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Research Article

Effects of peri-partum protein supplementation on the body condition score, colostrum yield and weight gain of calves of nondescript cattle

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Abstract

The aim of the present study was to evaluate the effects of peri-partum protein supplementation on the body condition score (BCS), colostrum yield and weight gain of calves of non-descript cattle. Eighteen advanced pregnant non descript cattle were selected 8-10 weeks before expected date of parturition and randomly divided into 3 groups, i.e. control, T_1 and T_2. The pregnant cows in control group, were fed as per farmers' practice (2 kg concentrate), while in treatment group specially formulated concentrate mixture with CP more than 10% (T_1) and 20% (T_2) was provided @ 2.0 kg per day along with the basal diet of wheat straw. The mean BCS just before calving was significantly higher ($P<0.01$) for T_2 group as compared to T_1 and control groups. The mean birth weights (kg) and average body weight gain (g) of calves were significantly higher ($P<0.01$) in T_2 and T_1 groups than control group. The mean average daily colostrum yield (kg), total colostrum yield (kg) and overall daily milk yield (kg) per animal were significantly higher ($P<0.01$) in T_2 and T_1 groups as compared to control group. On the basis of the present findings, it may be concluded that pre-partum supplementation of protein significantly improved the pre- and post-partum body condition score and colostrum yield in animals of Treatment 1 group. Further, the calves of T_2 and T_1 groups had higher birth weights and better growth performance than calves of control group.

Keywords: Body condition score, Colostrum, Concentrate, Growth, Protein

Highlight

- Peri-partum supplementation of protein significantly improved the pre- and post-partum body condition score.
- Strategic supplementation of protein during transition phase results in higher colostrum yield.
- Peri-partum supplementation of protein in dams results in higher birth weight and better growth performance of calves.

INTRODUCTION

India has the world's largest population of cattle and buffalo in the world. The non-descript cattle population in the country is 192.52 million (DAHD, 2019), but the production performance and fertility of the animals are very poor (Chopade *et al*., 2002). According to Bindal (2012), due to negligence and poor economic condition of farmers, no concentrate is fed to the animals, especially in the last trimester, leading to poor production by the animals. In rural areas, animals are fed mostly with low quality feeds and agricultural byproducts like wheat and paddy straw having low nutritive value and crude protein (CP around 3-4%), and total digestible nutrients (TDN) content is about 48% (Akbar and Khaleduzzaman, 2009).

The periods from two months pre- and post calving are the most stressful period because the fetal growth pattern places the greatest nutritional burden on the pregnant cow (Mondal *et al*., 2018). Nutrient requirements during pregnancy represent nutrients necessary to support the growth of the fetus and mammary gland for the upcoming lactation. The influence of maternal nutrition on the early growth performance of offspring is mainly mediated by its influence on the birth weight, as well as milk yield and quality. Improper feeding during this phase could lead to low birth weight of newborn calf, post-partum estrus and obviously low productive performance of cows (Qureshi, 1995). More than 60% of total fetal weight is accrued during the final two months of gestation; hence,

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nutritional management during the dry period affects the health as well as survival of the calf. Feeding during pre-partum period affects immunity of the newborn calf and quality of the colostrum (Fatahnia *et al*., 2012). Several studies have demonstrated a positive impact of maternal feeding on the birth weight of calves (Khan *et al*., 2004; Fatahnia *et al*., 2012).

The body condition score is an important tool to assess the overall body condition of the animal. Deterioration in the health status of animal can be seen in the adversely affected body condition score of the animal. Khan *et al*. (2015) observed that body condition score (BCS) in Murrah buffaloes fed on ration containing 20% higher nutrients than requirement increases up to parturition and thereafter decreases. Similarly, Sharma *et al*. (2017) found increased BCS in advanced pregnant crossbred cows fed on ration supplemented with strategic nutrients.

Hence, keeping this background in view, the research work is planned with the objective to determine the effects of strategic supplementation of protein during peri-partum period on body condition score of cows, colostrum yield and body weight gain of calf.

