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RELATIONSHIPS BETWEEN MILK YIELD LOSSES AND LOCOMOTION SCORE IN ANATOLIAN BUFFALO COWS

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ABSTRACT

Managemental factors related to productivity levels of dairy animals have been regarded by farm owners in many countries. This study was conducted to reveal the associations of milk yield losses with locomotion score (LcS) in Anatolian buffalo cows. Buffalo cows (n=61) raised at a private buffalo farm enrolled to the Buffalo Breeders Association (BBA) of Bafra district of Samsun province in Turkey were scored by LcS. To determine the effect of environmental factors, two parity (P; 1=1-2; 2=≥3), stage of lactation (SL; 1=≤118d; 2=≥119d), flank and leg hygiene score (FLHS; 1=1-2; 2=≥3) and body condition score (BCS; 1=1-2; 2=≥3) subgroups were obtained by the group means. To record LcS values, a chart with 1 to 5 points (1=normal, 2=mildly lame, 3=moderately lame, 4=lame and, 5=severely lame) was used. A significant difference ($P<0.05$) was found in the loss of daily milk yield (dMYL) of cows with 2 or 2.5 LcS and cows with 3 LcS. Besides, a high correlation ($r=0.789$; $R^2=0.791$) was estimated between dMYL and LcS. Finally, preventing LcS increment in the herd base was suggested to herd owners to prohibit milk losses.

Keywords: *Bubalus bubalis*, buffaloes, dairy, locomotion score, management, milk yield, water buffalo

INTRODUCTION

Suitable production conditions in livestock farming are one of the essential subjects for elevating the expected production potentials of the herds. In other words, to achieve a healthy and productive herd, management factors must be principally regarded (Atasever, 2002). Initial field studies apparently pointed out to effects of indoor conditions such as light, air ventilation, bedding structure, or general hygiene of the farms on the production level of large animals (Angrecka and Herbut, 2015; Somers *et al*., 2019; Atasever, 2002).

It was clearly noted that all these environmental factors are considered as the important components of animal welfare. Poor animal welfare is directly related to the production performance of farm animals and may adversely affect their health status. As a result of this situation, the quality of food produced by animals may also be adversely affected. Also, recently consumers associate food quality and safety with the welfare

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of the animal from which it is produced (Napolitano *et al*., 2019). Considering all these developments, improving animal welfare is important both for increasing the quality of the food produced and for reducing production losses.

As is well known, lameness is an important problem that negatively affects dairy cattle production and health, as well as animal welfare. Researchers define lameness as abnormal posture or gait resulting from a structural or functional disorder in the musculoskeletal system (Mohsina *et al*., 2014). Cows respond to pain and behavior, according to the level of lameness. As a result, milk production decreases depending on the level and duration of stress to which the animals are exposed (Sadiq *et al*., 2019). Some authors emphasized that the cow's daily (from 0.78 up to 5.5 kg) and lactation milk yield (from 270 up to 857 kg) losses are remarkable depending on the level of lameness (Onyiro *et al*., 2008; Bicalho *et al*., 2007; Amory *et al*., 2008; Ristevski *et al*., 2017; Żółkiewskia *et al*., 2018). In addition, it still stands out as an important problem that has negative effects on dairy farm profitability and sustainable production (Sadiq *et al*., 2019). If lameness is not treated or environmental risk factors are not improved, this process may result in the culling of high breeding value animals from the herd. A large body of studies reported that dairy cow lameness is a very common problem and has a multifactorial etiology (Whay and Shearer, 2017; Dolecheck and Bewley, 2018; Somers *et al*., 2019. Also, many researchers have expressed the importance of various lameness detection systems and treatment methods (Potterton *et al*., 2012; Sadiq *et al*., 2019; Dolecheck and Bewley, 2018). Keeping cattle within the comfort and ensuring a stressful environment on the pasture and barn ensures a positive effect on their yields. Therefore, routinely controlling some comfort parameters including body condition score (BCS), milk somatic cell count (SCC), lameness score, gait score or animal needs index (ANI) may be useful as practical tools. Of these, the lameness score or locomotion score (LSc) is known as a subjective evaluation of a cow's mobility during the walking activity (Van Nuffel, 2015; Alsaaod *et al*., 2019). For this aim, a visual LSc scale with 1 to 5 points has been developed and practically used (Winckler and Willen, 2001; Flower *et al*., 2005). It was pointed out that cow's comfort degree (Klaas *et al*., 2003; Pastell *et al*., 2009) and milk yield dramatically decreased with increased LcS values (Pastell *et al*., 2009). Some researchers concluded that higher LcS caused milk yield loss up to 2.6 kg/d in Holstein cows (Warnick *et al*., 2001; Napolitano *et al*., 2005). Many researchers emphasized the association of LcS with milk production in cows (Hernandez *et al*., 2005; Green *et al*., 2010; Green *et al*., 2014). Also, a large body of authors has emphasized that access to pasture or grazing has a beneficial effect on the movements and lameness of scores of cows (Hernandez *et al*., 2007; Somers *et al*., 2019). However, no sufficient information has been reported on this issue in water buffaloes. Napolitano *et al*. (2005) reported that lameness was almost not observed in buffaloes compared to cattle. The same investigators correlated the present findings with differences in lower diet and/or metabolism of buffalo compared to cattle.

