

## Influence of Body Condition Score on Yield and Composition of Milk in Crossbred Dairy Cows

Research Article

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### ABSTRACT

The study was carried out for a period of 150 days on 120 Holstein Friesian crossbred dairy cows between mid to late lactation to quantify the influence of body condition score (BCS) on yield and composition of milk. Total 12 dairy farms having same housing systems and holding at least 20 crossbred dairy cows per farm between mid to late lactation were selected for this study purposes. BCS of individual cows was recorded in a 1-5 scale. Milk samples were collected from individual cow. Samples collected from cows having same BCS were mixed together to make composite sample. Chemical analyses of the samples were carried out in triplicate for fat, protein, lactose, ash, total solids (TS) and solids not fat (SNF). Results indicated that, BCS significantly ( $P < 0.05$ ) affected milk yield, milk fat and ash content in crossbred Holstein Friesian dairy cows. Highest milk yield ( $13.45 \pm 1.80$  kg/day) was recorded with moderate BCS (3.00) followed by lower (2.75 to 2.25) and higher (3.25 to 4.00). Milk protein, lactose, TS, SNF and specific gravity (SG) increased non significantly ( $P > 0.05$ ) with increasing BCS up to 4.0. Correlation coefficient matrix indicated that BCS was negatively correlated with milk yield. However, there was a positive relationship of BCS with milk protein, lactose, TS, SNF and SG even though the strength of association was variable.

**KEY WORDS** body condition score, crossbred dairy cow, milk composition, milk yield.

### INTRODUCTION

Body condition score (BCS) is the visual assessment of the amount of muscle and fat covering the specific areas of the bones of cattle. This is an accepted, noninvasive, subjective, quick, and inexpensive method to estimate the degree of fatness in dairy cows (Waltner, 1993). As it independently measures the body weight and frame size, this is truly an indicative measure of body fatness (Wildman *et al.* 1982). Essentially, there are five key areas on the body re-

gions of cows that need to be assessed for BCS namely, the area between the tail head and pin bones, inside of the pin bones, backbone, hips and curvature between the hips and pin bones. There are different scoring scales, but the most common system in use for dairy cows in the US uses a scale of 1 to 5 with 1 being emaciated, 2 thin, 3 average, 4 fat and 5 obese (Wildman *et al.* 1982; Flamenbaum *et al.* 1995). It is common to divide the scale into 0.25 point increments (Ferguson *et al.* 1994; Wildman *et al.* 1982; Edmonson *et al.* 1989).

Body weight change is a poor estimate of tissue mobilization in lactating dairy cows as gut fill and shifts in body water when fat is mobilized for milk production may mask it. Additionally, energy store may vary up to 40% in cows with similar bodyweight (Andrew *et al.* 1994). Therefore, body condition scoring has received considerable attention as a means to estimate tissue mobilization (Domecq *et al.* 1997; Flamenbaum *et al.* 1995). The inter-calving profile of BCS is a mirror image of the milk lactation profile (Roche *et al.* 2009). It affects milk production (Waltner *et al.* 1993; Markusfeld *et al.* 1997; Roche *et al.* 2007a; Berry *et al.* 2007) and milk composition (Stockdale, 2001; Roche *et al.* 2007b; Broster and Broster, 1998) of cattle. Broster and Broster (1998) has reviewed a wide range of studies carried out over the last 30 years to evaluate the association between BCS and milk yield but the results were inconsistent indicating positive, negative and no effect. Additionally, most of the studies were carried out to quantify the relationship between BCS and milk yield in high yielding Holstein Friesian dairy cows reared under pasture based feeding systems in temperate region. Therefore, current study aims to find out the association between BCS, milk yield and composition of milk in medium yielding crossbred Holstein Friesian (Friesian×Shahiwal) cows reared under intensive farming condition in tropical region.

