Effects of body condition score on milk yield and calf birth weight in dairy cattle

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Recevied: 13.02.2025 Accepted: 24.04.2025 Published: 30.04.2025

Abstract

This study investigated the effects of pre-calving body condition scores (BCS) on milk yield and calf birth weights in pregnant Holstein heifers. For this purpose, data from 66 primiparous heifers, their first lactation milk yields, and the birth weights of 66 calves born from these heifers were analyzed. Two different rations consisting of concentrate feed and roughage with 36% HP and 1718 kcal/kg ME were used in the feeding of the animals pre- and post-calving. Approximately three weeks pre- calving, the heifers were classified into three groups based on their BCS as low (BCS ≤ 3.00), moderate (BCS 3.25 ≤ 3.50), and high (BCS ≥3.75). To determine changes in body condition, a second scoring was performed immediately post-calving. The differences between pre- and post-calving BCS values were calculated, and the BCS changes for each animal were identified. The effects of these changes on milk yield and calf birth weight were statistically analyzed using one-way analysis of variance (ANOVA). According to the results, BCS at calving had no significant effect on 305-day adjusted lactation milk yield ($p>0.05$). Additionally, pre-calving BCS and post-calving BCS changes did not affect calf birth weights ($p>0.05$). However, the findings indicated that a post-calving BCS loss of 0.50–0.75 points significantly increased milk yield ($p<0.05$). This finding suggests that controlled energy mobilization in early lactation may support milk production. Therefore, properly planned transition period rations are thought to be essential for ensuring herd health and increasing milk yield.

Keywords: *Birth weight, body condition score, holstein, milk yield, pregnant heifer*

INTRODUCTION

Productivity in dairy cattle is dependent on economically significant traits such as milk yield and reproductive performance. These traits are largely influenced by the physiological status of the animals. Body condition score is a crucial indicator, particularly in the pre-calving period, as it reflects cows' energy reserves and metabolic status. BCS is assessed visually and through palpation, evaluating the body fat reserves of dry or lactating cows without considering live weight or body measurements (Gallo et al., 1996; Hady et al., 1994). Thanks to BCS, the efficiency performance of cows can be increased by ensuring optimum nutrition in periods when energy needs vary, such as insemination, dry period, birth and lactation (Daşkın, 2011). By evaluating the current metabolic profiles and determining the energy balances of cows exhibiting different physiological characteristics, it is possible to prevent certain metabolic and production-related problems (Ural & Erdoğan, 2018)

In dairy cattle, milk yield is particularly high during the early stages of lactation. During this period, if essential nutrients such as energy, protein, and minerals are not adequately supplied, cows utilize their body reserves to sustain milk production. Consequently, a decline in body weight and condition occurs (Aeberhard et al., 2001). When nutrient requirements are not met and feeding is inadequate, a negative energy balance develops. BCS is widely used in dairy cattle to assess negative energy balance and to implement feeding programs that meet nutritional requirements (Edmonson et al., 1989; Lassen et al., 2003; Samarütel et al., 2006). The negative energy balance resulting from inadequate and unbalanced nutrition adversely affects reproductive performance and overall health in cows (Dechow et al., 2002; Fallah, 2022; Gillund et al., 2001; Lassen et al., 2003; Maršálek et al., 2008; Roche et al., 2007).

Numerous studies have examined the effects of pre-calving body condition scores on post-calving health disorders, fertility, and milk yield, yielding varying results (Butler & Smith, 1989; Kara et al., 2013; Meikle et al., 2004; Pedron et al., 1993; Roche et al., 2009; Ruegg & Milton, 1995; Tapkı et al., 2005ab; Waltner et al., 1993; Wathes et al., 2007). The optimal lower limit for BCS at calving is reported to be between 3.00 and 3.50 (Roche et al., 2009; Samarütel et al., 2006). Butler & Smith, (1989) suggested that low pre-calving BCS could negatively impact post-calving fertility and milk yield. Additionally, cows with an optimal BCS range have been shown to return to reproductive cyclicity more rapidly and achieve higher first-service conception rates (Roche et al., 2009; Walsh et al., 2011).

One of the economically important traits in cattle breeding is calf birth weight. Birth weight is a critical factor that directly influences calf viability, growth performance, and future milk yield. In addition to genetic factors, calf birth weight is affected by environmental factors such as maternal age, nutritional status, gestation length, and season of birth. Calves born with normal birth weights grow more rapidly under proper feeding and management conditions, contributing to early reproductive and milk production potential. In contrast, calves with low birth weights may have weaker immune systems, making them more susceptible to diseases. On the other hand, excessively high birth weights can lead to dystocia, posing significant risks to both the dam and the calf (Mee, 2008). Studies by Berry et al., (2007) and Lom-

How to cite this article: Kayar T., Erzurum O., (2025). Effects of body condition score on milk yield and calf birth weight in dairy cattle. *Journal of Advances in VetBio Science and Techniques*, 10(1), 60-65. https://doi.org/10.31797/vetbio.1638660

bard et al.,(2007) have reported that high pre-calving BCS can increase calf birth weight but may also elevate the risk of calving difficulties.

