RESEARCH ARTICLE

Dry Matter Intake and Body Condition Score in Ascending-Descending Phase of Lactation in Gir Cows Supplemented with Bypass Fat and Choline

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Abstract

Present study was conducted to observe dry matter intake on % body weight (DMI%BW) and body condition score (BCS) pattern in ascending-descending phase of lactation in Gir cows. A total of 18 cows were randomly assigned to three groups, with each group consisting of six cows. Cows in control group were fed basal ration, while in treatment 1 (T-1) were supplemented with bypass fat (10 g/kg of milk) with basal ration and in treatment 2 (T-2) were supplemented with bypass fat (10 g/kg of milk) and choline (45 g/day/cow) with basal ration from 2nd to 25th week of lactation. Lactation period was divided into ascending phase from 2nd to 9th week and descending phase from 10th to 25th week after parturition based on milk production pattern. Supplementation regime did not affect BCS during ascending phase and first three fortnights of descending phase, but from 17th week of lactation the BCS was significantly higher in both supplemented groups than control. The DMI%BW did not vary among the groups. There was a highly significant strong negative correlation between DMI%BW and BCS in all groups during ascending phase. However, during descending phase, degree of association was weak in control, strong in T-1 and moderate in T-2 groups. The results showed that additional energy intake from bypass fat and choline supplementation contributed significant gain in BCS from 17th week of lactation (or from 4th fortnight of descending phase of lactation).

Keywords: Ascending phase, Body condition score, Bypass fat, Descending phase, Dry matter intake, Gir cattle.

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Introduction

Animal husbandry plays a crucial role in Indian agriculture and holds great importance, as numerous farmers rely on it for a consistent source of income. Milk production in India was 230.58 million tonnes in 2022-23, representing a 22.81% increase over the previous five years (Anonymous, 2023). Indigenous cows play a crucial role in India's rural economy, particularly for small and marginal farmers. Their contributions in providing milk, manure, draught power and breeding animals are essential pillars supporting the livelihoods of farmers. Gir cattle are renowned worldwide as a valuable milch breed that originates from the Gir hills and forest region of Saurashtra, Gujarat. They are well known for their exceptional heat tolerance and disease resistance capacity (Savalia *et al*., 2024). Gir cows are highly regarded for their milk production potential and adaptability to the local climatic conditions. They are one of the most popular and highly productive dairy cattle breeds in India producing on an average of 2573 liters milk during 300 days of lactation (Patbandha *et al.,* 2020).

In dairy farming, body condition scoring (BCS) - a non-invasive method - is crucial for evaluating fat deposition/energy reserves in cattle, helping farmers make decisions about feeding and management to optimise productivity, health and welfare (Bewley and Schutz, 2008). Dairy cows encounter a metabolic challenge following parturition due to significant changes in their metabolic status as they prepare for the ensuing lactation (Chavda *et al*., 2024). As lactation progresses, energy demand increases, particularly in the ascending phase, and an inadequate supply may affect production capability throughout lactation (Sirohi *et*

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al., 2010). Cows also start losing weight and body reserves due to high milk production and limited feed intake in the ascending phase, leading to a negative energy balance (NEB) (Mishra *et al*., 2016). Therefore, it is essential to supply the diet with sufficient nutrients to mitigate the effects of NEB. During the ascending phase of lactation, cows utilise body reserves to sustain milk production until the descending phase of lactation. So, additional nutritional supplementation may be included in the diet during descending phases of lactation to either meet or slightly exceed the cow's energy need. This approach helps to build up body reserves, including fat stores that support the restoration of the cow's lost BCS in late lactation. The increased energy intake from bypass fat and choline supplementation significantly contributes to the reduction of body weight loss in lactating Gir cows (Gamit *et al*., 2024). Bypass fat increases energy intake and reduces the detrimental effects of NEB on lactation (Tyagi *et al*., 2010), while choline aids in fatty acid metabolism in the liver and acts as a methyl donor, facilitating the export of fat from liver by synthesising very low-density lipoprotein (Shahsavari *et al*., 2016; Acharya *et al*., 2019). Thus, considering bypass fat as a crucial energy source and choline's essential role in fat metabolism, the present experiment was designed to observe pattern of dry matter intake on % body weight (DMI%BW) and body condition score (BCS) in ascending-descending phase of lactation in Gir cows supplemented with bypass fat and choline.

