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DOI 10.26873/SVR-759-2019 **Original Research Article**

INFLUENCE OF BODY CONDITION SCORE ON BLOOD METABOLITES AND OXIDATIVE STRESS IN PRE- AND POST-CALVING OF FRIESIAN DAIRY COWS IN EGYPT

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Abstract: This experiment aimed to study the relation of body condition score (BCS) with blood metabolites in dairy cow. At 8 weeks before expected parturition, 90 multiparous Friesian dairy cows were divided according to their body condition score into 3 groups: Group1: low body condition score (n=30, BCS≤2.58, thinner cows); Group2: medium body condition score (n=30, BCS≤3.12, medium BCS cows); Group3: high body condition score (n=30, BCS≤4.75, obesity cows). The cows BCS, weight and back fat thickness were recorded at -60, -21, -14, -7, 0, 7, 14 and 60 days related to calving time. Blood samples were taken at the time of BCS measurement for determination of β hydroxy butyrate, non-esterified fatty acid, haptoglobin, glucose, triglyceride, albumin, aspartate aminotransferase, cholesterol, superoxide dismutase and malonaldehyde. The results showed a significant decrease in body condition score, body weight and back fat thickness throughout the experimental period accompanied by an increase in β hydroxy butyrate, malonaldehyde and cholesterol. The correlation analysis showed that changed body condition score positively allied with cow weight (r=0.860, P<0.01), back fat thickness (r= 0.977 P<0.01), malonaldehyde (r=0.445, P<0.01) and cholesterol (r=0.342, P<0.01) and was negatively correlated with β hydroxy butyrate (r=0.416, P<0.01), haptoglobin (r=-0.232, P<0.05), non-esterified fatty acid (r=-0.457, P<0.01), albumin (r=-0.133, P>0.05) and aspartate aminotransferase (r=-0.361, P<0.01). Concisely, body condition score loss before and after calving may have significant consequences for blood metabolites, oxidative stress and body condition score profile in dairy cows.

Key words: BCS; calving; blood metabolites; Friesian cow

Introduction

The transition period extends from 21 days ante partum to 21 days postpartum and can be described as the alteration from a gestational non-lactating state to a non-gestational lactating stage (1, 2, 3). The body condition score is a reliable, simple way of estimating the nutritional status, body reserves and energy balance in dairy cows. Its evaluation is centered on the outer appearance of cows that interrelates with its body fat reserves and so, influenced by the

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energy balance (4). Lowman and Somerville (5) were the first to use a BCS Scale (4- points), even so, the scale used to measure the BCS (5-, 6-, 8-, and 10- point scales) differs between the countries. But, collectively, the low values always reflect the emaciation while the high value equate to obesity (6). Back fat thickness (BFT) related to other approaches of body condition scoring because its objective and precise. Nearby parturition, the adipose tissue begins to decompose to create fatty acids and glycerol (lipolysis) afford energy to the body. Non-esterified fatty acid (NEFA) in blood is a respectable pointer of adipose tissue mobilization (7). NEFA and β hydroxy butyrate (BHBA) are important energy metabolites that are traditionally used as indicator of negative energy balance (NEB) during transition stage (8). The determination of malonaldehyde (MDA) and activity of superoxide dismutase (SOD) during transition period as an index of oxidative stress status.

The aim of the present study was to explore the relationship between body condition score from 60 days' pre- partum until 60 days' post-partum and BCS change, BW, BFT and some metabolic blood parameters in pregnant Friesian dairy cows.

Materials and methods

The experimental protocol was approved by the Animal Care and Use Committee of Faculty of Agriculture, Kafrelsheikh University.

