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Original Research Article

Relationships between Body Condition Score in Dry-Off, Calving or Different Lactation Days and Selected Reproductive Parameters in Dairy Cows

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ABSTRACT

The aim of this study was to investigate the relationships between body condition score in dry-off, calving or different lactation days and selected reproductive parameters in dairy cows. In this study, body condition scoring (using a 5-point scale with quarter-point divisions) was performed on 130 Holstein dairy cows in six period included dry-off (BCS_D), calving (BCS_C), days in milk (DIM) 70, 140, 210 and 280 (BCS_{70}, BCS_{140}, BCS_{210}, BCS_{280}) and analyzed its relationships with selected reproductive parameters (calving interval [CI], calving to first service [CFS], calving to conception interval [CCI] and service per conception [SC]). The relationships among the BCS assessment periods, the relationships between the difference of BCS_D and BCS_{70} (BCS_{D-70}) with BCS_D and BCS_{140} (BCS_{D-140}) and calving to first service (CFS) were found important (P<0.01, P<0.05 respectively). Also, the relationship between CFS and calving interval (CI) and average BCS (BCS_{avg}) during lactation were found important (P<0.01, P<0.05). While the relationship with dry-off and calving and selected reproductive parameters was not found to be statistically important, an important relationship was found between BCS_{70} and CFS, CI (P<0.01, P<0.05), BCS_{140} and BCS_{210} with CFS (P<0.01, P<0.05). When the effect of the determined relationships were assessed, the effects of BCS_{70} and BCS_{140} on CFS were found important (P<0.05, P<0.01). As a conclusion, it can be said that optimum BCS interval in DIM70 and DIM140 are $2.0< BCS_{70} \leq 3.5$ and $2.0< BCS_{140} \leq 3.75$; respectively for minimum CFS. Also in considering the possible negative effects of BCS loss in early lactation on reproductive performance, the optimum BCS interval in calving has been determined to be $2.25\leq BCS_C \leq 3.25$ for minimum condition loss in postpartum in this study.

Keywords: Body condition score, Dairy cow, Holstein, Reproduction

INTRODUCTION

Depending on the combination of improved management, better nutrition, and intense genetic selection, milk production per cow has increased steadily in the last 5 decades (Lucy 2001). However, selection pressures have resulted in many physiological changes in cows with the greatest milk production having the highest incidences of infertility (Lucy *et al.* 2009). Milk production of individual cows depends on their ability to become pregnant because the lactation cycle is initiated and renewed by pregnancy. On the other hand, female reproductive performance is affected by mobilization of the body energy reserves and this applies across a wide range of mammalian species to most aspects of reproduction (Friggens 2003). Dairy cattle, in common with most lactating mammals, are usually in negative energy balance in the first few weeks of lactation and lose their body energy reserves because the energy intake during this period is less than half of the energy requirements for reproduction (Pryce *et al.* 2001) and high milk yield increases the gap between the energy input and output during early lactation (Veerkamp 1998). Changes in body composition is related to changes in body condition in dairy cattle and research and field data suggest that changes in body condition influence health and productivity in dairy cows. Rapid loss of body condition after calving may be associated with a higher incidence of metabolic disorders, impaired fertility, and other health problems. Over-conditioning ("fat cow syndrome") is associated with a complex of digestive, metabolic, reproductive, infectious, and systemic problems at parturition and in the ensuing lactation (Gearhart *et al.* 1990).

The BCS of a dairy cow is an assessment of the proportion of body fat that it possesses, and has been widely accepted as the most practical method for assessing changes in energy reserves in dairy cattle (Bewley and Schutz 2008) and it is recognized by animal scientists and producers as being an important factor in dairy cattle management (Roche *et al.* 2009). The methods that are used to determine the body reserves are subjective and are based on visual and tactile appraisals of body fat reserves in the back and pelvic regions, and BCS is scored on different scale in different countries. The change in BCS over the first few weeks of lactation may

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indicate the extent of metabolic load as the shortfall of energy to fuel production is thought to be met through mobilizing body reserves (Pryce *et al.* 2000). Furthermore the level of fatness or BCS at key periods in lactation, as well as BCS changes over early lactation, and could affect the resumption of estrous cycles and reproductive success. Therefore BCS is very important in dairy breeding programs that are centered on production risk because cows are more likely to mobilize body tissue. This may be at the expense of fertility, so it is important to investigate the relationship between BCS and fertility traits (Pryce *et al.* 2001).

The purpose of this research was to determine whether or not BCS at dry-off and different lactation days affects selected reproductive parameters such as calving interval, calving to first service, calving to conception interval and service per conception and contribute to minimize reproductive problems that is common in dairy herds by using method which is subjective but has no extra cost such as body condition score.