Materials And Methods

The study was conducted at College of Veterinary Science & Animal Husbandry, Kamdhenu University, Junagadh (Gujarat, India), in collaboration with the Cattle Breeding Farm, Junagadh from April 2021 to March 2022. The research protocol No. JAU-JVC-IAEC-LA-72-20, was approved by the Institute's Animal Ethics Committee.

Experimental Animals and Treatment

Eighteen lactating Gir cows (mean body weight: 351.8±12.6 kg, mean parity: 1.72±0.21 and mean milk yield of previous lactation: 1633.6±190.6 L) were selected and randomly divided into three groups (control, T-1, and T-2) based on their body weight, BCS, parity and milk yield with each group consisting of 6 animals. The cows in the control group were exclusively fed a basal diet comprising 10 kg of seasonal green (sorghum & maize), 250 g of ground maize grain, and dry fodder *ad libitum*. Supplementary pelleted compound concentrate cattle feed (crude protein 22% and total digestible nutrients 70%) and cotton seed cake (CP 35% and TDN 75%) was provided to meet the cows' nutrient requirements according to the ICAR (2013) feeding standard.

The cows in the T-1 group were fed a basal diet and supplemented with bypass fat @ 10 g/kg of milk yield per day, whereas in the T-2 group, bypass fat was fed @ 10 g/kg of milk yield along with bypass choline @ 45 g/day with a basal diet. The bypass fat and choline were purchased from Kemin Industries South Asia Pvt. Ltd., Chennai, India. The bypass fat (EnerFAT™) comprised of saturated and unsaturated long chain fatty acids, added flavor and sweetener to enhance taste and increase intake. Rumen protected choline (CholiPEARL®) was encapsulated source of rumen bypass and intestinally released choline comprised of vegetable oil, choline chloride, silicon dioxide and water. Bypass fat and choline were mixed with ground maize grain and fed once a day in the evening. The study was conducted for a period of 24 weeks (2^{nd} to 25^{th} weeks of lactation) after an adaptation period of 22 days (-15 to +7 days peripartum). The experimental period was divided into two phases based on milk production pattern, *i.e.,* "ascending lactation phase" from 2^{nd} to 9^{th} week and "descending lactation phase" from 10^{th} to 25^{th} week postpartum.

The body condition scores (BCS) of cows were recorded at every two weeks intervals using a visual technique, involving a 5-point scale (Edmonson *et al*., 1989). The fat cover of cows was evaluated at eight different anatomical locations, and each area was assessed using a number scale ranging from 1 to 5, where a score of 1 represents extreme thinness and a score of 5 represented extreme obesity.

To determine the daily dry matter intake (DMI), the quantity of feed provided and the amount of leftover feed were recorded on a daily basis throughout the experiment. Dry matter intake on percent body weight (DMI%BW) was calculated using standard formula, *i.e.,* DMI%BW = (DMI in kg * 100) / (Body weight in kg).

Statistical Analysis

The experimental data were analyzed using one-way analysis of variance, as described by Snedecor and Cochran (1994). Pair-wise mean differences between groups were compared by the Duncan multiple range test for significance at 5%. Association of DMI%BW with BCS was carried out by correlation analysis and the association was considered as significant at 5%.

Results And Discussion

BCS Pattern of Gir Cows in Ascending & Descending Lactation Phase

The mean body condition score (BCS) of lactating Gir cows in control, T-1 and T-2 groups at the start of the experiment (7^{th} day or 1^{st} week of lactation) was 3.44±0.01, 3.38±0.03 and 3.43±0.01, respectively, which gradually reduced till the end of ascending phase of lactation (63^{rd} day or 9^{th} week of lactation). Compared to 1^{st} week of lactation, the mean BCS reduced significantly by 0.38 ($p<0.001$), 0.27 ($p<0.001$), and 0.34 ($p<0.001$) in control, T-1, and T-2 groups, respectively, at the end of ascending phase (9^{th} week of lactation). Results revealed that T-1 showed minimum loss (BCS loss = 0.27 or 7.99%), followed by T-2 (BCS loss = 0.34 or 9.91%) and control (BCS loss = 0.38 or 11.05%). However, between control and treatment groups, the mean BCS did not differ

(p>0.05) at any time point during the ascending phase of lactation (Fig. 1). Earlier studies reported that the BCS in dairy cattle follows inverted milk curve pattern, declines during ascending phase of lactation and reached to nadir or minimum during first 2-3 months of lactation (Bewley and Schutz, 2008; Roche *et al.,* 2009). Irrespective of treatment, the BCS of Gir cows declined gradually during the ascending phase of lactation in all groups. The cows fed basal rations without any supplementation showed a greater loss of body condition score than the cows fed with bypass fat alone or in combination with bypass choline during the ascending phase of lactation. At the beginning of lactation, a decrease in BCS might be attributed to the mobilization of fat reserves during the ascending phase of lactation for high milk production.