Animals

A total of 90 animals formed a herd of 350 Friesian dairy cows selected for experiment depend on their body weight (BW) and body condition score (BCS) 0 to 5 point scale according to the North American BCS (9), and divided into three groups (each of 30 cows) on 60th days pre-partum as fairly low (group 1, ≤ 2.58 BCS,≤490 kg BW), medium (group 2, ≤ 3.12 BCS, 600 kg) and obesity (group 3, ≤4.75 BCS, ≤713 kg BW). The body condition score was performed by one person at -60, -21, -14, -7 pre-partum, at day of calving, at days 7, 14 and 60 post-partum. Animals were housed in a free stall barns, had a free access to water and fed twice daily (8 am and 4 pm) with a ration formulated according to the recommendation of NRC (10) (Tables 1 and 2).

Measurement of back fat thickness (BFT)

The investigation site is positioned in the sacral region among the caudal quarter and fifth connection line extending from the dorsal portion of the tuber ischia (pins) to the tuber coxae and is evaluated by ultrasound (4) and the data was converted to BCS.

Biochemical assessment

Blood samples were taken from the jugular vein of all cows on fixed time before morning feeding at -60, -21, -14, -7, pre- partum, at day of calving and at days 7, 14 and 60 post-partum. Serum were stored at -20 °C till essayed for NEFA, BHBA, haptoglobin (HP), and other biochemical analysis. NEFA and BHBA quantified using commercially kits (Randox laboratories Ltd, Crumlin Co., Antrim, UK), Serum Hp measured calorimetrically using a commercial kit (Phase HP kit, Tridelta Ltd., Ireland) according to the constructor's guidelines.

MDA and SOD assessed using the commercially kit (Bio-diagnostic, Egypt) according to (11). Albumin, triglycerides, glucose, cholesterol and aspartate aminotransferase assessed spectrophotometrically using autoanalyzer (MCC-3000, China) (Biomed diagnostics Germany).

Statistical analysis

Mean and standard error were calculated. The obtained data were subjected to two-way factorial analysis of variance according to the procedures out lined by Snedecor and Cochran (12). The mean value of treatments was compared according to Duncan's multiple range test (DMRT) (13). Multiple correlation coefficient analyses were used. The data was analyzed using CoStat software for windows (version 6.3).

Results

Change of BCS, BW and BFT from pre- to post- partum in dairy cows

Fluctuations of BCS in each group were presented in figure l. The obesity BCS cows showed significantly higher BCS reduction (-1.17) 60 d pre-partum to 60 d post-partum than thinner (-0.5) and medium BCS cows (-0.67). Changes of BW and BFT were statistically significant ($P<0.05$) among the 3 groups (Fig. 2 and 3). The 3rd group showed higher BW and BFT reduction from d 60 before calving to d 60 after calving (106 kg and 1.14, respectively) compared to thinner (70 kg and 0.28, respectively) and medium groups (103 kg and 0.68, respectively). During the experimental time, highly significant positive correlations were found among reduction of BCS and both of BW ($r=0.86$, $P<0.01$) and BFT ($r=0.98$, $P<0.01$). Thus, cows with greater BCS losses had also higher BW and BFT losses (Table 3).

Metabolic parameters

Serum concentrations of BHBA, NEFA and HP in high BCS cows were significantly ($P<0.05$) higher than the other two groups before and after calving (Figs, 4-6). The differences in HP among groups were not significant. The concentrations of BHBA and NEFA increased from -7d before calving and reached the high levels on 7d post- calving and then decreased with high values as compared to those observed before parturition.

Oxidant and antioxidant status

SOD gradually increased ($P<0.05$) in the last 21 days of pregnancy (at 21 d before calving) and reached the maximum at 7d earlier calving. After parturition, SOD dropped to reach the levels recorded before calving (Fig. 7). Serum concentration of MDA was relatively steady before calving ($P>0.05$) at parturition and one week after calving (Fig. 8). The differences among groups were highly significant ($P<0.01$).

