INFLUENCE OF LAMENESS ON DAILY MILK YIELD, LACTATION CURVE AND BODY CONDITION SCORE DURING LACTATION IN BLACK-AND WHITE COWS

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Abstract

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The study included 187 cows from the Bulgarian Black-and White cattle breed for a period of 3 years. Of the total number of cows, 10.2% suffered from lameness during the first month of lactation, with most of them (73.7%) had other illnesses during the same period. Test-day and peak lactation milk yields were lower by about 2 kg in cows that suffered from lameness only and lameness with co-morbidity, compared to healthy cows. Daily milk yield was the lowest in cows with lameness and ketosis at the same time – by 4.6 kg less compared to healthy animals, and by about 2 kg compared to groups of cows with other diseases. The strongest negative effect had the combination of lameness and ketosis. These cows had a lower peak lactation milk yield – by 6.15 kg than healthy cows, and by a little more than 3 kg than the other groups.

No significant influence of the body condition score before calving on the groups with different health problems could be found, as well as a group effect on the mean BCS per lactation. Cows with the highest mean BCS before calving were the ones that suffered from lameness and ketosis simultaneously – a score of 3.95. The lowest BCS before calving was exhibited by cows that suffered only from lameness or other illnesses at the beginning of lactation. In cows affected only by lameness at the beginning of lactation, the effect of illness on milk yield was negative, yet it did not influence significantly the BCS of cows during lactation.

Key words: lameness, test-day milk yield, lactation curve, body condition score, Black-and White cattle

Introduction

Lameness in dairy cows is one of the most important illnesses from an economic and animal welfare point of view (Onyiro et al., 2008). The prevalence of the problem in dairy herds from different countries varies between 8% and 15% in studies for the USA (Warnick et al., 1995) up to 20.6% in England (Clarkson et al., 1996). Most authors have pointed out that a variation in the distribution per herds within the same study can be observed. The losses amount to about $300 to $450 (Atkins, 2009). Economic losses due to lameness result from lower milk yield decrease in animals'

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live mass, poorer reproductive qualities, medical expenses, and culling (Booth et al., 2004). These indicators vary a lot in different herds and countries (Enting et al., 1997). The difficulty in calculating economic losses comes from the contradictory data on the effect of lameness on productivity. The results from different researches are contradictory. Some of them have found out that lameness reduced milk yield (Rajala-Schultz et al., 1999), others did not observe such an effect (Martin et al., 1982), or established even greater milk yields in cows with lameness (Dohoo and Martin, 1984; Barkema et al., 1994). Establishing this relationship is based on different grounds, a veterinarian specialist most often diagnoses lameness, yet it can also be assessed by different scoring systems. The moment of diagnosis is also very important with respect to measuring milk yield.

Contemporary cattle breeding imposes more intensive technologies of production, housing of the cows in stalls, high milk yields, and, respectively, predominantly concentrate feeding (Onyiro et al., 2008). All of these are prerequisites to an increase in the incidence of hoof and foot problems. The genetic correlation between productivity and health condition is negative (Pryce et al., 1998) and production-oriented selection has led to increase in mastitis, reproductive problems, and lameness. Of great importance under these conditions is the search for early diagnostics and prevention alternatives, as well as using the potential of selection to reduce the risk of lameness (Wincker and Willem. 2001).

The goal of this study is to establish the connection between lameness, daily milk yield, the shape of the lactation curve, and the changes in the body condition score in Black-and white cows.

Material and Methods

The study included 187 cows of the Black-and white cattle breed for a period of 3 years. Only cows at their second or later lactation were included. The cows are reared in tie-stalls, milked at the same place via a central milk tube. During the day, cows were released in small yards to walk.

The body condition score BCS was measured monthly during the dry period and during lactation. A 5-point scoring system was used for evaluation, with an accuracy of up to 0.5 points (Edmonson et al., 1989). Evaluation of the BCS of cows before calving was performed 7 to 10 days before calving.

During the first month of lactation, the animals' health status was recorded. Cows with various illnesses after this period were not included in the study. For the research's purpose, the animals were divided into the following groups: 1 – healthy cows; 2 – only with lameness; 3 – other illnesses; 4 – lameness and other illnesses; 5 – lameness and ketosis. Other illnesses included placenta retention, metritis, mastitis, and milk fever. The farm's veterinarian has recorded only clinical cases. All clinical cases of hoof and foot diseases in cows were included in the "lameness" category without differentiation.

Data on the milk yield and milk contents were taken from the farm's official productivity control records.

The following model was used to evaluate the effect of health condition:

$$Y_{ij} = \mu + F_i + e_{ij},$$

Where: Y_{ij} is the dependent variable (test-day milk yield and peak lactation milk yield, BCS before calving and during lactation); μ is the population mean; F_i is the effect of health condition, and e_{ij} is the random factors effect.