MATERIALS AND METHODS

A total of 18 pre-partum (8-10 weeks) cows in their 3rd to 4th parity were selected from Rewa District of Madhya Pradesh for the on-farm trial randomly divided into three equal groups, control and treatment 1 and treatment 2. The feeding trial was conducted during January - April months, from 8-10 weeks before parturition to 2 months post-partum, for monitoring of body condition score, colostrum yield, birth weight and average daily gain (ADG) of calves. The housing and management practices for all the selected cows were identical for entire experimental period.

In control group, pregnant cows were fed 2 kg/d farmers formulated concentrate, while in treatment groups 1 and 2, pregnant cows were fed on formulated concentrate mixture with 16.5% and 18% CP, respectively @ 2.0 kg/d. The farmers formulated and treatment group concentrate mixture to post-partum cows was fed @1 kg/2.5 litres milk production plus maintenance and adjusted weekly as per milk yield. Fresh water was offered *ad libitum* two times a day to all the animals. Ingredients composition (%) of concentrate mixtures fed to cows is shown in Table 1.

Parameters studied: The body condition of animals was estimated by using a simple visual technique called body condition scoring (BCS) developed by Edmonson *et al*. (1989) that gives a fairly high accuracy. A chart was prepared in which all important areas of the body were examined individually for scoring from 1 to 5-point scale. A score of one indicated an emaciated condition, and a score of five indicated an obese condition. A total of eight areas of the cow's body were examined and criteria within each area were used to indicate the body condition.

After parturition, the colostrum yields of all the animals of three dietary treatments groups were collected. The first 3 days of yield were taken as colostrum yield, and thereafter, from 4th day onwards, up to 60 days of lactation, the yield was recorded as milk. Four percent fat corrected milk (4% FCM) was calculated by formula of Gains (1928) as mentioned below:

4% FCM (kg) = [(0.4 x total milk) + (15 x total fat)]

Energy corrected milk- Energy corrected milk (ECM) was calculated as per Tyrrell and Reid (1965).

ECM (kg) = [(7.2 x kg protein) + (12.95 x kg fat) + (0.327 x kg milk)]

The calves were weighed for two consecutive days before feeding and watering to get their average initial body weight. The weight of the individual calf was recorded up to sixty days at fortnightly intervals in the morning before feeding and watering to assess the body weight change and average daily gain. Absolute rate of growth (average daily gain, ADG) was estimated by using the Broody (1945) formula as given below-

Absolute rate of growth= (W2-W1)/ (T2-T1)

Where, W2= Final body weight, W1= Initial body weight, T2-T1= Time interval in days

Results obtained were subjected to statistical analysis using one way ANOVA test. Significance of treatments with respect to different characters was declared at $P \leq 0.05$ unless otherwise stated. All the statistical procedure was done as per Snedecor and Cochran (2004).

Table 1. Ingredients composition (%) of concentrate mixtures fed to cows

Ingredients	Control	T_1	T_2
Maize	35	25	17
Wheat bran	12	22	30
Wheat daliya	30	25	20
MOC	20	25	30
Mineral mixture	2	2	2
Salt	1	1	1
Total	100	100	100

RESULTS

The results of protein supplementation to non-descript cattle on pre- and post-partum body condition score, colostrum yield, and birth weight (kg), average daily gain (g) of calf are presented in the tables below.

Proximate composition of experimental feed: The analysis of feed samples was done to determine the proximate composition of treatment diets (AOAC, 2005) as given in Table 2.

Table 2. Proximate composition of experimental feed (% DM basis)

Parameter	Concentrate mixture			Wheat straw	Berseem
	Control	T_1	T_2		
Dry matter	91.03	91.15	91.08	90.25	18.40
Crude protein	15.04	16.60	18.12	3.28	18.90
Ether extract	3.50	3.60	3.80	1.45	3.27
Total ash	8.25	8.75	8.90	5.49	12.85
NDF	37.89	31.32	26.64	78.21	37.54
ADF	13.28	11.62	10.88	50.80	24.90

Table 3. Mean ± SE of body condition scores of experimental animals during the pre-partum period

Body condition score	Control	T_1	T_2	P value
60 d pre-partum	2.58±0.03	2.55±0.04	2.58±0.03	0.74
30 d pre-partum	2.66±0.02	2.68±0.03	2.71±0.04	0.53
Before calving	2.78^{a}±0.03	2.81^{a}±0.03	2.95^{b}±0.02	<0.01

Mean values with different superscripts (ab...) within a row differ significantly