Serum biochemical parameters

The concentrations of serum glucose were gradually increased from -60 d before calving and reached the highest values at calving and then dropped sharply at 7d post-calving and back increased to the levels registered 60 d before calving (Fig. 9). Serum triglyceride was not significantly differed among groups (Fig. 10). The serum cholesterol started to increase from -60 d before calving and reached the higher values on -7d before calving and then decreased to reach the low values on 60 d post-calving (Fig. 11), while the triglyceride concentration peaked at calving and dropped 7d and 14 d post-calving and then increased 60 d post-calving. Mean serum albumin content dropped to the lowest levels at calving followed by a subsequent increase to highest levels ($P<0.05$) at 7 d post-calving then dropped to levels 60d pre-calving and followed by an increase at 60 d post-calving. The differences among groups did not significantly differed (Fig. 12). AST concentrations steady increased ($P<0.05$) from 60 d before calving to parturition and followed by a subsequent increase at one wk., 2 wk and 2 months post-calving and reached maximum level ($P<0.05$) at 60 d post- calving (Fig. 13).

Correlation study

BCS, BW and BFT were negatively ($P<0.01$) correlated with both BHBA ($r=-0.416$, $r=-0.355$, $r=-0.361$, respectively), NEFA ($r=-0.457$, $r=-0.470$ and $r=-0.448$, respectively), and AST ($r = -0.361$, $r = -0.407$ and $r = -0.341$, respectively) and were definitely ($P<0.01$) linked with cholesterol ($r=0.342$, $r=0.423$ and $r=0.323$, respectively), (Table 3).

Table 1: Chemical composition of ingredients rations during the pre- and the post- partum period

Item		Composition of DM%					
Ingredients	DM%	OM	CP	CF	EE	NFE	Ash
CFM	89.71	91.58	15.62	9.63	2.92	63.41	8.42
Corn silage	35.10	94.89	9.39	23.18	2.19	60.13	5.11
Hay	89.89	92.23	14.29	27.5	3.12	47.32	7.77
Rice straw	91.08	83.58	2.98	34.89	1.36	44.39	16.42
Rations							
Pre-partum	78.97	91.58	12.84	18.44	2.66	57.64	8.42
Close up	76.24	91.74	12.54	19.12	2.62	57.46	8.26
Post- partum	73.5	91.91	12.23	19.79	2.59	57.30	8.09

DM (dry matter); OM (organic matter); CP (crude protein); CF (crude fiber); EE (ether extract); NFE (Nitrogen free extract); Ash (Ash) and CFM (concentrate feed mixture)

