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Influence of the milker on milkability of cows of the Bulgarian Rhodope Cattle breed

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Abstract: The milker's influence on the cows' milkability was studied in the local mountain breed, Bulgarian Rhodope cattle. The study included 18 cows, and on the 30th day after calving, the speed of the milk flow was measured at each milking at an interval of 30 seconds for 5 consecutive days. The average daily milk yield of the cows was 16.5 ± 0.12 kg, and the milkability was 1.197 ± 0.016 kg/min. The milker has a reliable influence on the milkability of the cows ($P < 0.001$) through the duration of milking ($P < 0.001$). The latter is determined both by the individual reaction of the cows to the milker and by his subjective decision to remove the milking apparatus and terminate milking. The difference in milking time for the same cows by different milkers is from 1.56 to 61.56 %, with the difference in milk yield being from 0.546 to 33.41 %.

Keywords: Bulgarian Rhodope cattle; milk cow; milkability; workability

INTRODUCTION

In 2009, milkability, along with temperament, was included as the seventh group of controlled traits by Interbull (Haugaard, 2023), and now is routinely part of the selection indices for dairy cattle breeds (Wrzecińska et al., 2024; Interbull, 2025). These traits are designated as “workability traits” and are defined as functional traits that affect the economics of dairy production (Szymik et al., 2021). Galluzzo et al. (2022) indicate that milkability is related to the efficient use of milking equipment and labour costs on farms. In this regard, low milkability is defined as a “management” problem (Galluzzo et al., 2022). However, high milkability is genetically associated with increased somatic cell count in milk and udder disease incidence (Galluzzo et al., 2022). This, in turn, reflects on longevity, which in recent years has been a priority in dairy cattle breeding (Sherwin, 2024; Weir et al., 2025). Sewalem et al. (2010) studied the relationship between milk-

ability and longevity in Holstein, Ayrshire, and Jersey cows and found that cows with very slow milking speeds had 36, 33, and 28% higher culling rates, respectively, compared to those with average milkability. However, culling rates were also higher for cows with very high milkability, by 11, 13, and 15%, respectively, which was primarily related to udder health. This demonstrates the difficulty in managing this trait, which is compounded by the low heritability of milkability (Jakobsen et al., 2008; Szymik et al., 2021).

The opinion that workability traits impact production profitability by reducing costs but are not directly related to milk yield (Szymik et al., 2021), is debatable. Erdem et al. (2010) found positive, significant correlations between milkability and daily milk yield (0.46), lactation milk yield (0.41), and 305-day lactation milk yield (0.45). Similar but lower correlations were established by Şahin et al. (2024). Vrhel et al. (2021) reported that primiparous cows have shorter milking times, lower

milking speed in the first two minutes, and lower milk yields compared to cows with more lactations.

Milkability is also related to other traits. Thus, in a study of robotic milking, Pedrosa et al. (2023) established moderate to high negative genetic correlations (-0.48 to -0.86) between milking time (min), milkability (kg/min), and somatic cells in milk, as well as high negative genetic correlations between average (-0.58 ± 0.02) and maximum (-0.56 ± 0.02) milkability (kg/min) with the number of unsuccessful milkings. The latter, according to the authors, shows that cows with lower milkability have more failed milking attempts. Japertiene et al. (2007) found that cows with subclinical mastitis had longer milking times and lower milkability compared to healthy cows, and first-lactation cows with higher milkability were more susceptible to udder infection. Gašparík et al. (2022) indicate that reduced milkability and prolonged milking time are observed up to one month after mastitis diagnosis. Japertiene et al. (2007) believe that more even milk flow is desirable in machine milking.

A significant number of factors influence milkability. Bobić et al. (2018) indicate that the duration and characteristics of machine milking depend on udder and teat conformation as well as cow productivity. Agravat et al. (2023) reported that in the Gir breed, milking time is significantly lower, while milk yield and milkability are significantly higher in calm cows compared to restless, nervous, and aggressive ones. The influence of temperament on cow milkability and milk yield was also observed by Fahim et al. (2021), when changing the type of milking parlour. Bruckmaier (2005) indicates that disturbed milk flow is due to reduced release or a complete lack of oxytocin from the pituitary gland, which can be caused by stress when milking in an unfamiliar environment, as well as in primiparous cows during the first months after calving. Tančin et al. (2004) also observed delayed milk release and significantly prolonged milking time when rearing conditions changed, with the individual response to change determined by the way animals were reared in the early postnatal period.