To the best of our knowledge, limited information exists on the lameness levels and milk production losses in water buffaloes, which have relatively lower milk yield and physiological differences compared to dairy cows. While lameness remains an important welfare problem resulting in production losses in dairy cattle farms, there is limited evidence as to what level this welfare parameter is in buffalo farms and whether these phenomena result in milk production losses. Therefore, further studies are required to reveal determining the lameness or locomotion scores in buffalo farms and reveal the relationships between the locomotion score of buffalo cows and milk production losses. The aims of this study were (i) to determine the environmental factors affecting the LSc value of buffalo cows, (ii) to evaluate the associations between buffalo cow's LSc with milk yield losses.

MATERIALS AND METHODS

In this study, Anatolian buffalo cows (n=61) raised on a buffalo farm registered to the Buffalo Breeders' Association (BBA) of Bafra district of Samsun province were used. On the farm where there are animals of all age groups, the animals are fed on the pasture during the summer period. In the winter period, a ration consisting of rice straw, barley straw, corn silage, and milk feed (18 HP-2700 ME) is given twice a day. All buffalo cows were milked individually using a milking machine once a day and kept in similar conditions for feeding and other livestock activities. The milk obtained was weighed with an electronic scale and recorded. At the time of data collection, the cows were not grazed on the pasture and were fed in the barn.

Animals were scored for LcS after morning milking during the winter housing period. A 1- to a 5-point scale (1 = normal, 2 = slightly lame, 3 = moderately lame, 4 = lame, and 5 = severely lame) was used to determine LcS values (Winckler and Willen, 2001). Parity, stage of lactation (SL), flank and leg hygiene score (FLHS), and body condition score (BCS) were considered environmental factors that are thought to have an effect on LcS and dMY. Two parity groups (P; 1: 1-2; 2: ≥3) were established to determine the effect of environmental factors on LcS and daily milk yield (dMY). To reveal the effect of SL, it was divided into two separate periods (SL; 1: ≤118d; 2: ≥119d) considering the general average for the total lactation periods. In addition, the hygienic scores of the animals were scored according to the 1 to 4 scale (1: clean, 4: dirty), and FLHS values were also used to determine whether they had an effect on LcS and dMY by dividing them into two groups (FLHS; 1: 1-2; 2: ≥3). Similarly, in terms of BCS, which is an indicator of the nutritional status of the animals, the animals were scored according to the 1-5 scale (1: thin, 5: obese), and the scoring values were divided into two groups (BCS; 1: 1-2; 2: ≥3).