This study aimed to evaluate the effects of pre- and post-calving BCS on milk yield characteristics and calf birth weights in primiparous pregnant heifers. By doing so, the study sought to highlight the importance of BCS management during both pre- and post-calving periods.

MATERIALS AND METHODS

This study was conducted at a private dairy farm located in Aksaray (38°19’11.7”N, 33°54’13.7”E) and was approved by the Ethics Committee of the SÜVDAMEK (Protocol No. 2025/02-17).

The study utilized data obtained from Holstein heifers and cows in a private dairy farming operation in Aksaray. The research material consisted of 66 primiparous heifers and the birth weights of their calves. All animals were subjected to the same feeding and management protocol, and milk yield records were collected using an automated robotic milking system. The animals were housed in modern free-stall barns and fed ad libitum with two different rations during the dry period and early lactation. Feeding was conducted twice daily, in the morning and evening.

The ration composition included wheat straw, dry alfalfa hay, barley silage, corn silage, corn flakes, a vitamin-mineral premix, bypass fat, a toxin binder, and a concentrate dairy feed containing 36% CP and 1718 kcal/kg ME. The ration was formulated according to NRC (2001) guidelines, and the composition and quantities are provided in Table 1. The chemical composition of the concentrate feed used in the ration was analyzed at a specialized feed manufacturing facility.

Body condition scores of heifers were determined three weeks before and at the time of calving according to the methodology of Ferguson et al., (1994) based on a 5-point scale with 0.25 points interval. The groups were formed as Low Body Condition Score (LBCS ≤3.00; n=25), Moderate Body Condition Score (MBCS 3.25 ≤3.50; n=25) and High Body Condition Score (HBCS ≥3.75; n=16) according to their fitness scores. The BCS of the animals was reassessed immediately post- calving.

Table 1*. Ingredients and chemical composition of the rations used in the study.*

Ingredients	Dry period ration (kg/day/head)	Post-calving ration (kg/day/head)
Wheat straw	3.00	0.40
Alfalfa hay	1.25	2.70
Concentrate dairy feed	1.80	7.60
Barley silage	5.00	5.50
Corn silage	6.00	19.50
Corn flake	2.00	5.50
Vitamin-mineral premix*	0.15	0.55
Bypass fat	0.00	0.40
Toxin binder	0.03	0.03
Ration dry matter	10.50	22.20
Ration dry matter ratio (%)	49.00	50.00
Ration crude protein (%)	12.50	17.30
Chemical analysis values of concentrated milk feed		
Crude protein (%)	36	
Crude fiber (%)	8	
Crude fat (%)	2.5	
Ash (%)	7	
Sodium (%)	0.4	
Metabolizable energy (kcal/kg)	1718	

*: Per kilogram of contains: 246.000 IU Vit. A, 61.500 IU Vit. D_3, 1538 mg Vit. E, 923 mg Mn, 923 mg Zn, 923 mg Fe, 369 mg Cu, 6 mg Co, 25 mg I, 9 mg Se.

The differences between the pre- and post-calving BCSs were calculated, and the body condition changes for each animal were determined. Based on the changes in BCS, the animals were classified into two groups: a 0.00-0.25 score change group and a 0.50-0.75 score change group.

Birth weights and genders of calves were recorded by weighing and observing the calves immediately after birth. Milk yield records were kept daily through the robotic milking system. Additionally, the 305-day milk yield predictions were calculated. The robotic milking system accurately measured the daily milk yields and maintained records on an individual animal basis. The system also provided data on milking frequency, milk quantity, and milk quality. These data were transferred to the farm management software at regular intervals for analysis.

Statistical analyses

The collected data were analyzed using IBM Corp. (2012) SPSS Statistics software (v.21). The normality of the data was assessed using the Kolmogorov-Smirnov test. For data that followed a normal distribution, one-way analysis of variance (ANOVA) was applied, while the Kruskal-Wallis test was used for data that did not follow a normal distribution. A significance level of $p<0.05$ was considered statistically significant.

RESULTS

The average body condition scores of all animals used in the study were determined to be 3.67 pre- calving and 3.30 post- calving, with an average BCS change of 0.36. The average corrected 305-day milk yield of the animals was found to be 7987 kg. Based on the birth weight measurements of the calves, the average birth weight was determined to be 38.07 kg (Table 2).

The effects of pre-calving BCS and post-calving BCS changes on the 305-day corrected milk yields and calf birth weights are shown in Table 3.

