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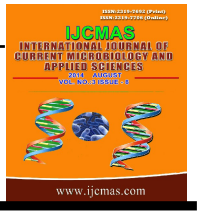

Original Research Article

Effect of milking temperament on productive traits and SCC in Black-and-White cows

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A B S T R A C T

The study was conducted with 143 Black-and-White cows at three dairy farms with different production systems. For evaluation of milking temperament, a 5-point scale was used: 1 – very nervous and 5 – very calm cows. Milking temperament scores had a substantial effect on test day milk yields and somatic cell counts (SCC). Nervous cows (score 1 and 2) exhibited higher test-day milk yields both in the beginning and throughout the lactation compared to calm cows (score 3 to 5), but lactation curves were irregular. Calm cows (score 3 to 5) had smooth lactation curves but their milk yields were lower in early and peak lactation by 1.0 and 1.7 kg respectively as compared to nervous cows. Milking temperament had no significant effect on milk composition traits. The milk of cows with nervous temperament (score 1 and 2) had a significantly higher SCC (557.96 thousand/ml) than calm cows (score 3 to 5) during milking – 461.12 thousand/ml. The relationship between temperament scores and SCC was however not linear, as very calm cows (score 5) also showed relatively high milk SCC.

Keywords

Milking temperament, test day milk, fat, protein, SCS, milk cow

Introduction

At present, animal welfare is becoming an increasingly important aspect of livestock husbandry. Through evaluation of cattle temperament, their reactions could be compared to known welfare standards in specific environmental conditions. Therefore, the temperament has become a really important criterion for welfare assessment (Herve et al., 2007). During the last decade, average dairy herd size increased in many countries over the world, so farmers could spent less time for each animal. The temperament is one of primary traits influencing the time spent for individual animal care and therefore, it is of great importance at large farms. Milking temperament has gained a growing attention after the introduction of milking robots in dairy cattle farming (Wadsworth, 2012).

It was established that the temperament influenced some traits as growth intensity (Voisinet et al. 1997) and systemic immune functions (Ivanov et al. longetivity (Sewalem et al. 2010). Only few studies were focused on the association between

production traits and milking temperament, most of them demonstrated a weak relationship (Fuerst, 2006, Sewalem et al. 2011).

Wadsworth (2012) believes that apart the classical traits determining the fitness of dairy cows – calving interval, longetivity, resistance to lameness and mastitis, the milking temperament could be an additional selection trait that should be included in programmes aimed at improvement of fitness of cows and their welfare.

Materials and Methods

The study included 143 Black-and-White cows from three dairy cattle farms, reared in different production systems: free stall barn with milking parlour at one of farms, and tie stall barns with central milk duct at the other two.

Data for milk yields, milk composition and somatic cell counts were obtained from test day records of herds. Data referring to lactations between 2011 - 2013 were retained. All milked cows from I^{st} to VII^{th} lactation in the three herds were included. Lactations with duration of at least 240 days were used, and for longer lactation periods only data for the first 305 days were taken. The total number of test days was 1383.

To determine the effect of the lactation number, lactations were divided into three classes, namely I^{st} (40 cows), II^{nd} (28 cows) and III^{-rd} and higher (75 cows).

To evaluate the effects of calving season, the four seasons comprises the following periods: spring – from March to May, summer – from June to August, autumn – from September to November and winter– from December to February.

Milking temperament was evaluated once during the lactation on all currently milked cows. Primiparous heifers until the 30^{th} postpartum day were not included, as they needed more time for adaptation to milking. The evaluation was done by the authors during milking, obtaining additional information for each cow from parlour workers. This way, we reduced to a minimum the evaluation of a given behaviour on a basis of a temporary condition of animals.

For better assessment of some relationships, the milking temperament scores were grouped in two classes, namely cows with nervous temperament including animals with scores 1 and 2, and cows with calm temperament – those with scores 3, 4, and 5. The statistical processing of data was done with the STATISTICA 6 software package. The following model was used for evaluation of the effect of milking temperament on test day production traits and SCC:

$$Y_{ijklmn} = \mu + F_i + L_j + G_k + S_l + T_m^* + PL_n + e_{ijklmn}$$

where:

$\mathbf{Y_{ijklmn}}$ is the dependent variable (test day milk yield, milk fat percentage, milk protein percentage and SCC); $\boldsymbol{\mu}$ is the population mean; $\mathbf{F_i}$ is the herd effect, $\mathbf{L_j}$ is the effect of lactation number, $\mathbf{G_k}$ is the calving year effect, $\mathbf{S_l}$ is the calving season, $\mathbf{T_m}^*$ is temperament score (between 1 and 5 or in two classes), $\mathbf{PL_n}$ is the effect of lactation period, and $\mathbf{e_{ijklmn}}$ is the effect of random factors.