Change of milker or milker behaviour can also be attributed to potentially stressful factors. Breuer et al. (2000) report a correlative relationship between milker attitude and behaviour and the behaviour and productivity of dairy cows. The study proved that numerous variable factors in the behaviour of both animals and handlers are interrelated with productivity. Animals showing fear have lower milk yield with lower percentages of fat and protein in the milk.

In our earlier research on Bulgarian Rhodope Cattle (Zgurova and Nikolov, 2022), we observed that milkability was low, primarily due to the extended decline phase of the lactation curve after reaching the peak of milking flow. In the present study, we present data regarding the influence of the milker on milkability.

MATERIALS AND METHODS

The study was conducted at the farm of the Research Center of Stockbreeding and Agriculture – Smolyan (RCSA). The cows on the farm are in tie-stall housing, with a barn-pasture system adapted to climatic conditions. In the winter period, the ration includes concentrated feed (0.7 kg/l), alfalfa hay (2 - 3 kg), corn silage (20 - 25 kg), beetroot slices (2 kg), alternating daily with sunflower meal (1.5 kg). In spring, corn silage is excluded, and animals are turned out to pasture. The amount of concentrated feed is 0.5 kg/l, alfalfa hay is 7 - 8 kg, with beetroot slices and sunflower meal again alternating.

Milking on the farm is with a central milk pipeline, twice daily. Morning milking begins at 6:00 h, and evening milking at 17:00 h. Cows are divided into groups and are milked by permanent milkers who are replaced during weekly rest periods (2 days per week) or vacation.

Milkability was studied in 18 Bulgarian Rhodope Cattle (BRC) cows on the 30th day after calving. Observations were conducted over 5 consecutive days, with 8 to 10 controls performed for each animal. The total number of recordings was 178. The amount of milk obtained was determined with a milk meter, with data recorded

every 30 seconds. Milkability was studied within the actual machine milking period, covering the interval from attachment of the milking cluster to its removal.

Multifactorial analysis of variance was used for data processing. The linear model has the following general statistical form: $Y_{ijkl} = \mu + I_i + M_j + D_k + IM_{ij} + ID_{ik} + MD_{jk} + IMD_{ijk} + e_{ijkl}$, where I , M , D are fixed effects of the i -th individual ($n=18$), j -th milker ($n=4$), and k -th control period ($n=2$ – morning, evening), respectively, IM , ID , MD , IMD are random effects of one factor within another, e_{ijkl} - residual variance.

RESULTS AND DISCUSSION

The average daily milk yield of cows included in the observation was 16.5 ± 0.12 kg, ranging from 8.3 kg to 26.8 kg. The average milk yield per control milking was 8.4 kg (3.5 - 15.2 kg), milking duration was 7.6 ± 0.10 min (3.7 - 17.7 min), and milkability was 1.197 ± 0.016 kg/min.

In a previous publication (Zgurova and Nikolov, 2022), we conducted a detailed analysis of the lactation curve. Comparing our data with those reported by Lee and Choudhary (2006) for the Holstein breed, we found that the ascending phase is relatively similar: 1.0 - 1.5 min in our study versus 1.08 min in Lee and Choudhary (2006), and the plateau duration is shorter: 1.5 versus 2.97 min, respectively. However, the

most significant differences are in the descending phase of the lactation curve. Lee and Choudhary (2006) established that it lasts 2.67 min, while in our study it begins from the third minute and occupies more than $\frac{3}{4}$ of the total milking time. This led us to think that one of the reasons for low milkability may be the subjective decision to remove the milking apparatus and terminate milking by the milker, which is crucial for milking duration.

Through the applied statistical model, we found significant individual differences in milk yield, milkability, and milking duration of cows, which are however modified by the influence of other investigated factors (Table 1).

The milking period had a significant effect only on milk yield, and this effect persists in the interaction with the individual. The average milk yield of cows at morning milking was 8.797 ± 0.097 kg, and at evening milking - 7.954 ± 0.123 kg, with the difference of 9.58% being significant ($P < 0.001$).