## MATERIALS AND METHODS

### Study area

The study was carried out in 12 different commercial dairy farms located in the peri-urban and urban areas of Chittagong, Bangladesh. Farms holding at least 20 Holstein Friesian dairy cows were selected for study purposes. The selected farms were Azizia Dairy Farm, Bhuyian Dairy Farm, Janata Dairy Farm, Jane Alam Dairy Farm, Jarif Dairy Farm, Liza Dairy Farm, Belal Dairy Farm, Mollah Dairy Farm, Rajabadsha Dairy Farm, Samia Dairy Farm, Bandhan Dairy Farm and Mainuddin Dairy Farm.

### Study animals

Only crossbred Holstein Friesian milking cows weighing between 250-400 kg and having in between mid to late lactation were selected for study purpose. A total of 240 multiparous dairy cows in between 2<sup>nd</sup> to 3<sup>rd</sup> calving were identified from 12 different commercial dairy farms to make a sample frame. Out of 240, 120 cows were selected by using simple random sampling technique. Dry cows or primiparous cows or multiparous cows in early lactation were rejected for this study purpose. All animals were reared under intensive system. Animals were offered green fodders *ad-libitum* and concentrates at the rate of 0.5 kg per liter of milk produced.

### Scoring of cows

BCS of individual cows was recorded in a 1-5 scale and increments of 0.25 were added within the whole number of values. Scoring started on March 15 and the final BCS was recorded on August 14, 2013. The BCS for all cows were assigned by the same individual throughout the whole study period.

### Milk yield

Daily milk weights for all cows were electronically stored in a computer. Record of milk yield was collected for 150 days from mid to late lactation for all the lactating dairy cows. From the record, total milk yield and average milk yield were calculated. Individual milk yield record was maintained so that it can accurately reflect biological changes in terms of BCS for individual cow during mid to late lactation. Finally, trend of milk yield was regressed with BCS.

### Collection of milk sample

The animals were milked twice a day at 12 hours interval. Milk samples were collected once a week from individual cow during morning and evening. Milk collected from cows having same BCS was mixed together by a manual stirrer. Approximately 500 mL of milk samples were collected for a particular BCS in a plastic container, stored in the ice box and immediately sent to the laboratory for chemical analysis.

### Analysis of milk sample

Fresh whole milk samples were collected weekly from all the lactating cows. Milk samples were sorted according to BCS of the individual cow. Chemical analyses of the samples were carried out immediately in triplicate for fat, protein, lactose, ash, total solids (TS) and solids not fat (SNF) content of milk in the dairy science laboratory, Chittagong Veterinary and Animal Sciences University, Chittagong, Bangladesh as per AOAC (1994).

### Statistical analysis

Data related to test variable for milk yield, milk fat, milk protein, lactose, ash, TS and SNF were compiled by using Microsoft Excel 2007. It was anticipated that the independent variable BCS may be correlated with the dependent variables and thereby the true contribution of each variable to the outcome of interest might not be demonstrated. To avoid this situation, Pearson correlation coefficients were calculated between the independent variable and the dependent variable one by one. Independent t-test was carried out to analyze the data by using SPSS 16.0 (Winer *et al.* 1991). Statistical significance was accepted at 5% level ( $P < 0.05$ ).

## RESULTS AND DISCUSSION

BCS significantly ( $P < 0.05$ ) affected milk yield, milk fat and ash content in crossbred Holstein Friesian dairy cows (Table 1).

Highest milk yield ( $13.45 \pm 1.80$  kg/day) was recorded with moderate BCS (3.00) followed by lower (2.75 to 2.25) and higher (3.25 to 4.00). Milk protein, lactose, TS, SNF and specific gravity (SG) increased non significantly ( $P > 0.05$ ) with increasing BCS up to 4.0. Correlation coefficient matrix indicated that, BCS was negatively correlated with milk yield (Table 2 and Figure 1).

However, there was a positive relationship of BCS with milk protein, lactose, TS, SNF and SG even though the strength of association was variable (Figures 2, 3, 4, 6, 7 and 8).