The data was analysed using the LSMLMW software (Harvey, 1987). Through analysis of variance (ANOVA) the least square means (LSM) and the least square estimates (LSE) that are sums of the squares of deviations from means derived by the model are calculated.

Results

10.2% of all cows suffered from lameness during the first month of lactation, with most of

them, 73.7%, exhibited other illnesses during the same period (Figure 1). From the total number of cows, only 2.5% suffered from lameness only. It was notable that most cows affected by lameness also suffered from ketosis during the same period – 52.6%. This showed a certain dependency between expressions of lameness and metabolic disorders such as ketosis.

lowest in cows that suffered from lameness and ketosis at a time – by 4.6 kg less compared to healthy animals, and by about 2 kg compared to other illnesses group.

The same dependency is observed for peak lactation milk yield, yet with a greater difference between cows with lameness and ketosis, and the other groups. Their milk yield was lower than that
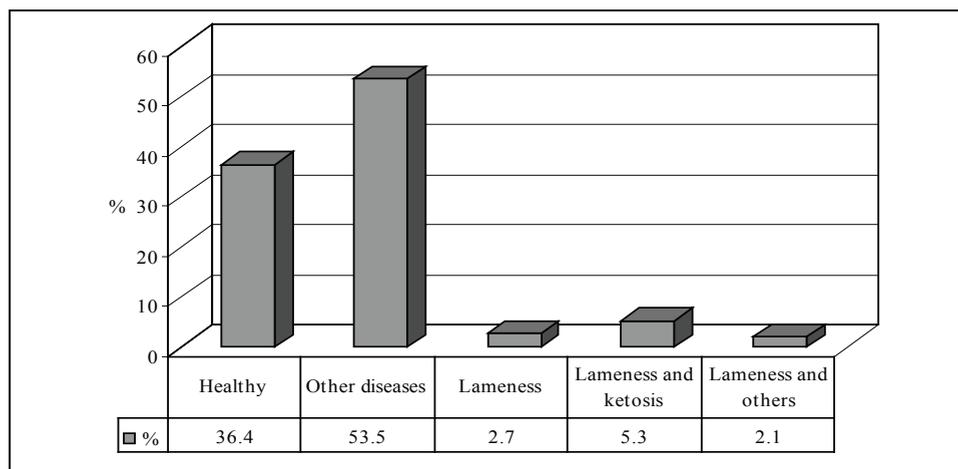

Fig. 1. Distribution of cows depending on their health condition

Table 1

Analysis of variance of the effect of cows' health condition on test-day and peak lactation milk yield

Factors	Degrees of freedom (n -1)	Test-day milk yield		Milk yield during peak lactation	
		F	P	F	P
Mean for the model	1449	11.71***		31.12***	
μu - yμ	1	63.41 -		20.27***	
Health condition	34	14.64***		38.90***	

Table 1 presents the results from the ANOVA. A significant effect of cows' health condition on per test-day and peak lactation milk yields (P< 0.001) was detected.

LS-means for the effect of health condition per groups are presented in Table 2. Milk yield per test-day and during peak lactation was lower by about 2 kg in cows that had suffered either from lameness only, or lameness and other illnesses, compared to healthy cows. Milk yield was the

of healthy cows during peak lactation by 6.15 kg, and by a little more than 3 kg than those of the other groups. Lameness had a negative effect on mean daily milk yield, as well as on the maximum daily lactation milk yield. The strongest negative effect was exhibited by the combination of lameness and ketosis.

Cows' health condition also affected the lactation curve's shape (Figure 2). The lowest milk yield and non-standard lactation curve was exhib-

Table 2

LS-means for the influence of the cows' health condition on test-day and peak lactation milk yield