The milker, as an independent factor, has a significant effect on milkability ($P < 0.05$) through milking duration ($P < 0.001$), since the differences in the amount of milk obtained by different milkers are not significant. In the individual*milker interaction, the significant effect of the milker on milkability is lost, but the effect on milking duration remains highly significant ($P < 0.001$), which shows that different milkers milk the same cows for different periods of time. In the individual*period*milker interaction, the signifi-

Table 1. Influence of individual, milking period, and milker on milk yield, milking duration, and cow milkability per control milking

Factor	Milk yield, kg		Milking duration, min		Milkability, kg/min	
	F	Sig.	F	Sig.	F	Sig.
Individual	28.236	0.000	21.289	0.000	25.772	0.000
Period (morning, evening)	18.791	0.000	1.456	0.230	2.346	0.129
Milker	2.251	0.087	14.592	0.000	3.485	0.019
Individual * Period	2.762	0.001	1.396	0.154	1.439	0.134
Individual * Milker	1.070	0.393	3.087	0.000	1.179	0.295
Period * Milker	1.024	0.385	1.034	0.381	1.296	0.280
Individual * Period * Milker	1.009	0.455	1.322	0.194	0.771	0.721

Source: Authors' own elaboration

cant effect of all factors decreases, one reason being their opposing influences.

The values of the studied indicators for individual milkers differ significantly (Table 2). Milker No. 3 obtained the largest amount of milk in the shortest time, and cow milkability was recorded as the highest. Milker No. 2 milked cows for almost the same time ($P>0.05$) (Table 3), but the amount of milk obtained was the lowest ($P<0.001$). Milker No. 1 milked cows for a longer time than No. 2 – 8.2% ($P<0.05$), but due to the greater amount of milk obtained ($P<0.01$), cow milkability does not differ significantly from his ($P>0.05$). Milker No. 4 milked cows significantly slower than the others – by 2.00 to 2.58 min ($P<0.001$) (Table 3). The prolonged milking time did not lead to substantial differences in milk obtained, and milkability was recorded as lowest compared to other milkers ($P<0.001$). The milk

obtained was only more than that of milker No. 2, but the difference was only 1.18% ($P>0.05$).

The individual reactions of cows to the milker are of interest, presented in Figures 1 - 6. Comparing the milking results of milkers No. 1 and No. 3 (Figs. 1, 2), it is evident that during morning milking, both milked the same cows for different times (Fig. 1), but the ranks by milking duration are mainly exchanged between neighbouring pairs. Spearman’s rank correlation (R_s) between the milking times of individual cows between the first and second milker is 0.857 ($P<0.05$). Milker No. 3 milked 4 cows slower than milker No. 1, and the remaining 3 (No. 1, 4, 5) in almost the same time, with the difference for cow 1 and 5 being 24 sec, and for No. 4 – 21.6 sec.

At evening milking, the differences for milking the same cows by the two milkers are more substantial, and R_s decreases to 0.429 ($P>0.05$).

Table 2. Milk yield, milking duration, and cow milkability per control milking when milked by different milkers

Milker №	Milk yield, kg		Milking duration, min		Milkability, kg/min	
	LS	SE	LS	SE	LS	SE
1	8.278	0.096	7.231	0.125	1.241	0.020
2	7.723	0.190	6.678	0.248	1.205	0.039
3	9.564	0.202	6.657	0.264	1.479	0.042
4	7.814	0.158	9.235	0.207	0.910	0.033

Source: Authors’ own elaboration

Table 3. Significance of differences in milk yield, milking duration, and cow milkability per control milking, when milked by different milkers

Indicator	Milker	2	3	4
Milking duration, min	1	0.553*	0.573	-2.004***
	2		0.021	-2.557***
	3			-2.578***
Milkability, kg/min	1	0.036	-0.238***	0.331***
	2		-0.274***	0.295***
	3			0.569***
Milk yield, kg	1	0.555**	-1.286***	0.463*
	2		-1.841***	-0.091
	3			1.749***