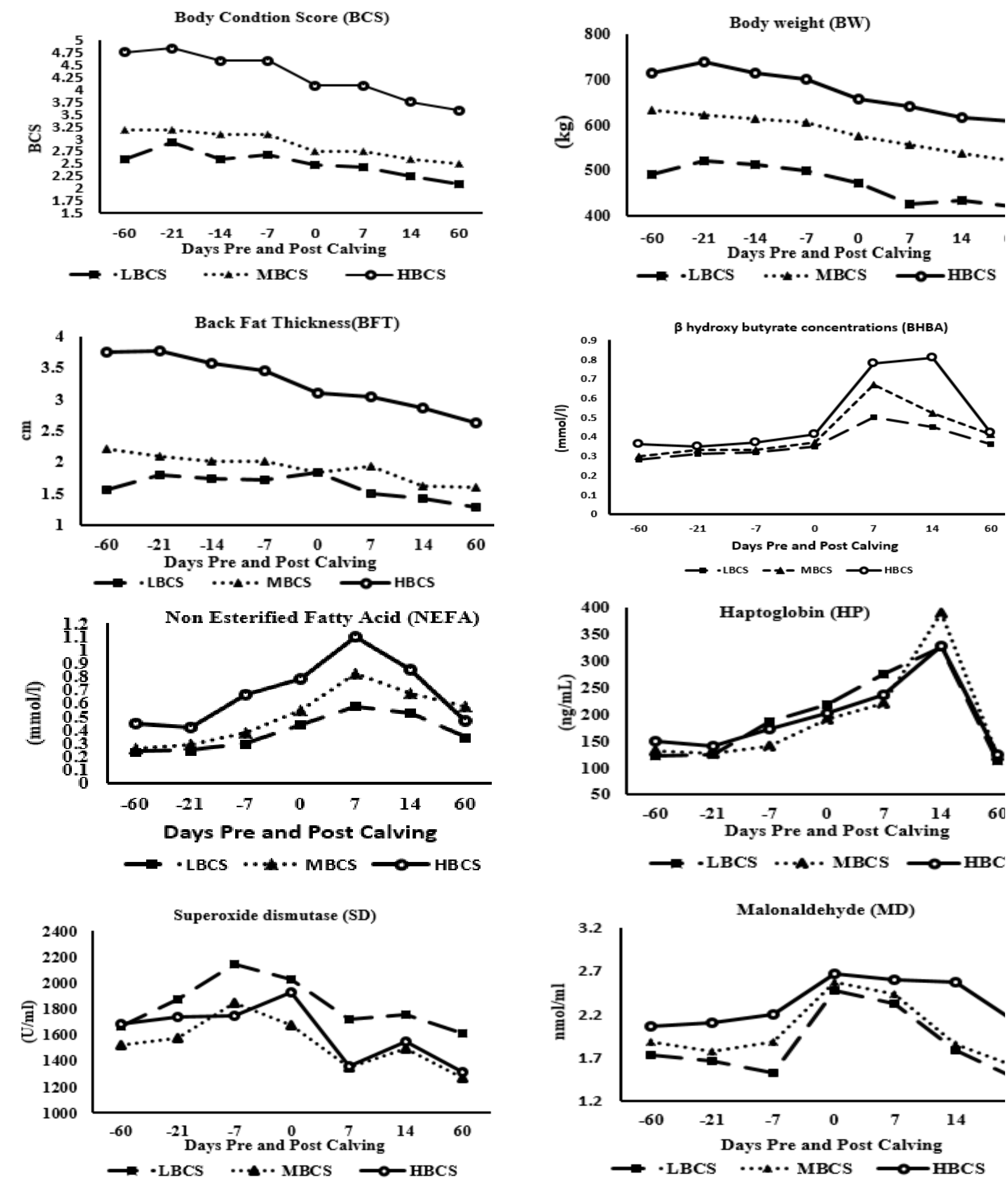
Table 2: Average daily feed intake (Kg/head/day) during pre- and post-partum period

Item	Pre- Partum	Close up	Post- Partum
CFM (concentrate feed mixture)	9.5	8.5	7.6
Corn silage	9.7	12.1	14.5
Hay	3.8	3.8	3.8
Rice straw	1.9	1.9	1.9

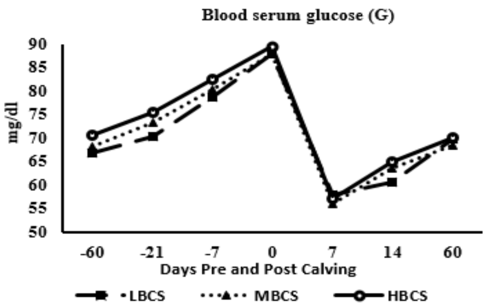
Table 3: Correlation coefficient between body condition score, body weight and back fat thickness with metabolic blood parameters and oxidative stress