Body condition scoring is a widely used method for evaluating the nutritional status of the dairy cows. When milk production peaks and the energy requirements exceed its intake, the cows usually go for negative energy balance and initiates to mobilize lipid reserves by losing their BCS (Aeberhard *et al.* 2001; Coffey *et al.* 2002; Agenäs *et al.* 2003). However, not necessary that all the cows will lose BCS equally. Usually, the cows having high genetic merit possess a higher propensity for mobilization of body reserves to cover higher milk yield (Veerkamp, 1998; Pryce *et al.* 2002; Berry *et al.* 2003).

It was evident that, cows having lower BCS during lactation changed their BCS more dramatically after calving than those having lower genetic merit (Buckley *et al.* 2000; Horan *et al.* 2005). Thus, mobilization of body reserves and milk yields are closely related parameters (Pryce *et al.* 2002). Gallo *et al.* (1996), observed a higher and more prolonged BCS loss in cows with higher milk yield. Therefore, BCS and milk yield are in a negative correlation (Veerkamp and Brotherstone, 1997) and high-yielding dairy cows generally have a lower BCS (Pryce *et al.* 2001). A moderate decrease in BCS post-partum depends on the milk yield as well as its level during calving. By born, cows possess a target level for body reserve particularly during early lactation (Garnsworthy and Topps, 1982). In a study, Garnsworthy (2007) observed that cows having higher BCS during calving lost more body fat in comparison to the thinner cows. This process is related to the daily milk yield curve, which is almost opposite to their energy balance (Banos *et al.* 2004). Therefore, in true sense, the pattern of BCS for dairy cows depends on their genetic merit to partition nutrients for milk production and deposition of body fat (Garnsworthy, 2007). In present study, there was a negative association between BCS and milk yield which is strictly in line with other investigators (Waltner *et al.* 1993; Markusfeld *et al.* 1997; Roche *et al.* 2007a; Berry *et al.* 2007) who reported a significant increase in milk production with subsequent decrease of BCS at calving.