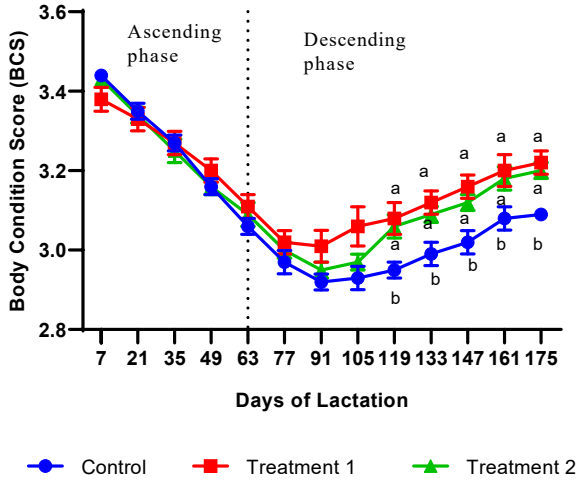

Fig. 1: Body condition score (BCS) pattern of Gir cows

The BCS of lactating Gir cows at the initiation of the descending phase of lactation (77th day or 11th week) was 2.97±0.03, 3.02±0.03 and 3.00±0.02, respectively, in control, T-1 and T-2 groups, then slightly reduced in all groups, but reached lowest level (nadir BCS) at 13th week (91st day) of lactation. Thereafter, the BCS increased to 3.09±0.03, 3.22±0.03 and 3.20±0.03 at the end of the experiment in the control, T-1 and T-2 groups, respectively. Thus, a significant improvement of BCS was observed in the T-2 (6.67%, p<0.001) group, followed by T-1 (6.62%, p<0.001) and control (4.04%, p<0.01) group. The mean BCS of Gir cows continued to decrease for initial two fortnights during descending phase of lactation. Between control and treatment groups, the mean BCS did not differ from 77th to 105th day of lactation. However, the mean BCS of lactating Gir cows was significantly (p<0.05) higher in both treatment groups from 119th day (17th week) of lactation till the end of the experiment as compared to control group (Fig. 1). In Gir cows, irrespective of treatment, the nadir BCS was observed at 13th week of lactation, which was in agreement with the previous studies (Bewley and Schutz, 2008; Roche *et al.,* 2009), who reported that BCS declines to nadir at 40 to 100 days postpartum. The BCS during the descending phase of lactation showed an increasing trend in all groups, but the BCS gain was higher in both the treatment groups. The higher gain of BCS post-nadir might be attributed to the supplementation of bypass fat and bypass choline, which helped to reduce fat mobilization of body reserves and favoured fat deposition in the later part of the descending phase of lactation. Previous study also reported that supplementary feeding regime shortened the time period of BCS loss and increased the rate of post-nadir BCS accretion (Roche *et al.,* 2006), which is supported by the current study. Similarly, Chavda *et al.* (2023) recorded significantly higher BCS in bypass fat supplemented group, whereas in combination with choline, though higher BCS was recorded during early lactation, the difference was non-significant.

Dry Matter Intake on % Body Weight in Ascending & Descending Lactation Phase

The average dry matter intakes on % BW basis (DMI%BW) were 2.30±0.06, 2.32± 0.13 and 2.46±0.11 kg/day in control, T-1 and T-2 groups, respectively, during initial phase (2nd - 3rd week of lactation) of ascending phase of lactation. The DMI%BW significantly (p<0.001) increased to 2.72 ± 0.07, 2.70 ± 0.12 and 2.98 ± 0.14 in control, T-1 and T-2 groups, respectively, at the end of ascending phase of lactation (8th - 9th week of lactation). Present finding revealed that in ascending phase of lactation, there was an increasing trend of mean DMI%BW in all groups. However, the supplementation regime did not affect the mean DMI%BW at any time point as compared to control group in the current study (Fig. 2). The mean DMI%BW observed in Gir cows was comparable to previous studies (Ranaweera *et al.,* 2020; Henrichs and Kmicikewycz, 2023), who reported that DMI of low producing small cattle breeds was around 2-2.5% of BW during early stage of lactation. The mean DMI%BW also increases with progress of the lactation (Ranaweera *et al.,* 2020), which is supported by the current study. Previous researchers also did not observe any significant effect of supplementation on DMI%BW of lactating cattle and buffaloes (Ranaweera *et al.,* 2020; Mishra *et al.*, 2022; Sadrasaniya *et al.*, 2022) and similar results were observed in this study.