Source: Authors’ own elaboration

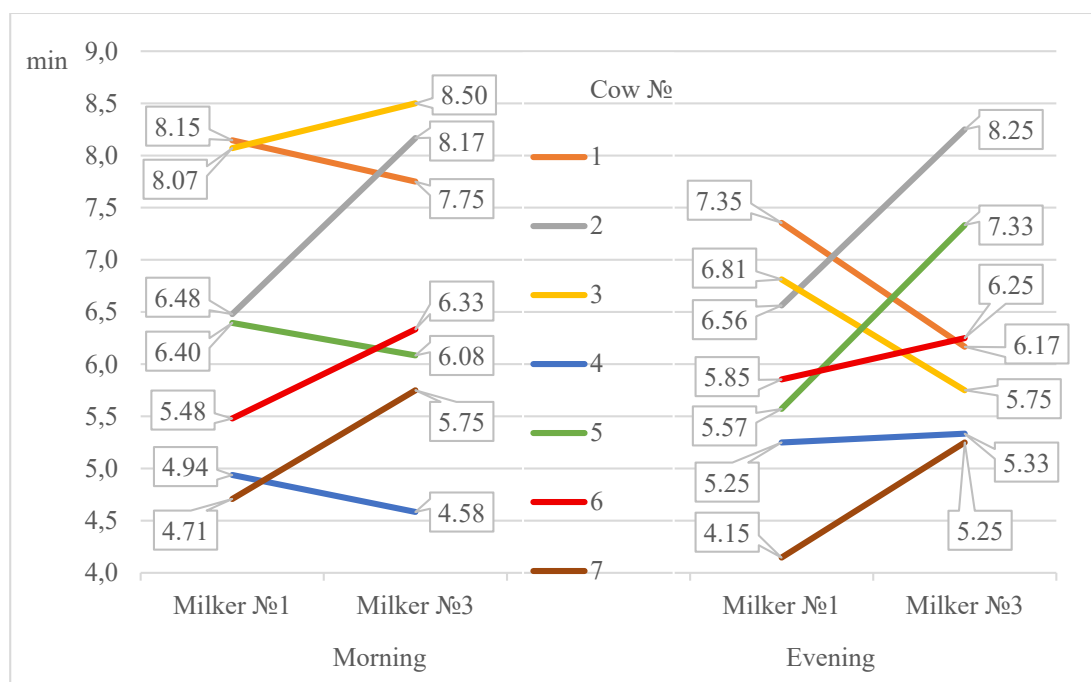


Figure 1. Milking time for the same cows by different milkers

Source: Authors' own elaboration

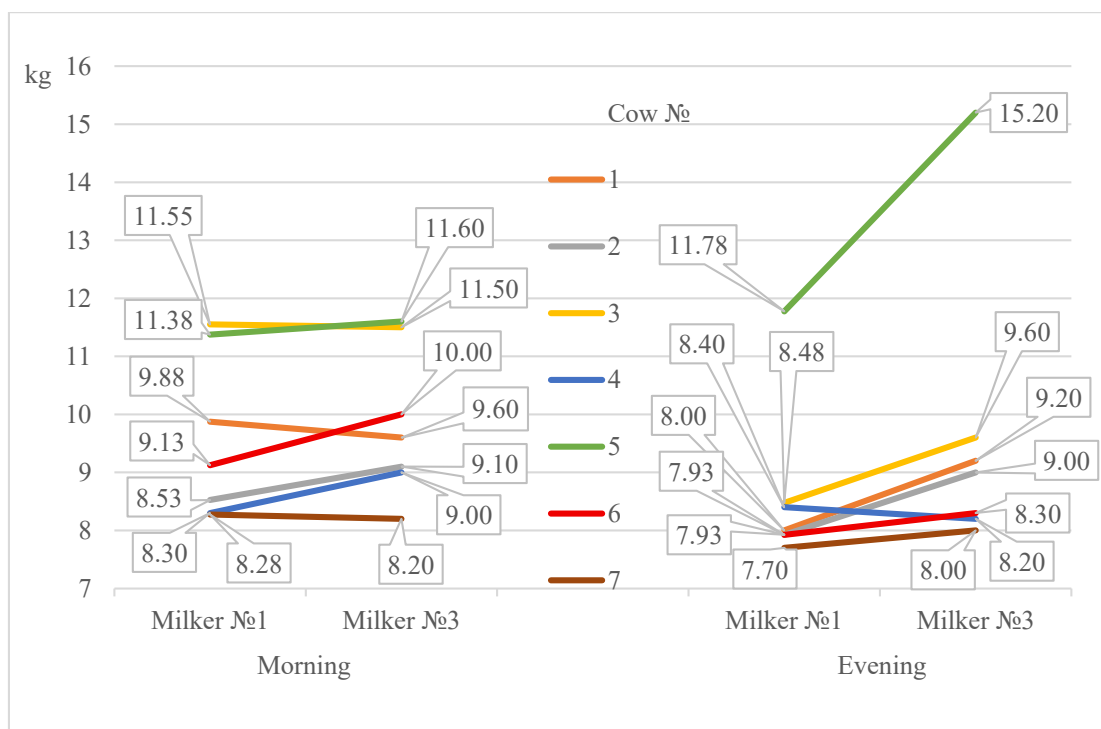


Figure 2. Milk yield of the same cows milked by different milkers (No. 1 and 3), at morning and evening milking