Sources of variance	Test-day milk yield , kg LS-mean ± SE	Milk yield during peak lactation, kg LS-mean ± SE
Mean for the model	14.96 ± 0.34	21.01 ± 0.26
Healthy cows	17.07 ± 0.23	23.75 ± 0.18
Lameness	15.20 ± 0.89	21.33 ± 0.69
Lameness and other illnesses	15.04 ± 0.99	21.13 ± 0.77
Lameness and ketosis	12.44 ± 0.98	17.60 ± 0.76
Other illnesses	15.02 ± 0.20	21.23 ± 0.16
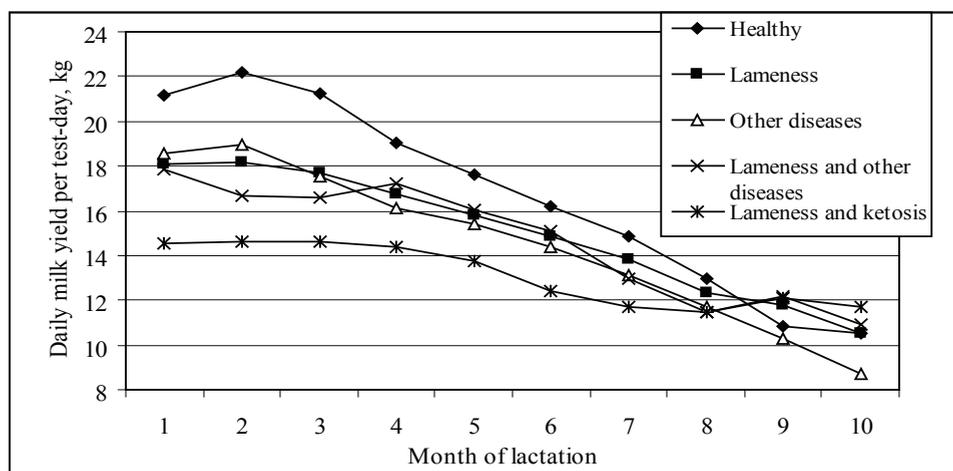
Fig. 2. Effect of health condition on lactation curve in Black-and-white cows

ited by cows suffering from lameness and ketosis at the same time, followed by the ones affected by lameness and other illnesses. This group includes animals with more than 2 diseases at the onset of lactation. The lactation curve of cows suffering only from lameness or another illness had a low peak and gradually decreasing milk yield towards the end of lactation.

No significant influence of BCS before calving on the groups formed depending on health issues could be indicated, as well as an influence of the groups on the mean BCS during lactation. Despite the lack of significant differences, Table 3 presents the LS-means per groups. Cows suffering from lameness and ketosis before calving at the onset of lactation had the highest mean BCS

– 3.95 points. The lowest BCS before calving was exhibited by the cows suffering from lameness and other illnesses at a time at the onset of lactation. In the other groups, BCS before calving was within 3.5 – 3.6 points. Cows affected by lameness and ketosis before calving lost the highest amount of body reserves. Their mean BCS during the lactation was the lowest – 2.03 points. Cows affected only by lameness exhibited comparatively lower losses of body reserves. Their mean BCS during lactation was the highest – 2.47 points.

The difference in the cows' health condition also reflected on the changes in BCS during lactation (Figure 3). Cows affected by lameness and ketosis at the onset of lactation would lose a lot more body reserves and their mean BCS declined

Table 3

LS-means for the influence of cows' health condition on BCS during lactation and BCS before calving

Sources of variance	BCS before calving LS-mean ± SE	Mean BCS for lactation LS-mean ± SE
Mean for the model	3.56 ± 0.09	2.25 ± 0.03
Healthy cows	3.51 ± 0.07	2.30 ± 0.02
Lameness	3.61 ± 0.27	2.47 ± 0.08
Lameness and other illnesses	3.22 ± 0.30	2.16 ± 0.09
Lameness and ketosis	3.95 ± 0.30	2.03 ± 0.09
Other illnesses	3.62 ± 0.06	2.26 ± 0.02

below 2 points. They would not restore their body reserves until the end of lactation and their mean BCS towards the 10th month of lactation remained below 2.4 points.

Major losses of body reserves were observed among healthy cows, yet their mean BCS did not fall below 2 points and reached almost 3 points by the end of lactation. Their losses were most likely caused by the high milk yield.

Cows affected only by lameness at the onset of lactation exhibited the lowest losses of body reserves. This showed that lameness affected negatively milk yield, but not the animals' appetite and, consequently, did not result in major body reserve losses.

Discussion

Other author's studies (Warnick et al., 1995; Clarkson et al., 1996) reported similar tendencies about the relative share of dairy cows suffered from lameness during the first month of lactation. Cook (2003) and Espejo et al. (2006) indicated that about 25% of the cows from stock herds reared in free stall barns in the USA have suffered at least once from lameness.