Regarding pre-calving BCS, no statistically significant differences were found among all groups in terms of 305-day milk yields ($p>0.05$). However, the highest milk yield was observed in the group with the moderate BCS score (BCS = 3.25 ≤ 3.50), which was 8263 ± 316 kg. The group with the heaviest calf birth weight was found to be the group with a BCS ≥ 3.75, with an average weight of 40.160 ± 1.190 kg. However, no significant differences were found for calf birth weights across the groups ($p>0.05$).

Post-calving, a BCS change of 0.00-0.25 was observed in 40 animals, while a BCS loss of 0.50-0.75 points was recorded in 26 animals. When the effects of these BCS changes on 305-day milk yields and calf birth weights were examined, no differences were found in calf birth weights ($p>0.05$). However, in the group with greater post-calving BCS loss, the 305-day milk yield was approximately 900 kg higher, and this difference was found to be statistically significant ($p<0.05$).

DISCUSSION

In this study, the effects of pre-calving and post-calving BCSs on 305-day milk yield and calf birth weight were examined. The general averages for BCS and post-calving BCS changes observed in the heifers were consistent with some findings in the literature, while differing from others. Kertz et al., (1997) reported similar average BCS at calving, with a value of 3.36. In a comparable study, Bayram et al., (2012) reported average BCS at calving and during the first month of lactation as 3.14 and 3.01, respectively, which aligns with the results of this study. However, Domecq et al., (1997), in their study examining the relationship between BCS and milk yield, reported lower pre-calving BCS in heifers, with a value of 2.66, which is lower than the pre-calving BCS found in this study.

In studies conducted by Yaylak & Kumlu, (2005) and Ural, (2012), it was reported that BCS significantly influenced 305-day milk yield, with animals having higher BCS exhibiting higher milk yields. In contrast, Bouska

Table 2. *Means and ranges of variables of the study herd (n=66).*

Variables	Mean	SEM	Range
Pre-calving BCS	3.67	0.50	4.50 to 2.75
Post-calving BCS	3.30	0.46	4.00 to 2.50
Post-calving BCS loss	0.36	0.02	0.75 to 0.00
305-day adjusted milk yield (kg)	7987	173	12215 to 5462
Birth weight (kg)	38.07	0.48	48.00 to 30.00

Note. BCS: Body condition score

Table 3. *Effect of body condition score on milk yields and calf birth weights.*

Groups	n	305-day adjusted milk yield X±Sx	p	Birth weight X±Sx	p
Pre-calving BCS					
≤3.00	25	7882 ± 308		37.300 ± 0.694	
3.25 ≤3.50	25	8263 ± 316	0.440	37.500 ± 0.647	0.237
≥3.75	16	7721 ± 188		40.160 ± 1.190	
Post-calving BCS loss					
0.00 ve 0.25	40	7620 ± 163	0.017	38.263 ± 0.650	0.820
0.50 ve 0.75	26	8551 ± 336		37.769 ± 0.691	

Note. Statistically significant when p values <0.05.

et al., (2008) found that cows with low BCS (≤ 3.5, 4, ≥4.5) during the dry period achieved the highest milk yields (7,345, 6,980, 6,868 kg, respectively). Similarly, Bayram et al., (2012) reported that cows with low BCS (BCS <3.00) at calving had significantly higher actual milk yield and 305-day milk yield compared to those with moderate BCS (BCS ≥ 3.00). However, they found no significant effect of BCS during early lactation on 305-day milk yield.

In contrast to these findings, in the present study, the highest milk yield was observed in the moderate BCS group (3.25–3.50 range) with a value of 8,263 ± 316 kg, while cows with BCS ≤3.00 had a lower milk yield (7,882 ± 308 kg). However, the differences between the groups were not statistically significant (p=0.440). Similarly, Poczynek et al., (2023) reported a milk yield of 8,288.0 ± 560 kg for the BCS group of 3.00-3.25, concluding that differences in milk yield based on BCS were not significant. In another study, Metin et al., (2023) found that milk yield was higher in the BCS 3.75 group (moderate score) compared to both BCS 3.50 and BCS 4.00 groups. Tapkı et al., (2005b) reported that cows with a moderate BCS (≤4) during the dry period had significantly higher milk yields compared to those with a high BCS (BCS >4). Contreras et al., (2004) similarly found a positive correlation between milk yield and moderate BCS values, with the correlation turning negative as BCS values increased. Butler & Smith, (1989), in line with the findings of this study, reported that low pre-calving BCS could negatively affect fertility and milk yield post-calving due to insufficient energy reserves.