The effects of environmental factors on dMY and LcS were evaluated by t-test. To estimate the loss of milk yield (dMYL) based on the LcS level, a scale of Shearer et al. (2004) was adapted (LcS2: 1% dMYL; LcS3: 3% dMYL; Lc4: 7% dMYL and LcS5: 16% dMYL). Kendall's tau-b correlation analysis was applied to estimate the relationships between dependent (dMYL) and independent (LcS) variables. Statistical analysis was performed using Windows for SPSS 17.0.

RESULTS

Environmental factors affecting dMY and LcS are presented in Table 1. According to the t-test, SL, FLS, and BCS significantly ($P<0.05$) affected dMY.

As seen, buffalo cows within the early SL period had more dMY. Moreover, animals noted as relatively cleaner and scored as higher BCS had higher dMY. However, except for SL, the factors were not significantly effective on LcS.

As understood, the buffaloes within the later SL period had higher LcS.

Different superscript letters in the same column indicate statistically significant differences (P<0.05); SL: stage of lactation; FLHS: flank and leg hygiene score; BCS: body condition score; dMY: daily milk yield (kg); LcS: locomotion score.

In this study, dMY values were classified by LcS categories (Figure 1). Accordingly, a floating distribution on the dMY was observed, but no statistical difference was found among the evaluated groups.

In Table 2, dMYL values according to high LcS are shown. While no milk loss was estimated in the cows with normal LcS (cows with 1 point), approximately 0.3 kg loss per animal was calculated in cows with higher LcS (P>0.05).

The dMYL value was found noteworthy in buffalo cows with >LcS 1.

The linear regression curve was established between LcS and dMYL (Figure 2). Accordingly, a high relationship (R^2=0.79) was calculated between the two traits.

Moreover, a regression model was estimated on these parameters using data in Table 3. As it appears, the regression model was obtained to be $\hat{Y}=-0.048+0.041x$ and the estimated coefficient was found to be significant (P<0.05).

DISCUSSION

As well known, cows with later parities have higher milk yield (Verma *et al*., 2017; Eldawy *et al*., 2021). This case can be explained by many physiological reasons such as the development of the mammary glands and body capacity, and the better adaptation of the cow to calving and milking.

Additionally, some researchers also report that physiological factors that affect the yield performance of cows when they reach mature equivalents may also be effective (Rangel *et al*., 2014; Erdem *et al*., 2022). In the present study, buffaloes with advanced parities had 6.72% more milk when compared to young animals, however, dMY was not affected by parity. Unlike in this study, it was reported that lameness increases with increasing parity (Bicalho *et al*., 2007; Alawnch *et al*., 2012; Bagate *et al*., 2012). Such that, animals with later age gain experience to find more suitable and mud-free areas for walking and resting activities. However, buffaloes with later parities had lower LcS but no statistical difference was determined between the two groups in this study (Table 2).

Dairy animals in early lactation are expected to produce more milk. Considering that the peak period with the highest productivity of the animals coincided with the 1st lactation period in this study, the values reached were found as expected. As can be seen, buffaloes milked in the early SL period produced approximately 0.5 kg more milk per animal. When the average dMY per animal is calculated as 2,829 kg, this amount can be considered a remarkable finding. Buffaloes with earlier SL had also well condition by LcS (Table 1). In this context, it can be commented that buffaloes with early SL had more dMY and an advantage by LcS when compared to the others. This may be due to the fact that the stockman pays more attention to the animals in the period when the yield is higher.

dMY of the clean buffaloes according to FLHS was found to be higher compared to the animals with ≥3 FLHS (Table 1). Accordingly, relatively clean buffaloes had more milk per cow than the others. This finding might be seen as an attractive result to prevent milk yield losses caused by the dirtiness level of dairy animals. It was determined that there was a decrease in milk yield with the increase in foot and leg hygiene scores in Holstein cows (Atasever and Erdem, 2009). Unlike this study, it was found that cows with low hygiene scores in buffaloes have lower milk yield [36]. However, no statistical difference was obtained between the two LcS groups by FLHS. But, in an initial study (Tongel and Brouček, 2010), a correlation of 0.63 was determined between leg hygiene and LcS.