MATERIALS and METHODS

Selection of cows

Data were obtained on Holstein cows housed and managed at the commercial dairy farm (600 lactating cows) located in east central Bursa/Turkey. The herd was housed in a free-stall barn; fed a total mixed ration (TMR) twice a day and milked three times a day. Cows were divided into five groups based on yield (low: 18–23 kg/day; medium: 28–32 kg/day; high: 43–44 kg/day) and period (dry or fresh). Dry cows were housed in two groups: an early dry group consisting of cows from dry-off to 3 wk before expected calving and a periparturient group consisting of cows from 3 wk before expected calving to calving. Average nutriments of rations given to groups are presented in Table 1. Cows were evaluated according to criteria such as their lactation number, daily milk yield, background of manipulation to reproductive cycle, reproductive diseases

Eventually, 130 dairy cows which were in second lactation, had 28-32 lt. average daily milk yields, had not been manipulated for reproduction and had no reproductive problems were used in the final data analysis, and a total of 1430 records were obtained throughout their calving interval from March 2012 to December 2013.

Table 1. Nutrient compositions of rations.

	Rations				
Chemical composition of ration	Dry period	Fresh period[1]	High [2]	Medium[3]	Low[4]
DM[5], %	62.07	58.09	57.96	58.04	52.22
NDF[6], % of DM	47.9	35.0	36.2	37.5	45.4
ADF[7], % of DM	29.7	21.6	21.7	22.1	26.7
Nel[8], Mcal/kg of DM	1.38	1.59	1.57	1.55	1.45
CP[9], % of DM	12.9	17.1	16.5	16.5	14.4
Ether extract, % of DM	2.4	4.6	4.7	4.6	2.9
Ca, % of DM	0.7	0.95	0.93	0.94	0.75
P, % of DM	0.41	0.54	0.55	0.54	0.54

[1] First 30 days of lactation, [2] Group has average 43–44 kg/day of milk production, [3] Group has average 28-32 kg/day of milk production, [4] Group has average 18-23 kg/day of milk production, [5] Dry Matter, [6] Neutral Detergent Fiber, [7] Acid Detergent Fiber, [8] Net Energy Lactation, [9] Crude Protein

Body condition score (BCS)

All BCS were assigned by one individual using the visual technique developed by Edmonson *et al.* (1989) (Figure 1). Cows were scored for condition in six periods including dry-off (BCS_D), calving (BCS_C), and different days in milk (DIM) 70, 140, 210 and 280 (BCS_{70}, BCS_{140}, BCS_{210}, BCS_{280}) by the same operator after the morning milking. The scorer had no knowledge of the previous BCS during the research.

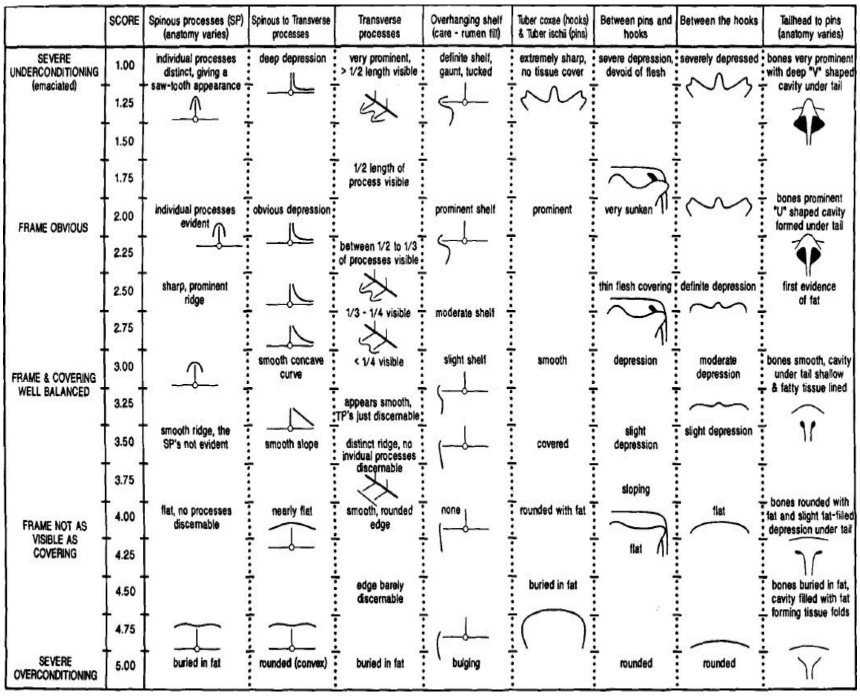

Figure 1. BCS chart for Holstein dairy cows (Edmonson *et al.* 1989).

