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Effects of Dietary Protein Level during Transition Period on the Performance of Crossbred Heifers

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ABSTRACT

This study was carried out from August to September, 2019 at Instructional Livestock Farm (Cattle) under Department of Livestock Production and Management, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati (781 022), Assam, India to study the production performance of crossbred heifers during transition period. Twelve pregnant crossbred heifers were selected in advance stage of pregnancy and were divided into two groups 21 days prior to calving viz., Treatment No. 1 (T_1) and Treatment No. 2 (T_2) consisting six animals in each group. Since 21 days prior to calving, the T_1 group was provided concentrate ration having 18% CP and 70% TDN and the T_2 group was provided concentrate ration having 22% CP and 70% TDN during the transition period. It was observed that the overall average daily DM intake during pre-partum did not show significant difference due to dietary protein level but during postpartum there was significant difference between the two level of dietary protein. The overall DM intake during postpartum was (10.92±0.27 kg) was significantly higher than pre-partum (6.85±0.16 kg) which might be due to milk production. The average birth weight of calves was not differing significantly. The overall average total blood protein and blood calcium concentration did not show significant difference due to dietary protein level, but there was significant difference between pre-partum and postpartum period. The overall average daily colostrum yield was apparently higher but not significantly higher in T_2 than T_1 group. From the present study it can be concluded that feeding crossbred heifers with higher dietary protein during transition period improved their production performance.

KEYWORDS: Transition period, crossbred heifers, dietary protein, colostrum

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Data Availability Statement: Legal restrictions are imposed on the public sharing of raw data. However, authors have full right to transfer or share the data in raw form upon request subject to either meeting the conditions of the original consents and the original research study. Further, access of data needs to meet whether the user complies with the ethical and legal obligations as data controllers to allow for secondary use of the data outside of the original study.

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1. INTRODUCTION

The transition is consider as the period between three weeks before to three weeks after parturition which is the most challenging and critical period in relation to the dairy cow's health status during the lactation cycle (Crookenden et al., 2020). It is apparent that most dairy cattle experience subacute inflammation for at least the first several days postpartum. However, few degree of inflammation during this period is clearly important for normal function of the reproductive system, for immunity, and possibly for homeorhetic shifts in metabolism. Defining and promoting a healthy degree of inflammation in transition cows will limit transition disorders while improving productivity of dairy animals (Bradford et el., 2015) and also have some effect on milk protein concentration in early lactation (Morton et al., 2016; Kvidera et al., 2017). Major physiological, nutritional, metabolic, and immunological changes occur within this time frame as the production cycle of the cow shifts from a gestational non-lactating state to the onset of copious milk synthesis and secretion (Ehrhardt et al., 2016). Properly formulated and delivered diets generally have positive effects on indicators of metabolic health and have the potential to reduce the effects of periparturient disease (Cardoso et al., 2021). The cow is subjected to lot of stress due to parturition, colostrogenesis and onset of lactation during transition period. During transition period nutrient requirement increases whereas the feed intake decreases which may result in metabolic changes at parturition imposing high stress on dairy cows (Kerwin et al., 2022). Therefore, it is important to feed a dairy cow with a diet rich in nutrients during the last 3 week of gestation not only to meet their nutrient needs but also to minimize the risk of peripartum metabolic disorders (Husnain and Santos 2019; Cardoso et al., 2021). At the onset of lactation, dairy cows are under metabolic stress due to negative energy balance leading to mobilization of considerable amounts of tissue reserves (Guadagnin and Cardoso, 2023). The transition period is a challenging time not only for dairy cattle but also for the farmers. Therefore, variety of environmental and management related stressors need to handled carefully for optimal productivity and profitability of dairy farming. Weaver et al. (2016) and Hernandez-Castellano et al. (2017) have demonstrated that the infusion of the 5-HT precursor 5-hydroxytryptophan (5-HTP) during the last days before parturition improved blood calcium concentrations around parturition. The increased susceptibility to disease is influenced by poorer immune function in both innate and adaptive immune responses during the transition period leading up to parturition and in the weeks afterward (Heiser et al., 2015; Crookenden et al., 2020).