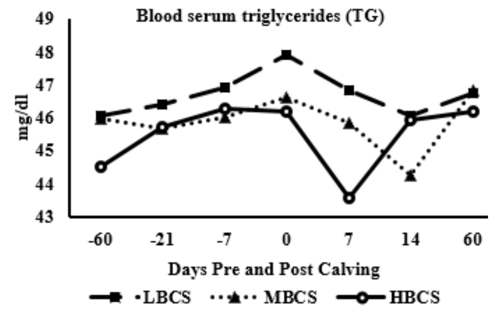
Items	BCS	BW	BFT
Body Condition Score	1		
Body Weight	0.860(**)	1	
Back Fat Thickness	0.977(**)	0.884(**)	1
β hydroxy butyrate	-0.416(**)	-0.355(**)	-0.361(**)
Non-esterified fatty acid	-0.457(**)	-0.470(**)	-0.448(**)
Haptoglobin	-0.232(*)	-0.215(*)	-0.184
Superoxide dismutase	0.123	-0.019	0.054
Malonaldehyde	0.445(**)	0.383(**)	0.465(**)
Blood Serum Glucose	0.133	0.208	0.146
Blood Serum Triglyceride	0.040	0.017	-0.009
Blood Serum Albumin	-0.133	-0.145	-0.137
Aspartate aminotransferase	-0.361(**)	-0.407(**)	-0.341(**)
Blood Serum Cholesterol	0.342(**)	0.423(**)	0.323(**)

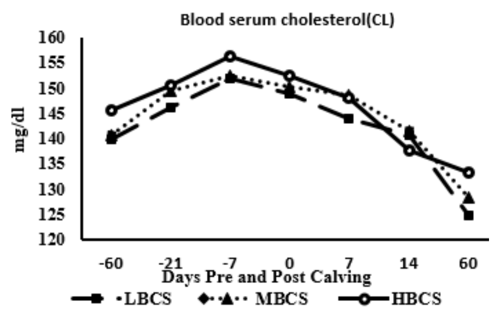
BCS (body condition score), BW (body weight), BFT (back fat thickness)
**Correlation is significant at the 0.01 level (1-tailed)
* Correlation is significant at the 0.05 level (1-tailed)

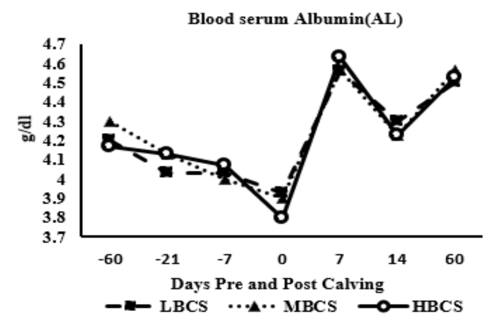


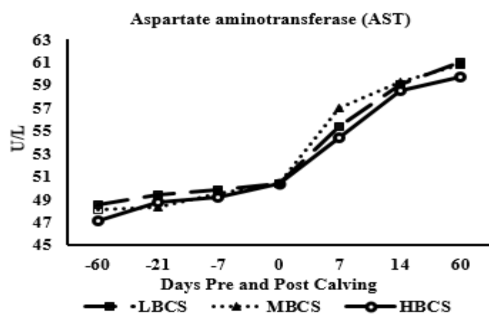
Figures 1-8: Effect of body condition score during pre- and post- calving on body condition score changes (BCS); body weight changes (BW); back fat thickness changes (BFT); β hydroxy butyrate concentrations (BHBA); non-esterified fatty acid (NEFA); haptoglobin (HP); superoxide dismutase concentrations (SOD) and malonaldehyde concentrations (MD), (Means ± SEM)











Figures 9-13: Effect of body condition score during pre- and post- calving on concentrations of blood serum glucose (G); triglycerides (TG); cholesterol (CL); albumin (AL) and aspartate aminotransferase (AST), (Means ± SEM)

Discussion

Cows with high body condition score showed higher (P<0.05) BCS loss pre and post-calving period than medium and thinner BCS cows. Greater loss of BCS in high BCS cows was expected and has been reported previously by Treacher et al. (14), who concluded that transition cows with great BCS waste more body weight and body condition than thinner one. In the present study, cows with high BCS had the greatest decline in BW and BFT when compared with the other groups, which is an indication of mobilizing greater body fat reserves than medium and thinner BCS cows. These results are in agreement with previous reports (6, 15, 16).