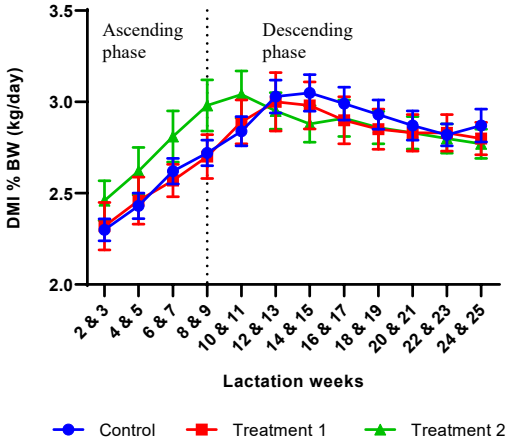

Fig. 2: Dry matter intake on % body weight (DMI%BW) pattern of Gir cows

The dry matter intake on a percent of body weight (DMI% BW) basis at the initiation of the descending phase of lactation (10^{th} - 11^{th} week of lactation) was 2.84±0.08 kg/day in control group, 2.89±0.12 kg/day in T-1 group and 3.04±0.13 kg/day in T-2 group. As lactation progressed, mean DMI%BW gradually increased up to 14^{th} - 15^{th} week of lactation and thereafter showed declining trend towards the end of experiment in control group. However, DMI%BW was observed maximum at 12^{th} - 13^{th} week of lactation in T-1 group and 10^{th} - 11^{th} week of lactation in T-2 group, which gradually declined as lactation progressed. In control and T-1 groups, the change of DMI%BW from initiation of the descending phase of lactation (10^{th} - 11^{th} week of lactation) to the end of experiment (24^{th} - 25^{th} week of lactation) did not differ statistically ($p>0.05$). On the other hand, in T-2 group, the DMI%BW declined significantly ($p<0.01$) from initiation of the descending phase of lactation (10^{th} - 11^{th} week of lactation) to the end of experiment (24^{th} - 25^{th} week of lactation). The supplementation regime did not significantly affect the DMI%BW at any time point as compared to control group (Fig. 2).

In small zebu type cows, the DMI on percent body weight basis has been reported to be around 2% during the initial two weeks and 2.5% of body weight during fifteen weeks post-calving (Ranaweera *et al.,* 2020; Henrichs and Kmicikewycz, 2023). In Gir cows more or less similar DMI%BW (DMI ranged between 2.3 and 3.0% of body weight) was observed during the ascending and descending phase of lactation. In a recent study, Casaro *et al.* (2024) reported gradual increase in DMI%BW with progress of lactation in Holstein cows. In this study, we also observed gradual increase in DMI%BW with progress of lactation in all groups and then gradual reduction. Similar to the findings of present study, previous researchers also did not observe any significant effect of supplementation on DMI%BW of lactating cattle and buffaloes (Ranaweera *et al.,* 2020; Mishra *et al*., 2022; Sadrasaniya *et al*., 2022).

Correlations

There was a significant ($p<0.001$) and strong negative correlation between DMI on % BW and BCS in control (r = -0.744) as well as T-1 (r = -0.708) and T-2 (r = -0.733) groups during the ascending phase of lactation. However, during descending phase of lactation, the correlation was weak in control group (r = -0.322, $p=0.026$), strong in T-1 group (r = -0.632, $p<0.001$) and moderate in T-2 group (r = -0.507, $p<0.001$). The variation of degree of association between DMI%BW and BCS during descending phase of lactation may be due to variation of BCS change among different groups. Similar negative associations of DMI on % BW and BCS have been observed by several authors in dairy cattle (Bewley and Schutz, 2008; Roche *et al.,* 2009). In a recent study, Casaro *et al.* (2024) observed higher intake of DM on % BW in thin cows and lower intake in fat cows. This indicates a negative association of between DMI on % BW and BCS in Holstein cows and similar negative association between the above parameters were observed in lactating Gir cows during both ascending and descending phase of lactation in the current study.

Conclusion

The results revealed that irrespective of treatment, there was gradual loss of body condition score (BCS) in Gir cows, which reached nadir on 13^{th} week of lactation. The dry matter intake on percent body weight showed negative correlation with BCS during both ascending and descending phase of lactation. Feeding of bypass fat alone or in combination with bypass choline had a positive effect on BCS accretion post-nadir as the lactation progressed.

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