Table 4. Mean ± SE of fortnightly body condition scores of experimental animals during the post-partum period

Variable	Control	T_1	T_2	P value
0 day	2.50±0.04	2.60±0.04	2.62±0.03	0.12
15 day	2.48±0.03	2.56±0.05	2.58±0.03	0.17
30 day	2.45±0.03	2.52±0.03	2.55±0.02	0.08
45 day	2.40^{a}±0.03	2.48^{b}±0.02	2.52^{b}±0.03	0.01
60 day	2.36^{a}±0.02	2.45^{b}±0.02	2.48^{b}±0.03	0.01

Mean values with different superscripts (ab...) with in a row differ significantly

Table 5. Mean ± SE of birth weight (kg) and fortnight body weight (kg)of calves born to animals of the three treatment groups

Days	Control	T_1	T_2	P value
Birth wt.	14.58^{a}±0.20	15.38^{b}±0.15	15.79^{b}±0.14	<0.01
Day 15	17.44^{a}±0.21	18.37^{b}±0.14	18.92^{c}±0.17	<0.01
Day 30	20.42^{a}±0.26	21.43^{b}±0.14	22.13^{c}±0.16	<0.01
Day 45	23.47^{a}±0.26	24.63^{b}±0.16	25.52^{c}±0.19	<0.01
Day 60	26.73^{a}±0.21	28.07^{b}±0.20	29.15^{c}±0.14	<0.01

Mean values with different superscripts (abc...) within a row differ significantly

Table 6. Effect of pre-partum protein supplementation on average daily gain (g) of calves

Fortnight	Control	T_1	T_2	P value
First	190.55±4.58	199.44±4.33	208.33±9.37	0.19
Second	198.33±8.15	204.44±2.93	214.44±4.60	0.16
Third	203.33^{a}±2.27	213.33^{a}±5.44^{b}	225.55^{b}±3.18	<0.01
Fourth	217.77^{a}±7.63	228.88^{ab}±5.62	242.22^{b}±6.59	0.06

Mean values with different superscripts (ab…) within a row differ significantly

Pre- and post-partum body condition score (BCS) changes: The scoring technique consists of a manual evaluation of the thickness of fat and flesh at the spinous process of the loin the rump area, the prominence of spinous process, the sharpness of the spinous process, the amount of fat surrounding the tail head region, and the prominence of the pelvic bones. Pre-partum changes in BCS of pre-parturient cows are presented in Table 3. The initial statistically similar body condition scores of pre-partum cows were 2.58±0.03, 2.55±0.04 and 2.58±0.03 units in control, T_1 and T_2 group, respectively (P>0.05). The BCS just before calving was significantly higher (P<0.01) in T_2 group, which may be due to higher plane of nutrition in T_2 group.

The mean post-partum BCS at parturition were 2.50±0.04, 2.60±0.04 and 2.62±0.03 units for control, T_1 and T_2 groups, respectively, as shown in Table 4. BCS up to 2nd fortnight were comparable among the three groups. During 3rd and 4th fortnight, BCS was significantly (P<0.01) higher in T_2 and T_1 in comparison to control. The post-partum cows showed a decreasing trend in BCS up to 4th fortnight (60 days).

Birth weight (kg) and average daily gain (g): Effect of prepartum supplementation of protein to cows on birth weight and fortnightly body weight changes of calves up to two months of age are given in Table 5. The mean birth weights of calves were found to be 14.58±0.20, 15.38±0.15, and 15.79±0.14 kg for control, T_1 and T_2 groups, respectively, which is significantly higher (P<0.01) in T_2 and T_1 group in comparison of control. Similarly, at 1st, 2nd, 3rd, and 4th fortnight the body weight of calves were found significantly higher (P<0.01) in T_2 and T_1 groups in comparison to control.

The average daily gain (g) of the calf at 1st, 2nd and 4th fortnight were higher for calves of T_2 than control group, while T_1 calves had intermediate position, but the difference was not significant (P>0.05). At 3rd fortnight average daily gain was significantly higher (P<0.05) for the calves of T_2 group (Table 6).