Source: Authors' own elaboration

Evening milking is shorter, but for milker No. 1 it decreased proportionally to the milking time of individual cows in the morning. For him, R_s between milking time in the morning and evening is 0.964 ($P<0.001$). For milker No. 3, the differences are greater and $R_s=0.500$ ($P>0.05$). However, the reason is not only the subjective decision of the milker to remove the milking apparatus, but rather the cows' reaction to him. This is evident when comparing Figs. 1 and 2. Thus, from cow No. 3, which at morning milking was milked by milker No. 3 27 sec slower compared to milker No. 1, 0.12 kg more milk was obtained. At evening milking, the first milker reduced the time by 1.34 min and obtained 3.07 kg less milk, while milker No. 3 reduced the milking time by 2.75 min and obtained 1.12 kg more milk. The difference is even greater for cow No. 5. With similar milking time in the morning – difference of 22.8 sec, the two milkers obtained equal amounts of milk – difference of 0.220 kg. At evening milking, milker No. 1 reduced milking time by 0.87 min, during which milk yield increased by 0.4 kg. Milker No. 3 increased the time by 1.76 min, and the milk obtained increased by 3.60 kg. Ob-

viously, similar milking time is not a sufficiently reliable indicator for characterizing milker skills. The assessment for proper individual approach to animals should be higher. In this case, the cows' reaction is more positive toward milker No. 3, which is also evident from the milk obtained – milker No. 3 received higher average yield -- 9.75 ± 0.514 , compared to 9.09 ± 0.388 for milker No. 1. This is against the background of similar amounts of milk obtained by both milkers from the same cows, with morning milking being practically identical – $R_s=0.929$ ($P<0.01$). At evening milking, R_s decreases to 0.775 but remains significant ($P<0.05$). The correlation between milk obtained from the same cows by one and the other milker for a control day is 0.882 ($P<0.001$).

The dynamics of milking time-milk yield correlations are also interesting. For milker No. 1 at morning milking, it is 0.699, and at evening – $R_s=-0.080$. For milker No. 3 at morning milking $R_s=0.347$, and at evening – 0.468. This again demonstrates the more positive reaction of cows to milker No. 3.

A second group of cows was milked by milkers No. 1 and 4. We already mentioned that milk-