Higher BCS had a positive effect on dMY (Table 1). Such that, buffalo cows with 1 or 2 BCS points produced about 0.5 kg lesser dMY compared to the buffalo cows with BCS ≥3 points. In a study (Mushtaq et al., 2012), it was reported that cows with higher BCS produced lower milk. But another researcher (Anitha *et al*., 2011; Banu *et al*., 2012) reported that cows with higher BCS produced more milk. However, no statistical difference was determined between the two BCS groups in the present study.

The distribution of dMY according to LcS is shown in Figure 1. As seen, a waved trend on dMY was designed but no statistical difference was found among the groups. At this point, investigating this item using more data may be beneficial to reveal clearer comments.

According to Table 2, dMYL increased with higher LcS. Besides, it can be noted that 15% of the buffalo cows evaluated in this study had zero milk loss. This rate might be found to be low and should be elevated to higher percentages. When LcS of animals with 2 or 2.5 points reached 3 points, the difference in dMYL was calculated to be 0.049 kg. In view of the obtained findings, avoiding the increase in LcS might be seen as a compulsory approach to prevent milk yield losses in milking buffalo cows. It was also emphasized that clinical lameness may cause a decrease in milk yield (Tongel and Brouček, 2010).

At the end of the correlation analyses, it was estimated that there was a high correlation (r=0.789) between LcS and dMYL. This value points out a close relationship of dMYL with LcS. In other words, managing buffaloes with relatively lower LcS would ensure more income in the farm economy. The association of dMYL with LcS was also shown with a linear regression curve (Figure 2). The curve clearly shows the close relationship between the two parameters. To support this case, the model summary and coefficients were calculated (Table 3). According to the regression model ($\hat{Y}=-0.048+0.041x$), an increase in LcS with one unit caused to rise in dMYL with 0.041 unit. Some initial study results also revealed that milk yield decreased in cattle (Juarez *et al*., 2003; Vatandoost *et al*., 2009) and buffaloes (Napolitano *et al*., 2005) with lame or high LcS. These results clearly supported the findings obtained in the present study. However, conducting further investigations with different water buffalo breeds using more data may confirm the definitive conviction.

In the view of obtained results in the present study, milk yield losses were found to be depending on the locomotion score, it is seen that milk yield losses are remarkable. While SL, FLHS, and BCS affected dMY, only SL influenced LcS values. dMY increased with advanced LcS. Milk loss significantly increased with high LcS in buffalo cows. Finally, a close association (r=0.789) that was calculated between dMYL and LcS and the estimated regression model emphasized that preventing LcS increment in the herd base should be seen as one of the major management applications to prohibit milk losses. For this reason, foot infections, injuries, the use of high-energy rations, or the elimination of farm-related problems that may cause gait abnormalities of

Table 1. Environmental factors affecting dMY and LcS.

Factors		n	dMY ($\bar{x}±S_x$)	LcS ($\bar{x}±S_x$)
Parity	1	31	2.73±0.135	2.13±0.106
	2	30	2.92±0.127	1.92±0.112
SL	1	40	3.00±0.109[b]	1.91±0.099[a]
	2	21	2.49±0.148[a]	2.24±0.112[b]
FLHS	1	17	3.26±0.171[b]	2.24±0.129
	2	44	2.65±0.101[a]	1.94±0.093
BCS	1	25	2.54±0.111[a]	2.08±0.137
	2	36	3.02±0.128[b]	1.99±0.092
General		61	2.83±0.929	2.02±0.779

Table 2. Milk yield losses by LcS.

LcS	n	dMYL (%)	dMYL (kg)
1	11	0	0
2-2.5	40	1-2	0.032±0.002[a]
3	10	3	0.081±0.007[b]
General	61		0.034±0.003

Different superscript letters in the same column indicate statistically significant differences ($P<0.05$); LcS: locomotion score, dMYL: loss of daily milk yield.

Table 3. Model summary and coefficients on the relations of LcS with dMYL.