Reproductive parameters

The fertility measurements calculated included: calving interval (CI), calving to first service (CFS), services per conception (SC) and calving to conception interval (CCI). The parameters relevant to fertility were obtained from herd recording system.

Statistical analyses

The data were analyzed by using the General Linear Model Procedure of SPSS (2008) and significant differences among the means were tested by Duncan's Multiple Range Test. The following model was used for determination of the effect of body condition scores at different stages of lactation on reproductive parameters;

$$Y_{ij} = \mu + BCS_i + e_{ij}$$

where Y_{ij} represents level of j-th animal at selected reproductive parameter, BCS_i is the effect of the i-th BCS group and e_{ij} is the error term, $\sim N(0, \sigma_e^2)$.

RESULTS

The average calving to first service for 130 animals, which were evaluated in the study, was found to be 81.7 days; calving to conception interval was found to be 153.2 days; calving interval was found to be 431.4 days, and service per conception was found to be 2.8. The descriptive statistics of the variables are given in Table 2.

Table 2. Descriptive statistics for reproductive parameters.

Trait[1]	**Min**	**Max**	**Avg.**	**SE**
CFS (day)	36	220	81.731	3.728
CCI (day)	41	549	153.162	6.787
CI (day)	282	669	431.415	6.155
SC (number)	1	10	2.838	0.156

CFS: Calving to First Service, **CCI**: Calving to Conception Interval, **CI:** Calving Interval, **SC:** Service per Conception.

The relationship between the differences in the minimum and maximum body condition scores and the reproductive parameters and average BCS during the lactation and the BCS differences between the 4 periods were investigated in the study, and it was determined significant positive correlation between CFS and difference between dry period and BCS_{70} (BCS_{D-70}) and BCS_{140} (BCS_{D-140}), (P<0.05). In addition, it was also determined that the negative correlation between the average BCS during lactation and CFS and CI was significant (P<0.01, P<0.05) (Table 3).

Table 3. Relationship between difference of BCS and reproductive parameters.

	CFS	CCI	CI	SC
ΔBCS_{D-C}[1]	-0.069	0.018	-0.023	0.023
ΔBCS_{D-70}[2]	0.179*	-0.034	-0.009	-0.092
ΔBCS_{D-140}[3]	0.186*	-0.039	-0.016	-0.168
ΔBCS_{C-70}[4]	0.103	-0.015	-0.036	-0.068
ΔVKS_{C-140}[5]	-0.121	0.022	0.041	0.150
ΔBCS_{140-70}[6]	-0.043	0.014	0.013	0.141
$\Delta BCS_{Max.-Min.}$[7]	0.056	-0.038	-0.067	-0.100
$BCS_{Avg.}$[8]	-0.235**	-0.109	-0.192*	0.003

** P<0.01, * P<0.05 [1]**ΔBCS_{D-C} =** Difference between BCS in dry period and BCS in calving
[2]**ΔBCS_{D-70} =** Difference between BCS in dry period and BCS in DIM70 [3]**ΔBCS_{D-140} =** Difference between BCS in dry period and BCS in DIM140 [4]**ΔBCS_{C-70}** = Difference between BCS in calving and BCS in DIM 70[5]**ΔBCS_{C-140}** = Difference between BCS in calving and BCS in DIM140 [6]**ΔBCS_{140-70}** = Difference between BCS in DIM140 and BCS in DIM70 [7]**$\Delta BCS_{Max.-Min.}$=** Difference between max and min BCS [8]**$BCS_{Avg.}$** $=\sum VKS_{k,d,70,140,210,280}/6$

When the relation between body condition scores evaluated in different periods and reproductive parameters was evaluated, it was observed that the negative correlation between BCS_{70} and CFS, CI and between BCS_{140}, BCS_{210} and CFS was significant (P<0.01, P<0.05) (Table 4).

Table 4. Relationship between BCS assessed in different periods and reproductive parameters.

	İTA	SP	BA	GBTS
BCS_D	0.089	-0.124	-0.185	-0.111
BCS_C	-0.139	-0.093	-0.182	-0.076
BCS_{70}	-0.290**	-0.107	-0.203*	-0.031
BCS_{140}	-0.274**	-0.083	-0.165	0.060
BCS_{210}	-0.205*	-0.109	-0.153	0.033
BCS_{280}	-0.181	-0.036	-0.082	0.081

** P<0.01, * P<0.05

In variance analyses, the effect of the BCS_{70} and BCS_{140} on CFS was found significant (P<0.05, P<0.01, respectively). While the relation between BCS_C and BCS_{C-70} with any reproductive parameter was not found statistically significant, a positive correlation was detected between BCS_C and BCS_{C-70} (P<0.01). After the variance analysis, the Duncan Multiple Comparison test was conducted for the periods in which important differences were determined. In this context, the results are given in Table 5, Table 6 and Table 7.