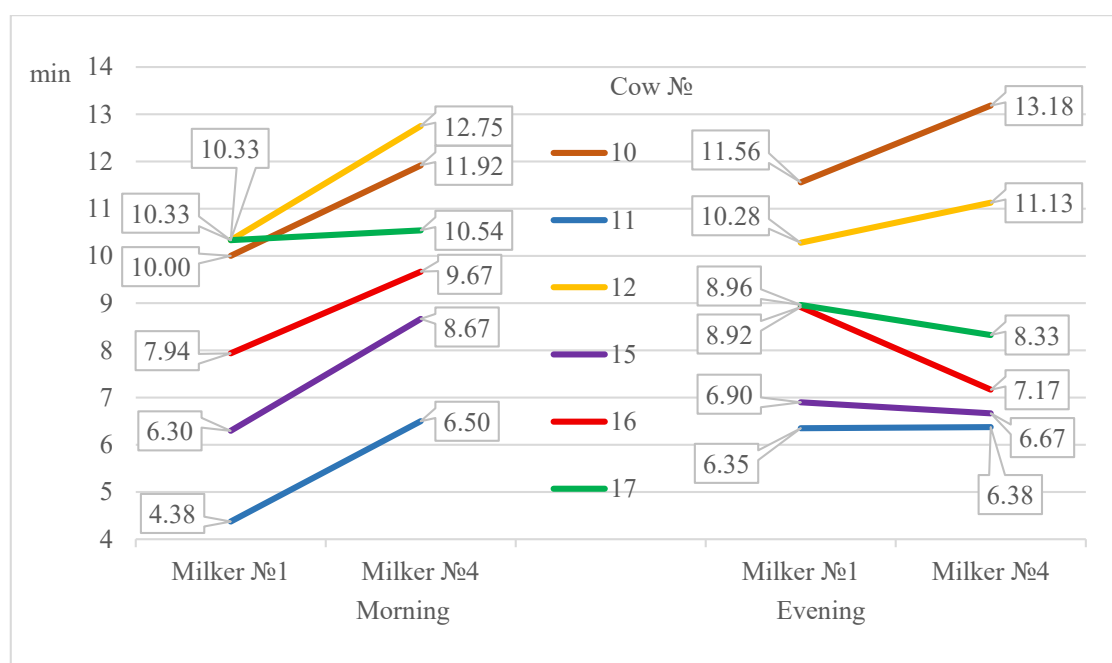


Figure 3. Milking time for the same cows by different milkers (No. 1 and 4)

Source: Authors' own elaboration

er No. 4 milks slowest (Table 2). At morning milking, the milking time for all cows was prolonged – from 2.0% for cow No. 17 to 48.4% for cow No. 11 (Fig. 3). This did not lead to obtaining more milk. The reaction of individual cows to the milker and prolongation of milking time is different. With an extension of milking time for 4 cows (No. 10, 15, 16, and 17) – a total increase of 10.77 min, their milk yield increased by an average of 0.270 kg. Obviously, the milker retained the milking apparatus for a longer time, thus “playing it safe” to some extent. However, such over-retention is associated with “blind” milking, which is a predisposition for mastitis.

Cows No. 11 and 12 reacted negatively to the change of milker, with milk yield decreasing by 3.95% in the first, and in the second, which has the highest milk yield in the group, the decrease was 2.87 kg (23.7%). Overall, milker No. 4 obtained an average of 0.744 kg less milk per cow compared to milker No. 1.

At evening milking, the total time for milking cows by both milkers equalized at 53 min, with

No. 1 increasing by 3.69 min and No. 4 decreasing by 7.20 min. This also led to equalization of the amount of milk obtained – 41.1 kg for milker No. 1 and 41.6 for milker No. 4. The cows’ reaction to milker No. 4 is weaker.

The milkers milked the same cows with equal duration, with $R_s=0.899$ ($P<0.05$) at morning milking and $R_s=1.0$ at evening milking.

The third group of cows was milked by 3 milkers – No. 2, 3, and 4 (Figs. 5, 6). Milker No. 4 again milks slowest (Fig. 5), but unlike the previous observation, at morning milking more milk was obtained from all cows (Fig. 6).

At evening milking, milker No. 2 milked at the same pace – cows were milked in 33.36 min in the morning and 33.42 min in the evening, and the rank correlation regarding milking of individual cows is 0.900 ($P<0.05$). The correlation between milking time and milk yield at morning milking is $R_p=0.220$, and at evening – $R_p=-0.301$.

For milker No. 4, R_s for milking time of individual cows in the morning and evening is 0.400. The correlation between milking time and milk