Colostrum yield: The colostrum yield in both the experimental groups increased from day 1 to day 3 of calving (Table 7). The means of average daily colostrum yield for first 3 days for control, T_1 and T_2 groups were 2.93±0.06, 3.21±0.10 and 3.34±0.08 kg, respectively. The mean daily colostrum yield in T_2 and T_1 groups was significantly higher (P<0.01) than control group. At 1st day colostrum yield was significantly higher (P<0.05) in T_2 group than T_1 and control group, whereas, on 2nd and 3rd day significantly higher colostrum yield was recorded in T_2 and T_1 than control group (P<0.01). The total colostrum yield was also found to be significantly higher (P<0.01) in T_2 and T_1 groups than control. The mean of average daily milk yield (kg d-1) per animal were 4.54±0.13, 4.93±0.14 and 5.25±0.06 kg for control, T1 and T2 groups, respectively (Table 8), which is significantly (P<0.01) higher in T2 and T1 groups than control group. The overall mean daily yield of 4% FCM during the 8 week of lactation was 4.88±0.16, 5.46±0.19 and 6.23±0.18 kg for control, T1 and T2 groups, respectively. The overall mean yield of ECM (kg d-1) during the 8 weeks of lactation were 5.36±0.18, 6.02±0.50 and 6.80±0.17 kg for control, T1 and T2 groups, respectively, which is significantly higher (P<0.01) for T2 and T1 in comparison of control.

Table 7. Mean ± SE of daily colostrum yield (kg) of the experimental animals of the three treatment groups

Colostrum yield (kg)	Control	T_1	T_2	P value
Day 1	2.71^{a}±0.07	2.75^{a}±0.08	3.06^{b}±0.09	0.01
Day 2	2.96^{a}±0.08	3.26^{b}±0.07	3.34^{b}±0.11	0.02
Day 3	3.14^{a}±0.06	3.62^{b}±0.09	3.61^{b}±0.13	<0.01
Av. yield	2.93^{a}±0.06	3.21^{b}±0.10	3.34^{b}±0.08	<0.01
Total yield	8.80^{a}±0.17	9.62^{b}±0.22	10.01^{b}±0.28	<0.01

Mean values with different superscripts (ab…) within a row differ significantly

Table 8. Various milk production traits of 60 days of lactation

Attributes	Control	T_1	T_2	P value
Colostrum (kg d^{-1})	2.93^{a}±0.06	3.21^{b}±0.10	3.34^{b}±0.08	<0.01
Whole milk (kg d^{-1})	4.54^{a}±0.13	4.93^{b}±0.14	5.25^{b}±0.06	<0.01
4% FCM (kg d^{-1})	4.88^{a}±0.16	5.46^{b}±0.19	6.23^{c}±0.18	<0.01
ECM (kg d^{-1})	5.36^{a}±0.18	6.02^{b}±0.50	6.80^{c}±0.17	<0.01

Mean values with different superscripts (abc...) within a row differ significantly

DISCUSSION

Pre- and post-partum body condition score (BCS) changes: The result of this experiment regarding pre-partum body weight change was in agreement with the findings of Usmani and Inskeep (1989), who studied the response of pre-partum feeding in Nilli-Ravi buffaloes (101) of mixed ages and lactations, and reported that pre-partum gain was higher (P<0.01) in buffaloes kept on high plane of nutrition than those on moderate plane of nutrition. Similarly, Ojha *et al*. (2017) found that feeding concentrate during the pre-partum period notably (P<0.05) enhanced the overall dry matter intake and body condition score of pregnant buffaloes when compared to the control group. Likewise, Anthony *et al*. (1986) reported that cows on a low nutritional plane gained less weight compared to those on a high nutritional plane during the pre-calving period. Khan *et al*. (2002) also noted that cows on *ad libitum* feeding during the pre-calving period had a significantly higher increase in body weight (38.50±6.04 vs 21.37±8.04 kg/cow) than cows subjected to restricted feeding (P<0.05).

Body condition reflects the body fat reserves of the animal, which is utilized by the animal when she is unable to eat enough quantity of feed to fulfill her energy need. The improved BCS and body weight of T_2 and T_1 groups may be caused by higher plane of nutrition during pre-partum period. Khan *et al*. (2015) reported that BCS increased during pre-partum and decreased during post-partum period while body weights changes during pre-partum and post-partum period were not reflected in BCS changes.