In the present study, cows with high BCS had a sharp increase in plasma NEFA and BHBA concentration, which reached the highest values at 1 week after calving, while the lowest levels were found in LBCS cows. The highest plasma NEFA and BHBA concentrations for cows with high BCS were in accordance with other studies (17) and could be explained by the high fat mobilization.

Results of the present study indicated that serum glucose increased in all groups reaching the peak at parturition then a sharp decrease 7 d post-calving, which may be attributed to cortisol and estrogen (17) or inherent hypoinsulinemia which reduce glucose uptake by tissue sensitive to insulin (18). On the other hand, García et al. (19) found that low glucose level was during calving and explained these results due to sever NEB suffered by the animals in this group that delivered high milk during the experimental time. Moreover, others found that glucose concentration remained stable and increase slightly at calving reflecting an increase in gluconeogenesis in response to calving stress (20, 21). Cheng et al. (22) reported that cows in negative EB have low rates of glucose and high levels of BHBA.

In the present study, triglycerides were relatively stable at range from 43.6 to 46.9 mg/dl and no significant differences were noticed among groups. This finding is consistent with previous report by García et al. (19) and González et al. (23) who attributed this to the excess of fatty acids mobilized to liver to be as energy resource. The reasons for such case are triglycerides accumulation in the liver and triglycerides taking up by the mammary gland for milk fat synthesis and secretion (24). Reduced cholesterol concentrations starting from the time at calving and post-calving weeks were found in all groups, which could be associated with reduced DM intake (25, 26). Conversely, Mouffok et al. (20) found that cholesterol was significantly elevated in post-partum which indicates good energy nutrition (27). Total cholesterol was significantly lower on week around parturition with the lowest value one week prior to calving (28, 29). Alternatively, García et al. (19) described that cholesterol level had a gradual upsurge as the lactation advanced.

Reduced albumin concentration reaching the lowest values at the time of parturition in all groups and increase to the highest values one-week post calving. Our results are in disagreement with findings of Soca et al. (26), who found that albumin concentrations decreased after calving in low and moderate BCS cows and this may be associated with increasing of NEFA. Our results were in agreement with finding of Gheise et al. (16), who noted that the highest albumin levels at 1 d after calving. Albumin is synthesized via the liver and it's the core source of plasma thiol groups which are considered as an element of extracellular antioxidant defense against oxidative stress (30).

In the present study, the activity of aspartate amino transferase (AST) was not significantly changed by BCS on the calving day in all experimental groups and increased gradually at 7, 14 and 60 d post-calving. No significant different was found among groups pre and post-calving. The higher level of AST in dairy cattle are allied with the fatty liver syndrome, lower dry matter consumption and ketosis marks (32).

Haptoglobin (HP) concentration in the present study was significantly higher at calving day and post-calving days than before parturition. The present finding was in agreement with the finding of others (31, 32), who found that the highest value of HP was recorded in cows 3wk postpartum. This finding supported the previous results of Montagner et el. (33) who found the trend for higher HP concentrations in cows' pre-partum and the enhanced concentration in the post-partum were consistent with impaired hepatic function.

Highest MDA concentration was recorded on the day of calving in all treated groups, then continuously decreased after calving on 7, 14 and 60 d post-calving that was in agreement with the finding of others (34). Castillo et al. (35) reported that MDA is the last product of lipid peroxidation, therefore changes of MDA concentrations can be used as a biomarker of oxidative stress. SOD enzyme is the major antioxidant defense competent in protecting the cells against increased ROS (36). The increase of SOD around calving (-7 d to +7 d pre and post- calving) because of a possible homeostatic control (37).

Conclusion

This study showed that lost body condition in 8 wks before calving had an adverse metabolic status, with increased serum concentrations of NEFA, BHBA, MDA and AST post calving. In addition, high BCS cows (obesity, G3) had highest BHBA profiles that suggested they had a higher risk of subclinical ketosis, in addition, highest serum concentrations of NEFA in all cows after calving, indicated the highest mobilization of body reserves after calving.

Conflict of interest

The authors state no conflicts of interest.

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