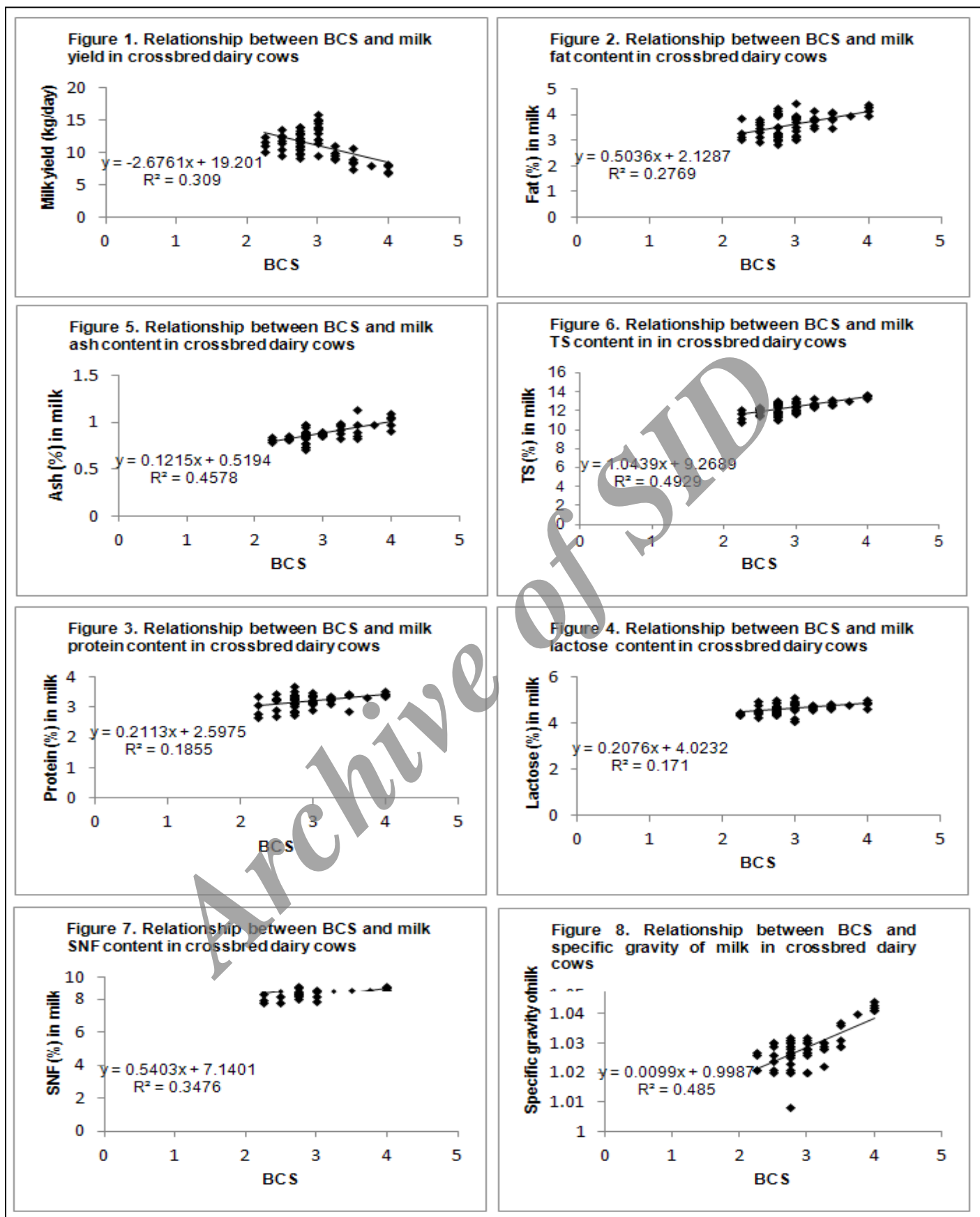
**Table 1** Effect of BCS on milk yield, milk fat, protein, lactose, ash, total solids (TS), solids not fat (SNF) and specific gravity (SG) in crossbred dairy cows (N=120)

BCS	Milk yield	Fat %	Protein %	Lactose %	Ash %	TS	SNF	SG %
4.00 (10)	7.62±0.61	4.22±0.17	3.44±0.07	4.85±0.14	1.02±0.08	13.53±0.14	9.31±0.14	1.04±0.00
3.75 (10)	7.90±0.51	3.95±0.12	3.34±0.01	4.79±0.09	0.98±0.03	13.06±0.07	9.11±0.13	1.04±0.00
3.50 (10)	8.84±1.21	3.85±0.24	3.32±0.24	4.71±0.09	0.94±0.13	12.82±0.23	8.97±0.20	1.03±0.00
3.25 (20)	9.80±0.71	3.78±0.25	3.27±0.08	4.69±0.07	0.93±0.06	12.66±0.31	8.88±0.15	1.03±0.00
3.00 (20)	13.45±1.80	3.60±0.46	3.24±0.16	4.65±0.33	0.88±0.01	12.37±0.53	8.77±0.37	1.03±0.00
2.75 (30)	11.77±1.40	3.50±0.47	3.20±0.25	4.62±0.19	0.85±0.08	12.16±0.66	8.66±0.39	1.03±0.01
2.50 (12)	11.69±1.36	3.43±0.33	3.16±0.26	4.57±0.23	0.83±0.01	11.98±0.32	8.55±0.45	1.03±0.00
2.25 (08)	11.29±0.95	3.33±0.37	2.97±0.32	4.39±0.06	0.81±0.02	11.49±0.59	8.17±0.37	1.02±0.00
Sig.	**	*	NS	NS	*	NS	NS	NS

NS: non significant.  
\*\* ( $P < 0.01$ ).