In several previous studies, post-calving BCS changes were reported to range between 0.29 and 1.20 units (Dechow et al., 2002; Domecq et al., 1997; Koenen et al., 2001; Maršálek et al., 2008; Samarütel et al., 2006; Waltner et al., 1993). However, Bayram et al., (2012) reported a lower post-calving BCS loss (0.11) compared to the aforementioned studies. In the present study, the average post-calving BCS loss was determined to be 0.36. When the effects of these losses on milk yield were examined, cows that experienced a 0.50-0.75 BCS loss had significantly higher 305-day milk yields (8,551 ± 336 kg) compared to those with lesser BCS loss (p=0.017). This finding supports the idea that post-calving BCS loss may contribute to milk production through the mobilization of body reserves during lactation.

Consistent with the present study, other research has reported higher milk yields in cows with higher BCS loss (Berry et al., 2007; Dechow et al., 2002; Roche et al., 2007). Additionally, Dechow et al., (2002) found a genetic correlation between BCS loss and milk yield characteristics ranging from 0.17 to 0.55. In contrast, Bayram et al., (2012) reported no significant effects of BCS changes on reproductive and milk yield traits. This discrepancy may be explained by the very low level of BCS loss in their study. There are also studies reporting no effect of BCS at calving on milk yield (Domecq et al., 1997; Jilek et al., 2008; Markusfeld et al., 1997; Pedron et al., 1993; Ruegg and Milton, 1995; Samarütel et al., 2006; Waltner et al., 1993). The varying results in studies examining the effect of BCS on milk yield suggest that the relationship between pre-calving BCS and milk yield is not always linear. Moreover, discrepancies in findings may be attributed to differences in breed, age, management practices, and scoring methods used in the studies.

In this study, the average birth weight of the calves was found to be 38.07 kg. When BCS values were evaluated in conjunction with calf birth weights, an increase in birth weight was observed in parallel with higher pre-calving BCS. Specifically, calves born from cows in the ≥3.75 BCS group had a higher average birth weight (40.160 ± 1.190 kg) compared to the other groups. However, the difference between the groups was not statistically significant (p=0.237). Similarly, the post-calving BCS changes had no significant effect on calf birth weight (p=0.820). This finding is consistent with those reported by Karslıoğlu & Galiç, (2021). Bayram et al., (2012) also found that calves born to cows with lower BCS had an average birth weight 0.5 kg lower than those born to cows with higher BCS, though the difference was not significant.

The average birth weights in this study were lower than those reported in some other studies (Bayram et al., 2012; Karslıoğlu & Galiç, 2021; Kertz et al., 1997). Similar average calf birth weights were reported by Tapkı et al., (2005a), Metin et al., (2023), and Poczynek et al., (2023) (37.5 and 37.9, 40.1 kg), but in these studies, the effect of BCS on calf birth weight and growth performance was found to be significant. Many studies have reported that cows with higher pre-calving BCS give birth to heavier calves. These studies also indicate that high BCS positively affects placental development and fetal nutrient intake, although the risk of dystocia increases in cows with excessively high BCS (Berry et al., 2007; Roche et al., 2007). The inconsistencies in these results suggest that the energy balance during the post-calving period may not have a direct effect on calf birth weight, and pre-calving nutrition could be a more determining factor. Additionally, when evaluating calf birth weight, environmental factors such as maternal age, gestation length, and calving season, in addition to genetic factors, should be considered.

CONCLUSION

In this study, the effects of pre-calving BCS and post-calving BCS loss on 305-day milk yield and calf birth weight were evaluated. The results showed that while numerical differences in calf birth weights were observed due to pre-calving BCS and post-calving BCS loss, these differences were not statistically significant. However, post-calving BCS losses had significant effects on milk yield. This finding suggests that controlled energy mobilization in the early stages of lactation may support milk production.

Nevertheless, there are differing opinions in the literature regarding the impact of BCS loss on milk yield. Some studies report that slight BCS loss contributes to increased milk production, while other studies emphasize that excessive BCS loss poses risks to reproductive performance, metabolic health, and long-term milk yield. Therefore, optimal BCS loss should be achieved at the beginning of lactation, and excessive energy mobilization should be prevented.

In this regard, it is recommended that feeding programs be adjusted according to energy balance, BCS changes be monitored regularly, and balancing nutritional strategies be implemented during the post-calving period. Future studies investigating the relationships between BCS loss and milk composition, reproductive performance, and metabolic health in more detail would be beneficial. Furthermore, long-term follow-up studies assessing the effects of genetic differences and management conditions could provide more definitive conclusions on the subject.

Financial support

The authors declared that this study has received no financial support.

Conflict of interest

The authors declared that there is no conflict of interest.

Ethical statement or informed consent

This study was approved by the Ethics Committee of the SÜVDAMEK (Approval No. 2025/02-17).

Author contributions

TK and OE conceptualized and designed the study. They also contributed to data collection. Statistical analyses were performed by TK and OE. TK drafted the manuscript, and all authors reviewed and approved the final version.

Availability of data and materials

Data supporting the findings of this study are available from the corresponding author upon reasonable request.

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