according to daily milking frequency in Carpathian goats

Group	Milking frequency	n	Milk production (kg milk/female), $\bar{X} \pm SD$	CV (%)	Minimum (kg/milk/female)	Maximum (kg/milk/female)
L1	Once daily	30	176.84 ± 21.42	12.11	135.62	219.74
L2	Twice daily	30	214.93 ± 24.67	11.48	168.35	269.82
L3	Three times daily	30	229.41 ± 22.83	9.95	184.73	276.65

Females in group L1 achieved a mean milk production of 176.84 ± 21.42 kg/milk/female, with individual values ranging from 135.62 to 219.74 kg/milk/female.

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In group L2, characterized by twice-daily milking, the mean milk production was 214.93 ± 24.67 kg/milk/female, with individual values ranging from 168.35 to 269.82 kg/milk/female.

The highest mean milk production was recorded in group L3, in which females were milked three times daily, reaching 229.41 ± 22.83 kg/milk/female, with values ranging from 184.73 to 276.65 kg/milk/female.

Compared with group L1, increasing the milking frequency from once to twice daily resulted in a difference in mean milk production of 38.09 kg/milk/female, corresponding to an increase of 21.54%.

In group L3, mean milk production exceeded that recorded in L1 by 52.57 kg/milk/female, corresponding to an increase of 29.73%.

Regarding the dispersion of individual values, the coefficient of variation was 12.11% in L1, 11.48% in L2, and 9.95% in L3. The standard deviation was 21.42 kg/milk/female in L1, 24.67 kg/milk/female in L2, and 22.83 kg/milk/female in L3.

One-way analysis of variance revealed highly statistically significant differences among the mean milk production values of the three experimental groups ($p < 0.001$). The exact value obtained from the analysis was $p = 2.31 \times 10^{-10}$, confirming the influence of daily milking frequency on milk production.

The comparison between groups L2 and L3 revealed a smaller difference of 14.48 kg/milk/female, with milk production in the group milked three times daily being 6.74% higher than that in the group milked twice daily (Table 2).

Table 2. Differences in milk production among the experimental groups according to daily milking frequency

Comparison between groups	Difference in milk production (kg/milk/female)	Percentage differences (%)
L2 vs L1	+38.09	+21.54
L3 vs L1	+52.57	+29.73
L3 vs L2	+14.48	+6.74

Increasing daily milking frequency was associated with an upward trend in mean milk production (Figure1).

However, the magnitude of the productive response differed among the experimental groups, being more pronounced when milking frequency increased from once to twice daily and lower with the introduction of the third daily milking.

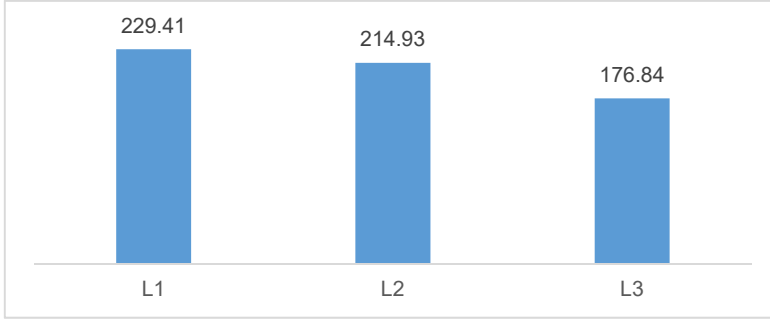


Figure 1. Mean milk production according to daily milking frequency in Carpathian goats (kg/milk/female)

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DISCUSSIONS

The results obtained in the present study highlight a distinct productive response of Carpathian goats to changes in daily milking frequency.

The greatest increase in milk production was recorded when milking frequency increased from once to twice daily, with a difference of 38.09 kg/milk/female between groups L1 and L2, corresponding to an increase of 21.54%. In contrast, the introduction of a third daily milking resulted in a smaller additional increase of 14.48 kg/milk/female, corresponding to 6.74%. This response indicates that successive increases in the number of daily milkings were not accompanied by proportional increases in milk production.