Results and Discussion

To evaluate more precisely the effects and relationships between the different factors

and traits, the study encompassed all traits controlled on test days. Table 1 presents mean values of test day productive traits and milk SCC at each farm. The differences between farms were statistically significant for all traits studied.

The highest daily milk yield was established at Farm 1 – 21.72 kg, and it was considerably higher that average yields at the other two farms which were almost equal – 14.20 and 14.29 kg. At that farm, milk content parameters and SCC were relatively good. The lowest milk protein content was detected at Farm 2 – 2.99%, as well as highest milk SCC – 676.54 thousand/ml. Most probably, SCC could predetermine the lower values of milk composition parameters at the farm. According to Ma et al. (2000) and Lindmark-Månsson et al. (2006), high milk SCC were associated with lower milk fat, milk protein and worse organoleptic quality of milk.

The highest mean milking temperament score was assigned on cows at Farm 3, and the lowest – at Farm 1, but the differences were not significant. Although small, the differences between score indicated fewer cows with milking problems at Farm 3 compared to the other farms. Pedersen et al. (2008) outlined that lowering milking temperament score of all cows at a farm with 70 cows by one unit meant 5 min per day additional work.

The effect of milking temperament, in both variants was evaluated with respect to test day traits: milk yield, milk fat percentage, milk protein percentage and milk somatic cell counts (SCC).

Table 2 presents the analysis of variance of studied factors, including milking temperament scores (from 1 to 5) on production traits and milk SCC on test days. The results from the analysis indicated that the farm, lactation number, calving year and lactation period had a statistically significant effect on test day milk yields ($P<0.001$). Milking temperament scores were also with a substantial effect on test day yields ($P<0.05$).

With regard to milk composition traits –fat and protein percentages, there are few studies investigating the effect of milking temperament. The farm and calving year influenced strongly (*$P<0.001$*) milk fat content. Also, the calving season, temperament score and lactation period had a significant effect ($P<0.05$). Test day milk protein percentage was influenced considerably only by the farm ($P<0.001$) and the lactation period ($P<0.01$), Table 2. Milking temperament score had no statistically significant effect on milk protein. Test day SCC was influenced substantially by all factors included in the model ($P<0.001$ and $P<0.01$) except for lactation period.

The analysis of the influence of studied factors on production traits and test day SCC showed that milking temperament scores had a statistically significant effect on all of them ($P<0.05$) except for milk protein.

Table 3 presents LS-means for production traits and test day SCC depending on milking temperament scores. The highest average milk yield was established by cows with very nervous temperament (score 1) – 19.34 kg followed by nervous cows (score 2) – 18.83 kg. The milk yields of calm and very calm cows (scores 4 and 5) were by 1.24 and 1.89 kg lower than values of nervous and very nervous animals. The lowest test day milk yield was detected in cows with score 3 – 16.97 kg. The behaviour reactions in cows with this score consisted

mainly in shifting from foot to foot, moving in the bed, shivering and withdrawal during handling. These reactions are determined by several authors as fearfulness, not aggression, unlike lifting feet, kicking and attempts for bringing down the milking machine, observed in cows with score 1 and 2. Shifting from foot to foot, "dancing" during milking is related rather to fear, increased heart rate and higher milk cortisol concentrations while kicking during preparation and milking was not provoked by nervousness or anxiety i.e. it is not exhibited by frightened cows (Rushen et al., 2001, Wenzel et al., 2003, Rousing et al., 2004). This could be the reason for the observed lowest test day milk yields in cows with milking temperament score 3.

The results from studies on the relationship between milking temperament and milk yield of dairy cows are contradictory. For instance, Orban et al. (2011) did not establish statistically significant differences in daily milk yields of cows with different temperament type. Praxedes et al. (2011) observed a close relationship between temperament and milk yield, namely cows with intricate, nervous temperament had the highest milk yields – 6546.67 kg whereas those with calm temperament – low milk yields – 3406.45 kg. The authors attribute the cause for keeping bad-tempered animals in the herds to their good productivity. Higher costs for handling nervous animals are therefore compensated by their high productivity.