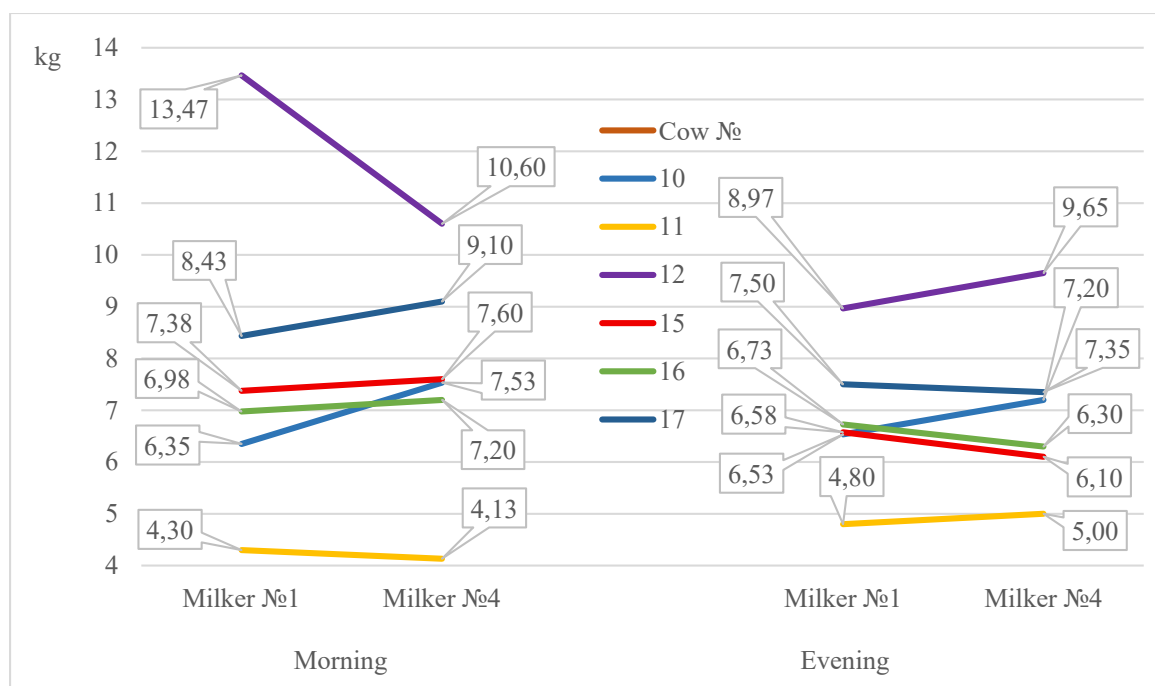


Figure 4. Milk yield of the same cows milked by different milkers (No. 1 and 4), at morning and evening milking

Source: Authors' own elaboration

yield at morning milking is $R_p=-0.017$, and at evening – $R_p=0.081$. Unlike milking the previous group, at evening milking milker No. 4 increased the average milking time by 3.49 min, with mixed effects. Thus, the sharp increase in milking time

for cow No. 9 – by 4 min did not even lead to obtaining the morning amount of milk, and milk yield decreased by 1.1 kg. Conversely, with a decrease in milking time for cow No. 18 by 29.3%, 18.1% less milk was obtained.

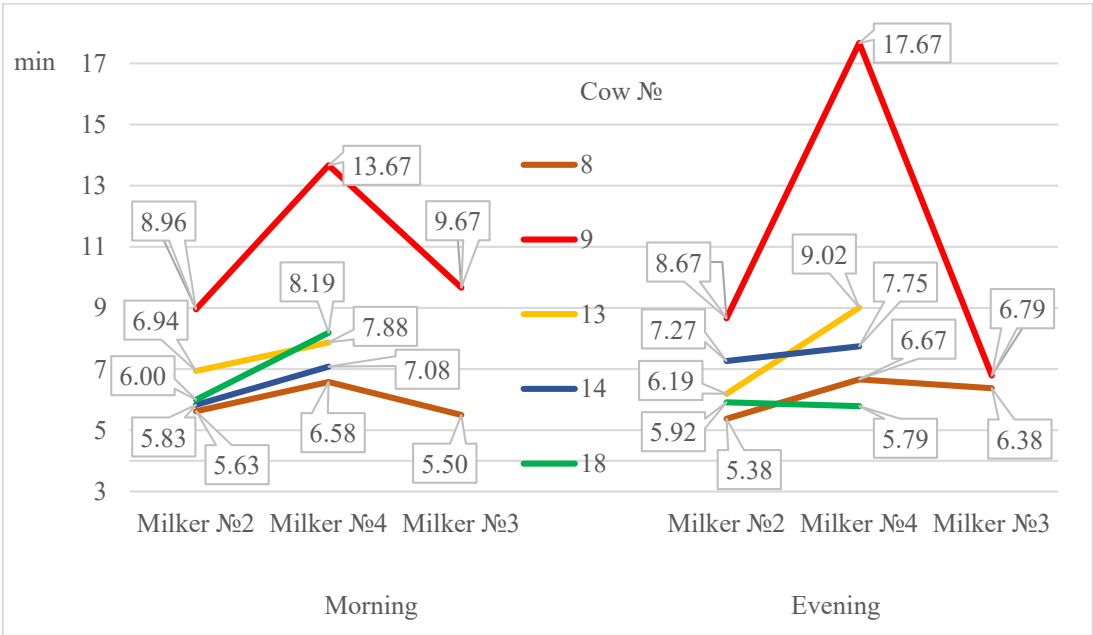


Figure 5. Milking time for the same cows by different milkers
Source: Authors' own elaboration