Table 5. Effects of BCS_{70} on CFS

BCS Groups	Animal number	Avg. CFS (day) ±SE[1#]
2.0	6	98.83±16.66[ab]
2.25	6	112.83±16.66[b]
2.50	45	95.16±6.08[ab]
2.75	43	69.88±6.22[a]
3.0	16	73.81±10.20[ab]
3.25	6	71.83±16.66[ab]
3.50	8	57.00±14.43[a]
Total	130	81.73±3.73*

[#]Means in a column with no common superscript differ significantly (P<0.05). [1]Standard Error [*]Standard Error of Avg.

Table 6. Effects of BCS_{140} on CFS.

BCS groups	Animal number	Avg. DFS (day) ±SE[1#]
2.0	6	134.50±16.19[b]
2.25	6	63.33±16.19[a]
2.50	32	100.03±7.01[ab]
2.75	43	72.88±6.05[a]
3.0	22	80.45±8.46[ab]
3.25	11	65.82±11.96[a]
3.50	3	44.67±22.90[a]
3.75	7	67.86±14.99[a]
Total	130	81.73 ± 3.73*

[#]Means in a column with no common superscript differ significantly (P<0.01). [1]Standart Error *Standart Error of Avg.

Table 7. Effects of BCS_C on BCS_{C-70}.

BCS_C	Animal number	Avg. BCS_{C-70} ±SE[1#]
2.5	8	0.16 ± 0,10[a]
2.75	28	0.29 ± 0,05[ab]
3.0	28	0.39 ± 0,05[abc]
3.25	23	0.45 ± 0,06[abc]
3.5	18	0.65 ± 0,07[bc]
3.75	12	0.79 ± 0,08[c]
4.0	7	0.79 ± 0,11[c]
4.25	3	1.33 ± 0,16[d]
4.5	3	1.25 ± 0,16[d]
Total	130	0.50 ± 0,03*

[#]Means in a column with no common superscript differ significantly (P<0.01). [1]Standart Error *Standart Error of Avg.

DISCUSSION

The effect of the changes in BCS in dry period, calving, insemination and lactation periods when energy needs change is important on animal health, milk, and reproductive parameters and in acquiring high economic profit in dairy herds (Roche *et al.* 2007a). As a matter of fact, when the changes in body condition scores, which is a scale for measuring the ability to cover the energy need in the body, are followed, this will help to ensure proper feeding and will keep the reproductive parameters at the highest level (Daşkın 2011).

According to the study results, unlike Roche *et al.* (2007b), effects of difference between BCS_C and BCS_{70} which corresponds to insemination period (BCS_{C-70}) on any of the reproductive parameters was found not important, however, a positive correlation was determined between the BCS_{D-70} and CFS, BCS_{D-140} and CFS (P<0.05). These results may be explained with the after-calving high insulin and glucose levels (Vizcarra *et al.* 1998) of the animals which were fed well in postpartum period and which were in proper or high condition for dry period, and with the fact that this situation triggering the GnRH release resulting with the early expression of estrous cycle and shortening in the first estrous cycle (Varışlı and Tekin 2011). As a matter of fact, the ovulation time is related with negative energy balance at a high level (Bewley and Schutz 2008). The result on the BCS loss amount during early lactation period and the body condition at calving is consistent with the result of many compilation studies conducted by Gransworthy (1988), and Broster and Broster (1998). The researchers reported that the decrease in the reproductive yield in modern dairy herds was related mostly with the negative energy level, the involution time was increased in the cows that were in negative energy balance, various tissue mobilizations during the period caused metabolic changes and damaged the ovaries and these types of changes in the reproductive system caused delays in the first ovulation time and calving to first service interval increased and decreased the reproduction rate. Similarly, in the results of this study, calving to first service interval was increased with the decrease in the body condition score on 70th days of the lactation when the negative energy balance is observed at the highest level.

As a conclusion, the key lactation periods for body condition score are the 70th and 140th days of the lactation in terms of the direct effects on CFS and effects of their relation with dry period on CFS. According to this, the BCS interval in70th and 140th day of the lactation for minimum CFS was found $2.0 \leq BCS_{70} \leq 3.5$ and $2.25 \leq BCS_{140} \leq 3.75$ respectively. For minimum BCS loss in after calving periods because of possible negative effects on reproductive performance, optimum BCS interval in calving period was determined to be $2.50 \leq BCS_{C} \leq 3.25$. In the light of the data obtained in the study, especially in big dairy herds, it may be suggested that the BCS controls should be made on the dry period, at calving, and on the 70th and 140th days of the lactation in order to ensure maximum profits in terms of labor force and time, and to estimate it's possible effects on reproductive performance and in order to take necessary precautions.

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