The highest milk fat content was established in cows with calm temperament (score 4) – 3.96 %, followed by very nervous cows (score 1) – 3.92 %, Table 3. The milk of the other cows was with lower fat content – from 3.83 to 3.88%, but no definite trend could be found between this trait and milking temperament.

Although the lack of a statistically significant effect, Table 3 presents the LS-means for milk protein percentage depending on milking temperament score. As with milk fat percentage, there was no clear tendency associating milk protein and milking temperament. It could be affirmed that calm cows (scores 4 and 5) exhibited a moderate, stable content – 3.23%, less variations and smaller error in comparison with cows with other scores, especially scores 1 and 2. The latter (cows with nervous temperament) demonstrated a significant difference in average test day milk protein percentages: 3.16 and 3.27%, respectively.

Cows with nervous milking temperament (score 1 and 2) had the highest test day milk SCC – 618.35 and 526.36 thousand/ml (Table 3). Calm cows with score 3 and 4 had significantly lower SCC values – 382.79 and 406.95 thousand/ml. Very calm cows (score 5) were an exception as SCC in their milk was relatively high – 524.13 thousand/ml. This indicated that no linear relationship between milking temperament and milk SCC could be identified.

Studies in Canadian Holstein population indicated that the correlation coefficient between milking temperament and milk SCC was lower than 0.20. This fact meant that sires with very calm daughters also tend to exhibit higher milk somatic cell counts (Canadian Dairy Network, 2002).

Table 4 presents the data from analysis of variance of effects of the same factors when milking temperaments were grouped into 2 classes: cows with nervous temperament (score 1 and 2) and cows with calm temperament (scores 3, 4 and 5). The model with 2 classes of milking temperament revealed considerable effect of milking temperament only on test day milk yield and

SCC ($P<0.01$ and $P<0.05$). Table 5 presents the LS-means for test day production traits and milk SCC for the 2 temperament classes – nervous (score 1 and 2) and calm (scores 3, 4 and 5). There was a difference between groups with respect to daily milk yields and milk SCC, as nervous cows had higher milk SCC than calm ones. As milk composition was concerned, no difference between temperament groups was noted.

The differences in lactation curves was more pronounced when temperaments were grouped in 2 classes (Fig. 1). Cows with nervous behaviour during milking – scores 1 and 2 had higher milk yields both in the beginning and throughout the entire lactation compared to calm cows (score 3, 4, 5) but their lactation curve was irregular, with drops and peals in daily yields. Calm cows (with scores from 3 to 5) had a smooth lactation curve, but their milk yields were lower in the beginning and peak lactation by 1.0 and 1.7 kg respectively, in comparison with nervous cows.

Sullivan and Burnside (1988) found out that the milking temperament correlated negatively with milk productivity (-0.17), but there was a high correlation with feeding aggression and the latter was positively related to milk yields (0.23). To sum up, this indicates that cows with more nervous reactions when milked (scores 1 and 2) exhibited a more-aggressive behaviour vs their herdmates. This gives the advantage of more prolonged and more abundant feeding, which is beneficial for production of milk. Maffei et al. (2006) demonstrated that more aggressive cows were with better reactivity, more motile and with higher hierarchical rank in the groups.

Fig. 2 presents the milk fat percentage curves per test day depending on the milking temperament in 2 classes. Calm cows (scores from 3 to 5) nearly exhibited the classic milk fat curve – reduction until peak lactation, a certain persistence followed by gradual increase until the end of the lactation.

Nervous cows with scores 1 and 2 showed unstable milk fat curves throughout the lactation, with sharp drops and peaks, similar to test day milk yield curves. Most probably, this was the reason for the lack of a relevant correlation and statistically significant difference in milk fat percentage according to the milking temperament score. The tendency for milk protein percentage was identical with that observed for test day milk fat content (Fig. 3). In cows with calm temperament (scores 3 to 5) the variation in milk protein largely corresponded to the biological pattern of reduction at peak lactation followed by gradual increase until the end of lactation. Unlike milk fat, the milk protein curve was not equally smooth. Milk protein curve in cows with nervous temperament (score 1 and 2) exhibited considerable deviations, sharp declines and peaks throughout the lactation. This explains to a great extent the absence of statistically significant differences between mean values and the lack of substantial effect of studied factors on this trait.