The determined by ANOVA significant effect of cow's health condition on the per test-day and peak lactation milk yields is confirmed in the investigations of other authors. Warnick et al. (2001) also established a decrease in daily milk yield due to
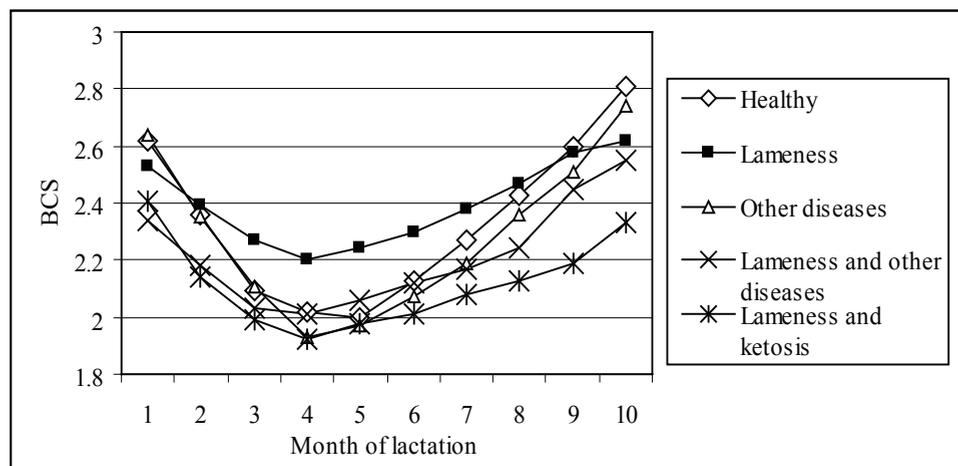
Fig. 3. Effect of health condition of cows on the changes in BCS during lactation

lameness in two herds of Friesian-Holstein cows. In one of the herds, daily milk yield was lower by 1.5 kg for 2 weeks after diagnosing lameness compared to healthy cows. In the second herd, milk yield was lower by 0.8 kg/day during the first and second week after diagnosis and by 0.5 kg during the third week. Lameness was also observed more often in cows within their second or later lactation, compared to primiparous cows. Warnick et al. (1995) pointed out that milk yield started to decrease 2 weeks before diagnosing lameness as a result of lower food intake and negative energy balance.

In recent years, evaluation of breeding value of dairy cattle has been done using test-day models, which allow for evaluation of the lactation curve's shape. Based on this, Green et al. (2002) have established that in 900 cows from five farms, 305-day lactation milk yield dropped by 360 kg in those suffering from lameness. By applying test-day models, Bicalho et al. (2008) also established losses of 424 kg/cow due to lameness during 305-day lactation. Archer et al. (2010) found out that cow with long-term lameness of 4, 6 and 8 months, yielded, respectively, 0.51 kg/day, 0.66 kg/day and 1.55 kg/day less milk. The authors pointed out that losses could be higher if lameness lasted for longer periods or recurred periodically.

In our study the lowest milk yield and non-standard lactation curve was exhibited by cows suffering from lameness and ketosis at the same time, followed by the ones affected by lameness and other illnesses. Confirmations of these results are found in the studies of other authors. According to Rajala-Schultz et al. (1999), the ketosis is a metabolic illness, which has a negative effect on cows' milk productivity. The cows' milk yield started to drop 2 to 4 weeks before ketosis was diagnosed, continuing to decline after diagnosis for a period of varying length. Milk losses were the highest during the first 2 weeks after the diagnosis – from 3 to 5.3 kg/day depending on the parity number.

Onyiro et al. (2008) found out that lameness was related to a significant decrease in milk yield within a later period during lactation. They also discovered a significant influence of lameness on the shape of the lactation curve. The mean lactation curve stability was better in cows, which have never been lame before, compared to the ones with diagnosed lameness until the 60th day of lactation.

The fact that a major difference in the daily and peak milk yield of cows that suffered only from lameness, compared to the healthy ones was not established, could be due to the fact that highly productive cows are affected by lameness more often, in which case, even if their milk yield drops, it reaches the herd's mean level (Barkema et al., 1994, Green et al. 2002). This is considered one of the reasons why some authors failed to establish the influence of lameness on milk productivity.

Hoedemaker et al. (2008) pointed out that cows with low BCS before calving were 9.4 times more predisposed to lameness than those with good BCS. On the other hand, Bicalho et al. (2009) found out that the intensive loss of BCS at the onset of lactation was also related to a higher risk of lameness.

Gillund et al. (2001) reported that cows with BCS of more than 3.5 points before calving were predisposed largely to a risk of ketosis, and would lose much more body reserves during and after the illness.

Conclusion

Of the total number of cows, 10.2% suffered from lameness during the first month of lactation with the majority of them, 73.7% having other illnesses during this period. There is a certain dependency between the occurrence of lameness and illness related to metabolism, such as ketosis.

Test-day and peak lactation milk yields were lower by about 2 kg in cows that suffered from lameness only and lameness with co-morbidity, compared to healthy cows. Daily milk yield was the lowest in cows with lameness and ketosis at

the same time – by 4.6 kg less compared to healthy animals, and by about 2 kg compared to groups of cows with other diseases. The strongest negative effect had the combination of lameness and ketosis. These cows had a lower peak lactation milk yield – by 6.15 kg than healthy cows, and by a little more than 3 kg than the other groups.

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