Model Summary[b]					
Model	R	R Square	SE of the Estimate	SE of the Estimate	
1	0.890[a]	0.791	0.788	0.012888	
Coefficients[a]					
Model	Unstandardized		Standardized		
	B	SE	Beta	t	Sig.
1 (Constant)	-0.048	0.006		-8.324	0.000
LcS	0.041	0.003	0.890	14.962	0.000

In the Model Summary; a. predictors: (constant), LcS; in the Coefficients; a. dependent variable: dMYL.

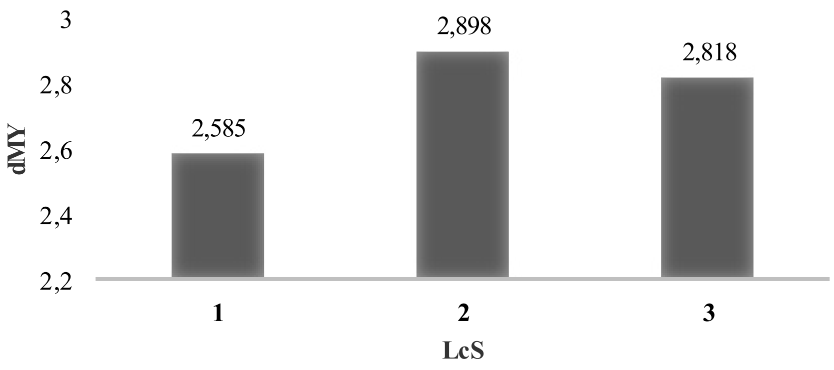

Figure 1. dMY values (kg) according to LcS categories (P>0.05).

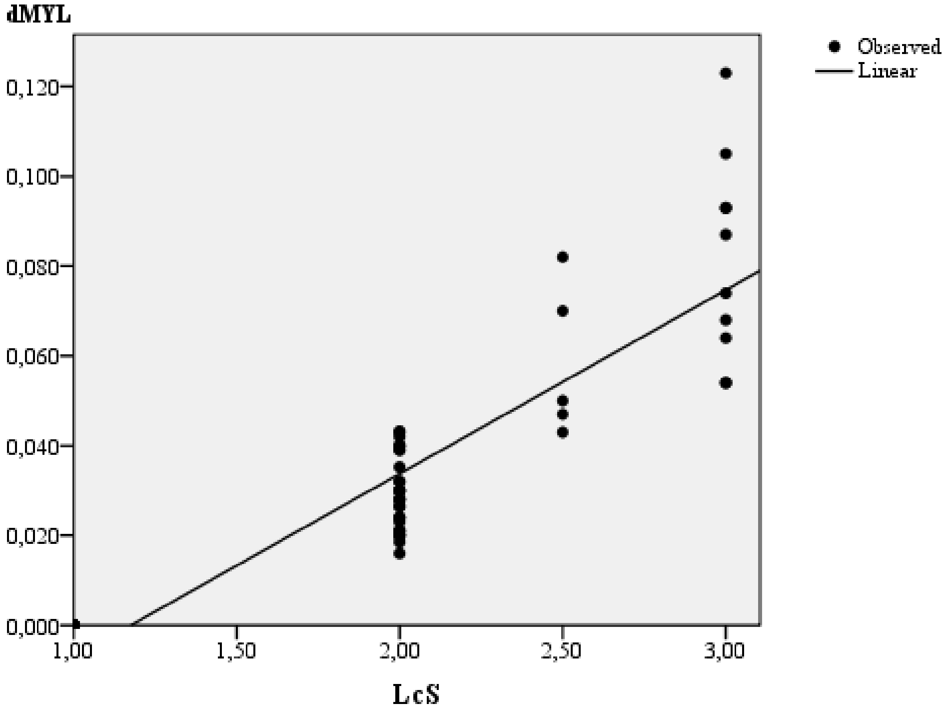

Figure 2. Linear regression curve between LcS and dMYL.

buffaloes should be considered in terms of both animal welfare and productivity.

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