Likewise, other researchers have not observed any significant effect of milking temperament score on milk composition traits. Fig. 4 presents the changes in milk SCC during the lactation depending on the both milking temperament classes. In general, SCC values varied greatly throughout the lactation in the two groups, but fluctuations in cows with calm temperament (score from 3 to 5) were less pronounced and the values remained lower during most lactation days in comparison to cows with nervous temperament (score 1 and 2).

Table.1 Mean values of studied traits per test day by farms

Trait	Farm 1 n = 695 x ± SE	Farm 2 n = 335 x ± SE	Farm 3 n = 353 x ± SE
Milk yield, kg	21.72 ±0.31^{aa}	14.20± 0.24^{a}	14.39 ±0.25^{a}
Average milk fat percentage	3.89 ±0.02^{b}	3.83 ±0.03^{a}	4.02± 0.04^{ba}
Average milk protein percentage	3.29 ±0.01^{aa}	2.99 ±0.02^{aa}	3.42 ±0.02^{aa}
SCC, thousand/ml	410.26 ±13.43^{a}	676.54 ±66.16^{aa}	399.30 ±43.93^{a}
Average milking temperament score	3.74±0.14	3.94 ±0.22	4.18 ±0.18

Individual trait values with equal superscripts are statistically significant at: a – P<0.001; b – P<0.01; c – P<0.05; - n.s.

Table.2 Analysis of variance of effects of studied factors on test day production traits and milk SCC

Source of variation	Degrees of freedom (n – 1)	Milk yield	milk fat %	milk protein %	SCC
		F P	F P	F P	F P
Farm	2	216.14***	7.37***	140.40***	12.67***
Lactation number	2	11.90***	0.14-	1.05-	21.33***
Calving season	3	1.94-	3.02*	1.37-	5.36**
Calving year	2	9.56***	8.38***	0.75-	12.56***
Milking temperament score	4	2.94*	2.44*	1.68-	2.87*
Lactation period	9	25.35***	1.84*	2.92**	0.71-
Error	1359				

**** – P<0.001; ** – P<0.01; * – P<0.05; - n.s.*

Table.3 LS-means for test day production traits and SCC depending on milking temperament scores

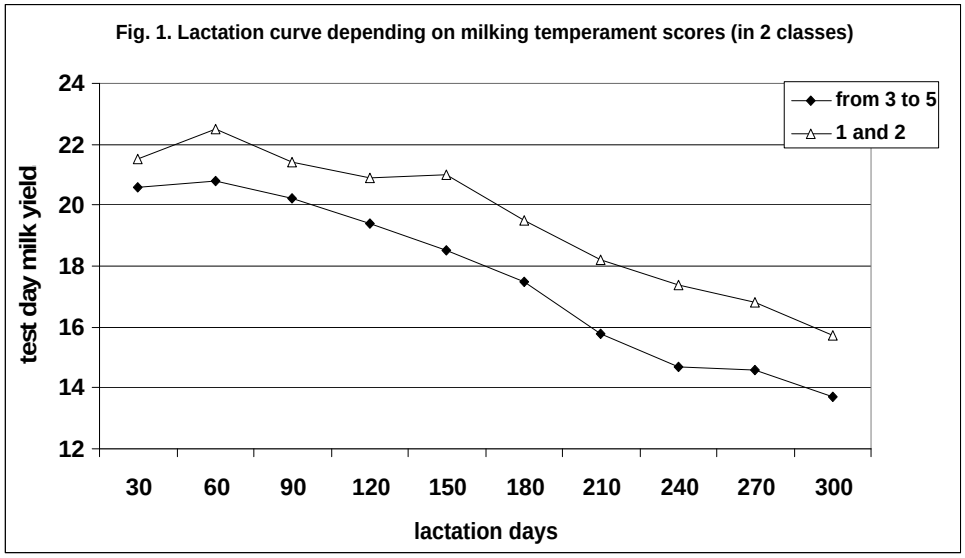
Trait	Milking temperament score				
	1	2	3	4	5
Number	66	117	232	333	635
Milk yield, kg	19.34±0.86	18.83±0.64	16.97±0.51	17.45±0.41	17.59±0.35
Milk fat %	3.92±0.084	3.86±0.062	3.88±0.049	3.96±0.041	3.83±0.035
Milk protein %	3.16±0.043	3.27±0.032	3.26±0.025	3.23±0.021	3.23±0.018
SCC, thousands/ml	618.35±99.39	526.36±73.80	382.79±58.79	406.95±48.15	524.13±41.06

Table.4 Analysis of variance of effects of studied factors and two classes of milking temperament on test day production traits and milk SCC