A similar trend was reported by Williams et al. (2012) in West African Dwarf goats, where the authors investigated, as in the present study, once-, twice-, and three-times-daily milking. Mean milk production increased from 181.5 mL/day with once-daily milking to 322.2 mL/day with twice-daily milking, while three-times-daily milking resulted in a production of 334.8 mL/day [9]. The increase obtained when milking frequency was raised from twice to three times daily was only 3.8% and was not statistically significant. Although the production levels and the breed investigated differed, the trend was similar to that observed in Carpathian goats, in which the 6.74% increase between L2 and L3 was considerably lower than the 21.54% increase between L1 and L2.

The results obtained for groups L2 and L3 are also supported by the findings of Henderson et al. (1983). The authors found that increasing milking frequency from twice to three times daily resulted in an approximately 8% increase in milk production, an effect observed at different stages of lactation [10]. The reported value is close to the 6.74% increase recorded in the present study for L3 compared with L2. In addition, the authors found that the response occurred immediately after the introduction of the third daily milking and highlighted the local nature of the stimulatory effect on the mammary gland.

Boutinaud et al. (2003), in a study conducted on Saanen goats in late lactation, also demonstrated the sensitivity of milk production to changes in milking frequency. After 23 days of the experimental protocol, milking frequency significantly influenced milk production, with an 8% increase recorded with three-times-daily milking and a 26% reduction with once-daily milking [11]. The authors also reported changes in the number of mammary epithelial cells and alveolar diameter according to milking frequency, providing physiological support for the productive response associated with changes in the number of daily milkings.

A marked response to reduced milking frequency was also observed by Wilde and Knight (1990). In their study, once-daily milking resulted in a 26% reduction in milk production. After returning to twice-daily milking, production recovered rapidly, and subsequently five of the six goats studied responded to the introduction of a third daily milking with an additional, but relatively small, increase in production [12]. This response supports the observation made in the present study that the productive difference associated with increasing milking frequency from once to twice daily is more pronounced than the additional benefit obtained by introducing a third daily milking.

Comparison of the results obtained in Carpathian goats with those reported for other breeds highlights differences in the magnitude of the response to changes in milking frequency. The 21.54% increase recorded in the present study when milking frequency increased from once to twice daily was higher than the approximately 18% reported by Salama et al. (2003) in

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Murciano-Granadina goats [4], but lower than the approximately 26% increase reported by Torres et al. (2014) in Majorera goats [6]. Thus, the response recorded in Carpathian goats falls between the values reported for these two breeds, confirming the importance of the second daily milking for the expression of milk production.

Differences among the results reported in the literature may be associated with the breed and productive characteristics of the animals, stage of lactation, duration of exposure to different milking frequencies, and characteristics of the experimental protocols. Therefore, comparisons of absolute milk production values among studies should be made with caution, whereas the relative response to changes in milking frequency allows a clearer assessment of productive trends.

From a technological perspective, the difference between the responses obtained with twice- and three-times-daily milking is of particular practical importance. Increasing milking frequency from once to twice daily was associated with an increase of 38.09 kg/milk/female, whereas the introduction of a third daily milking resulted in an additional increase of only 14.48 kg/milk/female.

Therefore, three-times-daily milking should be evaluated not only in terms of the additional milk production obtained, but also in relation to labour requirements and the organization of milking activities on the farm.

Overall, the results of the present study contribute to the available information regarding the productive response of Carpathian goats to changes in daily milking frequency.

The findings indicate that the main productive advantage is associated with increasing milking frequency from once to twice daily, whereas the introduction of a third daily milking provides additional milk production, but with an increase of lower magnitude.

CONCLUSIONS

Daily milking frequency significantly influenced milk production in Carpathian goats, confirming the importance of this technological factor in the expression of the animals' productive potential.

Among the variants analysed, increasing milking frequency from once to twice daily resulted in the most pronounced productive response, whereas the introduction of a third daily milking resulted in an additional increase of lower magnitude.

From a practical perspective, twice-daily milking may represent an efficient option for Carpathian goat production when considering the productive advantage obtained in relation to the labour requirements associated with milking activities. Three-times-daily milking may contribute to a further increase in production; however, the suitability of this option should be evaluated according to the technological and organizational conditions of the farm.

The results obtained contribute to expanding the available information on the productive response of the Carpathian breed to changes in milking frequency and may provide a basis for establishing milking practices adapted to the specific characteristics of this goat population.

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