**Table 2** Correlation coefficient matrix of body condition score (BCS), milk yield, milk fat, protein, lactose, ash, total solids (TS), solids not fat (SNF) and specific gravity (SG) in crossbred dairy cows (N=120)

Parameter	BCS	Milk yield (kg)	Fat (%)	Protein (%)	Lactose (%)	Ash (%)	TS (%)	SNF (%)	SG (%)
BCS	1	-	-	-	-	-	-	-	-
Milk yield (kg)	-0.56	1	-	-	-	-	-	-	-
Fat (%)	0.53	-0.51	1	-	-	-	-	-	-
Protein (%)	0.43	-0.09	0.31	1	-	-	-	-	-
Lactose (%)	0.41	-0.15	0.10	0.49	1	-	-	-	-
Ash (%)	0.68	-0.42	0.22	0.12	0.29	1	-	-	-
TS (%)	0.70	-0.46	0.80	0.71	0.60	0.40	1	-	-
SNF (%)	0.59	-0.21	0.26	0.83	0.87	0.42	0.78	1	-
Sp. gv.	0.70	-0.49	0.42	0.46	0.34	0.53	0.60	0.54	1



**Figure 1** Relationship between BCS and milk components in crossbred dairy cows

However, in a wide range of studies (Pedron *et al.* 1993; Ruegg and Milton, 1995; Domecq *et al.* 1997), no significant association of BCS at calving was found on milk production. In another study Garnsworthy and Jones (1987) reported that, the quality of diet post-calving may impact the association between BCS at calving and milk production, since greater intake of energy dense diets in low BCS cows at calving may be sufficient to meet the energy requirements. In contrast, thin cows fed low energy diets may not be able to ingest sufficient quantities of energy and as a consequence milk production, as well as other physiological functions may disrupt (Berry *et al.* 2007). Waltner *et al.* (1993) reported that overly fat cows may have depressed appetite due to their expected rapid catabolism of body tissues (Roche *et al.* 2007b) and the subsequent effect of circulating free-fatty acids on intake (Garnsworthy and Topps, 1982).

The greater milk yield in cows that lost more BCS post-calving is in agreement with Roche *et al.* (2007a). Similarly, Domecq *et al.* (1997) reported significantly higher 120-day milk yield in multiparous cows that lost more condition in the first 4 weeks of lactation, although, the effect was not significant in primiparous cows. Similarly, cows that lost more weight to nadir, on average, produced more milk which is in agreement with Pedron *et al.* (1993). Similarly, Berry *et al.* (2007) found that those cows that lost 100 kg from calving to nadir yielded 139 kg more milk in the first 60 days of lactation than cows that lost 50 kg from calving to nadir. The non-linear association between BCS loss to nadir and milk yield indicated that the marginal increase in milk yield per unit BCS loss decreased as the amount of condition lost increased with the marginal response in milk yield (Berry *et al.* 2007). Waltner *et al.* (1993) also reported that high rates of BCS loss may be associated with diminished milk yields. In fact, substantial BCS loss post partum has been associated with a greater incidence of metabolic or other diseases (Ruegg and Milton, 1995; Gillund *et al.* 2001) which may disrupt subsequent milk yield (Block, 1984). Additionally, the poorer fertility in cows that lose more condition in early lactation (Roche *et al.* 2007b) may have impaired implications on milk yield in late lactation (Roche, 2003).

In a series of novel studies, the fatter cows yielded milk with higher fat concentration in early lactation (Treacher *et al.* 1986; Holter *et al.* 1990; Stockdale, 2001). It could be due to the capacity of fatter cows to lose more condition in early lactation used for milk fat synthesis (Pedron *et al.* 1993; Stockdale, 2001; Roche *et al.* 2007b). In another study, Pedron *et al.* (1993) reported a higher concentration of short-chain fatty acids and a lower concentration of long-chain fatty acids and unsaturated fatty acids in the milk of cows calving at a lower BCS.