Source of variation	Degrees of freedom (n – 1)	Milk yield	milk fat %	milk protein %	SCC
		F P	F P	F P	F P
Farm	2	218.67***	7.34***	144.43***	20.17***
Lactation number	2	11.61***	0.14-	1.14-	20.53***
Calving season	3	1.92-	2.57-	1.23-	5.21**
Calving year	2	9.79***	8.05***	0.87-	11.52***
Milking temperament score	1	9.94**	0.0-	0.04-	3.50*
Lactation period	9	25.39***	1.62*	2.96**	0.69-
Error	1362				

Table.5 LS-means for test day production traits and SCC depending on milking temperament class

Trait	Milking temperament	
	Nervous (score 1 and 2)	Calm (score 3,4 and 5)
Number	183	1200
Milk yield, kg	18.28 ± 0.499	16.73 ± 0.278
Milk fat %	3.88 ± 0.053	3.88 ± 0.029
Milk protein %	3.23 ± 0.027	3.24 ± 0.015
SCC, thousands/ml	557.96 ± 62.274	461.12 ± 34.753



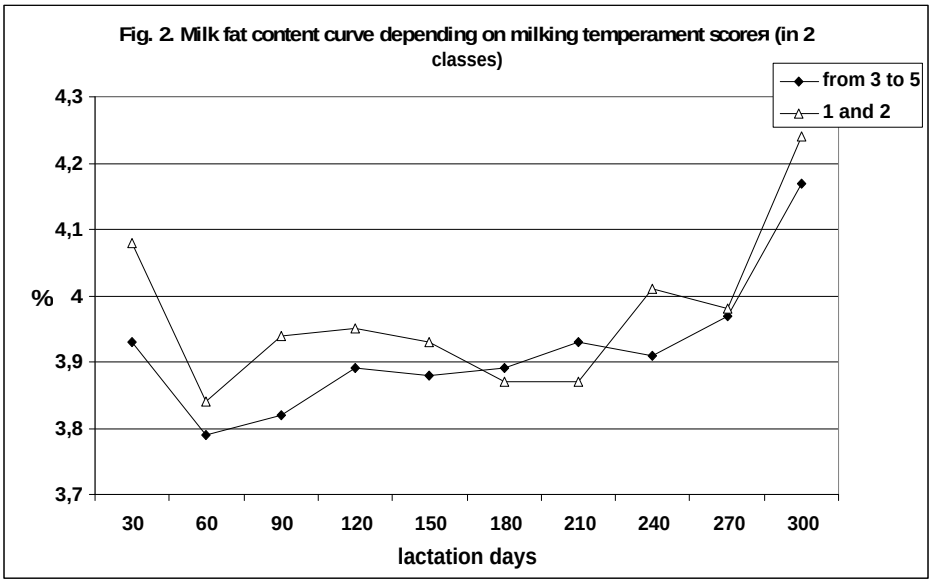


Fig. 2. Milk fat content curve depending on milking temperament scoreя (in 2 classes)
from 3 to 5
1 and 2
4,3
4,2
4,1
%
4
3,9
3,8
3,7
30
60
90
120
150
180
210
240
270
300
lactation days