Singh *et al*. (2003) found that the average body weights of crossbred cows decreased during the first three weeks under different nutrition levels, suggesting that the strain of pregnancy and the onset of milk production resulted in weight loss in early lactation. As the stress diminished, the animals began to regain weight, with those receiving a higher nutrition level (20% above NRC recommendations during the peripartum period) gained more weight compared to control group animals receiving basal diet during the 4th to 8th weeks.

Bindal (2012) found no significant effect of challenge feeding on post-partum BCS of animals of the treatment group. Likewise, Kokkonen *et al*. (2004) and Sharma *et al*. (2017) reported that strategic supplementation during pre-partum improves post-partum BCS of dairy cows.

On the contrary, Sullivan *et al*. (2009) observed the positive effect of nutritional treatment in the first and second trimesters on dam body weight extended throughout lactation; however, the effect of nutrition on body condition score was not apparent in the post-partum period. This might be attributable to the less sensitive nature of the 1 to 5 BCS assessment compared with sensitivity of body weight in detecting small differences in cows. Similarly, Panigrahi (2003) also reported that during post-partum, overall loss in

BCS was 1.37±0.25, 1.56±0.20 and 1.50±0.26 units for T1, T2 and T3 groups, respectively, over the 14 week lactation which did not differ significantly (P>0.05).

Calf birth weight (kg) and average daily gain (g): The higher pre-partum feeding regime for the treatment group during the pre-partum period as well as post-partum period might have resulted in higher mean calf birth weight, growth rate and average daily gain than control group animals.

The final body weight of calves and the changes in body weight every fortnight were significantly (P<0.01) greater in the treatment group compared to the control group. The present results are compatible with the observations of Das *et al*. (2007), Martin *et al*. (2007) and Singh *et al*. (2019), they reported higher growth rate in calves in dietary supplemented group than non-supplemented group. Similarly, Nowak *et al*. (2012) also reported feeding of high energy diets during dry period may indirectly affect growth of newborn calves. Further, daily body weight gain during 21 day of rearing period was more (P<0.05) in high energy group than in the lower energy group. Similarly, Ojha *et al*. (2015) reported that the birth weight and average daily gain of calves up to 120 days of age were significantly (P<0.01) higher in treatment group. It may be concluded that the prepartum supplementation of protein to pre-partum cows significantly improved the performance of dam as well as birth weight and growth performance of calves.

Contrary to these findings, Keady *et al*. (2001), Khan *et al*. (2002) and Panigrahi *et al*. (2005) reported a non-significant effect of pre-calving nutrition on calf birth weights.

Colostrum yield: The results of the present investigation are in agreement with Ojha *et al*. (2015), Kopde (2019) and Singh (2019), who reported a significantly higher yield of colostrum in animals which were fed at a higher plane of nutrition prior to calving. Contrary to it, Prasad and Tomar (1995), Panigrahi (2003) and Bindal (2012) reported a non-significant effect of pre-partum feeding on colostrum yield. Although the yield was higher in treatment group as compared to control group.

The present findings are in agreement with Roche *et al*. (2006) and Nandkishore *et al*. (2006) those have reported considerable improvement in productivity in terms of total and daily milk yield (kg) in pre-partum supplemented groups. Similar reports were also found by Narang *et al*. (2012), they reported considerable improvement in productivity in terms of total and daily milk yield (kg), and 4% FCM (kg) through strategic supplementation in pre-partum buffaloes. Likewise, Sihag *et al*. (2009) reported that by increasing 10% CP in the prepartum diet, milk yield and 4% FCM yield increased significantly (P<0.05). Mantysaari *et al*. (1999) reported that during the last trimester, a high feeding intensity increased (P<0.04) milk yield and ECM yield by approximately 11%.

Based on the results obtained from the present investigation, it is concluded that peri-partum protein supplementation improved the pre- and post-partum body condition score and colostrum yield of the non descript cattle. Further, the calves of protein supplemented groups had higher birth weights and better growth.

Conflict of interest: The authors have declared that no conflict of interest exists in the study.

Author's contribution: RKM, BKO: Conception and design of experiment; KG, JSR: Analysis and interpretation of data; AKS, RR: Performed statistical analysis of data.

Data availability statement: All the data supporting the research findings have been presented in this paper. The corresponding author is willing to provide the raw data upon reasonable request.

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