Short-chain fatty acids are produced from acetate in the rumen while long-chain fatty acids are generated either from body fat mobilization or ingested lipids (Payne *et al.* 1979). In another studies (Treacher *et al.* 1986; Garnsworthy and Jones, 1987; Holter *et al.* 1990) milk protein concentration in early lactation increased linearly with BCS at calving.

Broster and Broster (1998) suggested that the association between BCS at calving and milk protein content depends on dietary protein content. He found a positive effect with low protein diet and a negative effect with high protein diet. Similar trends were reported for the association between BCS at calving and milk fat concentration (Broster and Broster, 1998).

In present study, we found a negative relationship between BCS and milk yield and a positive relationship between BCS and all milk components. It could be due to the reason that, as milk yield increased linearly, BCS tended to decrease gradually at the expense of reserved body fat. However, during late lactation, as BCS tended to increase due to linear decrease in milk yield the concentration of milk fat, protein, lactose, ash, TS and SNF increased in the same fashion. Similarly, SG also tended to increase with a very little extent.

## CONCLUSION

Multiple correlations and linear regression indicated that there was a negative association between BCS and milk yield in crossbred Holstein Friesian dairy reared under intensive farming conditions at tropical environment. However, milk protein, lactose, TS, SNF and SG was positively correlated with BCS. Cows having intermediate BCS yielded maximum milk. Cows having intermediate BCS from mid to late lactation produced more milk than cows at either extreme. This knowledge of BCS may help the farmer better tune their feeding program to ensure optimum milk yield with standard composition.

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## تأثیر نمره شرایط بدنی بر تولید و ترکیب شیر در گاوهای شیری آمیخته

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### چکیده

این مطالعه بر روی ۱۲۰ گاو شیری آمیخته هلشتاین فریزین در طی یک دوره ۱۵۰ روزه در میانه دوره شیردهی صورت گرفت و هدف از اجرای آن کمی‌سازی تأثیر نمره شرایط بدنی (BCS) بر تولید و ترکیب شیر بود. از ۱۲ مزرعه پرورش گاو شیری با شرایط پرورشی یکسان استفاده شد. در هر یک از این دو مزرعه حداقل ۲۰ گاو شیری آمیخته که در میانه دوره شیردهی بودند، در این مطالعه استفاده شد. تأثیر نمره شرایط بدنی انفرادی گاوها در مقیاس ۱ تا ۵ رکورد برداری گردید. از هر گاو به صورت انفرادی نمونه شیر گرفته شد. نمونه‌های جمع‌آوری شده از گاوهای با BCS مشابه با یکدیگر مخلوط شدند تا نمونه مرکب به دست آید. آنالیزهای شیمیایی نمونه‌ها برای چربی، پروتئین، لاکتوز، خاکستر، ماده خشک کُل (TS) و ماده خشک غیر چربی (SNF) سه بار صورت گرفت. نتایج نشان داد که BCS تأثیر معنی داری بر تولید شیر، چربی شیر و خاکستر شیر در گاوهای شیری آمیخته هلشتاین فریزین دارد ( $P < 0.05$ ). بالاترین تولید شیر ( $13/45 \pm 1/80$ ) در تأثیر نمره شرایط بدنی‌های متوسط ( $3/0$ ) رکورد برداری شده و پس از آن مقادیر کمتر ( $2/75$  تا  $2/25$ ) و بیشتر ( $3/25$  تا  $4/00$ ) قرار می‌گرفتند. افزایش پروتئین، لاکتوز، TS، SNF و گرانروی مخصوص (SG) همگام با افزایش BCS تا ۴ معنی داری نبوده است ( $P > 0.05$ ). ماتریس ضرایب همبستگی نشان داد که BCS با تولید شیر همبستگی منفی دارد. ولی همبستگی بین BCS و پروتئین، لاکتوز، TS، SNF و SG شیر مثبت بوده ولی شدت این رابطه متغیر بوده است.

کلمات کلیدی: تأثیر نمره شرایط بدنی، گاو شیری آمیخته، ترکیبات شیر، تولید شیر.