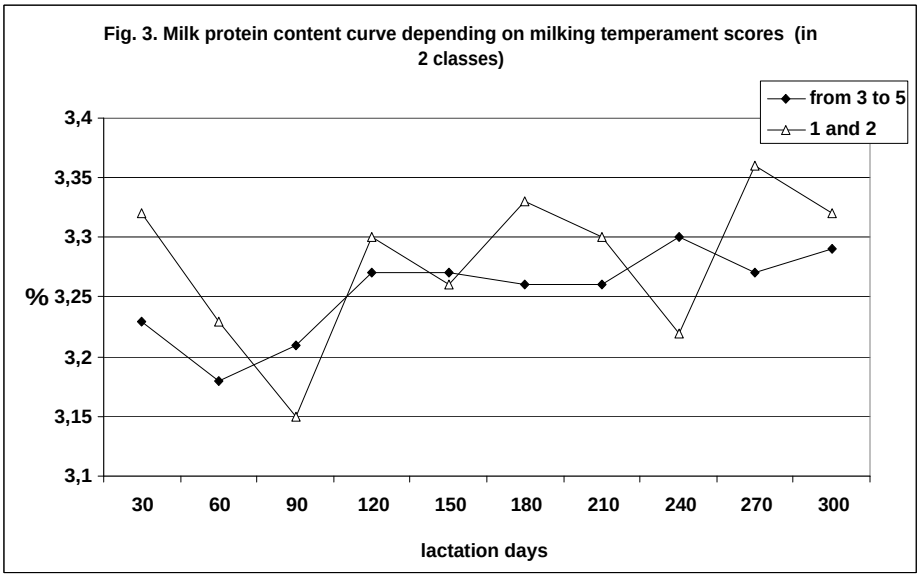
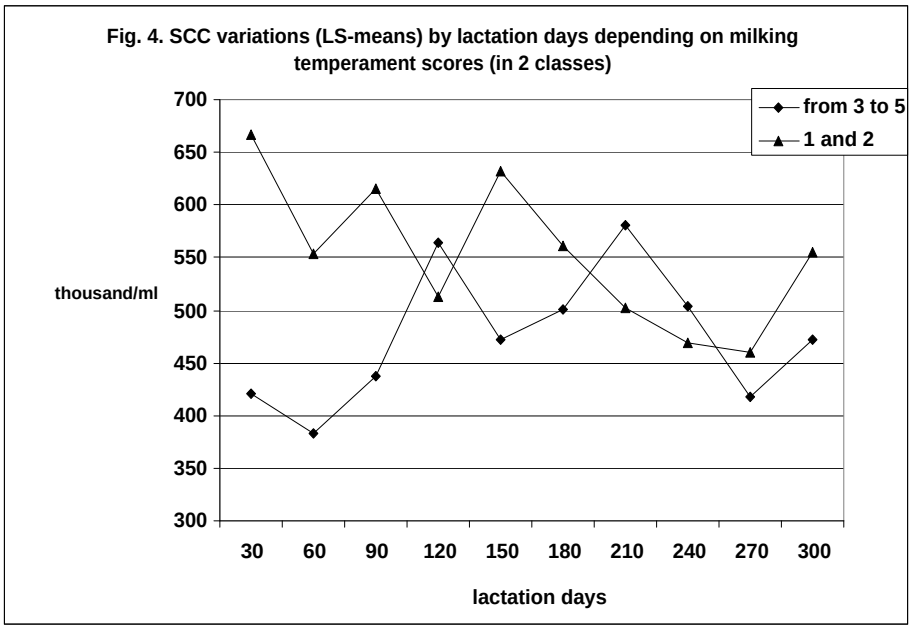


Fig. 3. Milk protein content curve depending on milking temperament scores (in 2 classes)
from 3 to 5
1 and 2
3,4
3,35
3,3
%
3,25
3,2
3,15
3,1
30
60
90
120
150
180
210
240
270
300
lactation days



Orban et al. (2011) also reported lower milk SCC in cows with calm temperament, namely in Jersey – $135.40\times10^3/cm^3$, in Holstein – $176.07\times10^3/cm^3$, vs nervous Jersey cows ($540.44\times10^3/cm^3$) and Holstein cows ($744.91\times10^3/cm^3$).

Berry et al. (2004) suggested that the observed negative genetic correlation between temperament and SCC (-0.42) could be attributed to increase blood cortisol concentrations (Hemsworth et al. 1989), which increase the susceptibility of animals to mastitis and other diseases. Lund et al. (1994) reported a strong negative genetic correlation (-0.96) between the temperament type and other diseases, supposing that more nervous cows were more prone to diseases of a various nature.

Milking temperament scores had a substantial effect on test day milk yields, which was more pronounced when temperament was classified into 2 classes ($P<0.01$) compared to the 5-point scoring system (score 1 to 5; $P<0.05$).

Nervous cows (score 1 and 2) exhibited higher test-day milk yields both in the beginning and throughout the lactation compared to calm cows (score 3 to 5), but lactation curves were irregular. Calm cows (score 3 to 5) had smooth lactation curves but their milk yields were lower in early and peak lactation by 1.0 and 1.7 kg respectively as compared to nervous cows.

Milking temperament had no significant effect on milk composition traits. Nervous cows with scores 1 and 2 showed unstable milk fat and protein curves throughout the lactation, with sharp drops and peaks.

The milk of cows with nervous temperament (score 1 and 2) had a significantly higher SCC (557.96 thousand/ml) than calm cows (score 3 to 5) during milking – 461.12 thousand/ml. The significant variations of values in both groups was one of the reasons for the lack of statistically significant difference. The relationship between temperament scores and SCC was however not linear, as very calm cows (score 5) also showed relatively high milk SCC.

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