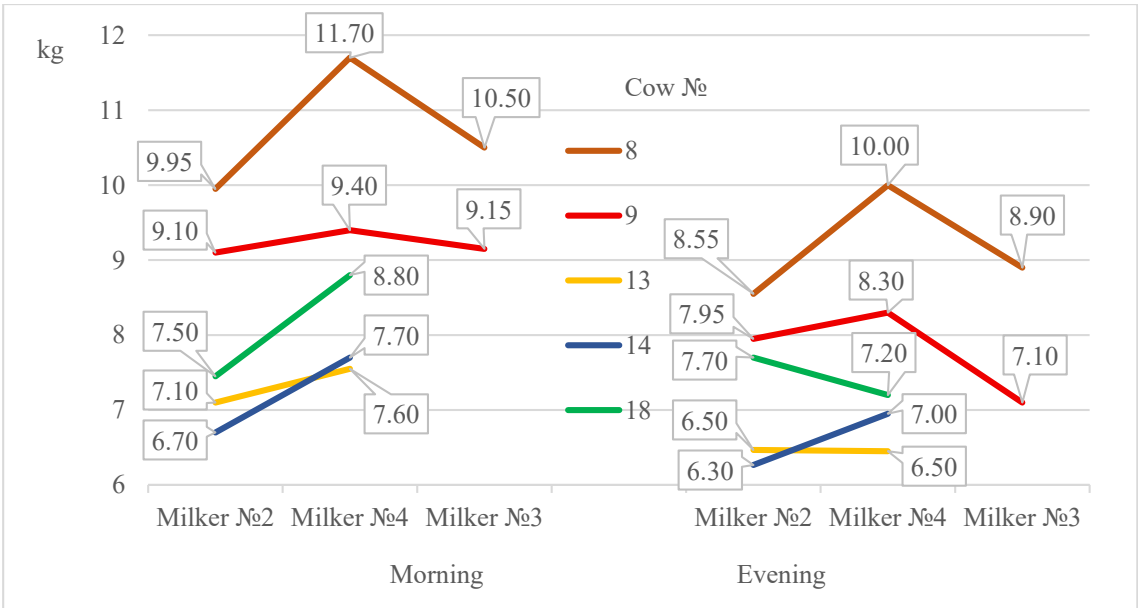


Figure 6. Milk yield of the same cows milked by different milkers at morning and evening milking
Source: Authors' own elaboration

Overall, at evening milking, less milk was obtained from all cows. Milker No. 4 again obtained the largest amount of milk, but the difference from milker No. 2, compared to morning milking, decreased from 4.85 to 1.967 kg.

Milker No. 3 milked cow No. 9 in intermediate time. The shorter time at morning milking compared to milker No. 4 by 4 minutes led to a decrease in milk yield of only 0.2 kg. At evening milking, the time was reduced by another 2.88 min, which led to a 14.5% decrease in milk obtained.

From the analysis performed, it is evident that milkers have different approaches to milking, to which animals react in different ways. Milker No. 3 is most positively perceived by cows, who obtained the largest amount of milk in the shortest time. After the initial morning milking, he tries to determine the exact milking time for each animal based on the amount of milk obtained. Milker No. 4 also has an individual approach to cows. Depending on milk yield at morning milking, he increases or decreases milking time, but plays it safe by unnecessarily retaining the milking apparatus longer than necessary. Milker No. 2 does not show an individual approach to milking. Most cows are milked for the same amount of time, morning and evening, regardless of the difference in milk yield. Milker No. 1 is perceived most negatively by animals. He milks chaotically and does not show an individual approach to milking depending on animal's milk yield.

CONCLUSIONS

The milker has a significant effect on cow milkability ($P < 0.001$) through milking duration ($P < 0.001$).

Milking duration, in turn, is determined both by the individual reaction of cows to the milker and by their subjective decision to remove the milking apparatus and terminate milking. The difference in milking time for the same cows by different milkers ranges from 1.56 to 61.56%, with the difference in milk obtained ranging from 0.546 to 33.41%.

To improve cow milkability, measures are needed of both an organisational nature – training of milkers, and of a breeding nature – reducing stress sensitivity of cows regarding their reaction when changing milkers.

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