Supplementation of protein rich ingredients in the diet of heifer is essential along with the supply of adequate amount of green grass (Miguel-Pacheco et al., 2017). Further, it is essential to monitor the changes of dry matter intake, growth performances as well as health status of heifers in response to protein supplementation (Kerwin et al., 2022). In developing countries like India, heifers were supplied with small amount or almost no concentrate feed and if at all supplied but not nutritionally balanced. Thus, animals are being physiologically challenged which interfere with reproductive functions and ultimately affects the profitability of the dairy farm. The present study was conducted to know the effect of dietary protein level during transition period on production performance of heifers.

2. MATERIALS AND METHODS

2.1. Selection of the study area

The research work was carried out from August to September, 2019 for a period of total 42 days i.e. 21 days prior to calving (pre-partum) and 21 days after calving (post-partum) at Instructional Livestock Farm (Cattle) under the Department of Livestock Production and Management, College of Veterinary Science, Assam Agricultural University, Khanapara, Guwahati (781 022), Assam, India.

Twelve (12) pregnant crossbred heifers were selected for the experiment and they were divided into two groups consisting six (6) animals in each group were subjected to the following treatments from twenty one (21) days before calving to twenty one (21) days after calving (Table 1).

Table 1: Feeding schedule of the experimental animals

Treatment No. 1 (T_1)	Treatment No. 2 (T_2)
Six pregnant heifers were fed with a concentrate having 18% CP & 70% TDN during the transition period (ICAR, 2013) as follows:	Six pregnant heifers were fed with a concentrate having 22% CP and 70% TDN during the transition period (ICAR, 2013) as follows:
a) Pre-partum: Concentrate ration @ 1.5 kg day^{-1} $animal^{-1}$ in two divided doses, twice daily and forage ad libitum	a) Pre-partum: Concentrate ration @ 1.5 kg day^{-1} $animal^{-1}$ in two divided doses, twice daily and forage ad libitum.
b) Post-partum: Concentrate @ 1.5 kg day^{-1} $animal^{-1}$ in divided amount+1 kg concentrate 2.5 l^{-1} of milk production in two divided doses, twice daily and forage ad libitum.	b) Post-partum: Concentrate @ 1.5 kg day^{-1} $animal^{-1}$ in divided amount+1 kg concentrate 2.5 l^{-1} of milk production in two divided doses, twice daily and forage ad libitum.

2.1. Design of experiment and statistical analysis

The experiment was conducted in factorial RBD design and data were analyzed by using statistical tools of descriptive statistics, ANOVA, Post Hoc test etc. in statistical software package SAS Enterprise Guide 3.4.

2.2. Preparation of concentrate feed

The concentrate mixture was prepared with the available ingredients by mixing in the Feed Mill (Table 2).

Table 2: Ingredients of concentrate ration provided to the experimental animals

Sl. No.	Ingredients	T_1 (%)	T_2 (%)
1.	Maize	41	30
2.	Wheat bran	12	11
3.	Soyabean meal	12	18
4.	Ground nut cake (GNC)	12	18
5.	Rice polish	10	10
6.	Rice bran	10	10
7.	Mineral mixture	2	2
8.	Common salt	1	1
Calculated nutrient value of theration as per ICAR (2013)	DCP	18.16	22.03
	TDN	72.6	72.15

2.3. Parameters studied

2.3.1. Feed/Dry matter (DM) intake

Daily feed intake on dry matter (DM) basis was calculated by subtracting the leftover feeds from feed offered in 24 hours. Then weekly average was calculated. The dry matter was estimated as per the following formula:

$$\text{DM (\%)} = \frac{\text{Weight of the sample after drying}}{\text{Weight of the sample before drying}} \times 100$$

The total DM intake was calculated by adding the DM consumed from different feeds.

2.3.2. Body weight

The body weights of the heifers were recorded from 3 weeks pre-partum to 3weeks post-partum by using Shaeffer's formula.

$$\text{Body weight (lb)} = \frac{L \times G^2}{300}$$

L=Body length, from point of the shoulder to the pin bone in inches.

G=Heart girth, circumference of the girth just behind the point of elbow in inches.

Body weight (kg)=Body weight (lb)×0.4536

2.3.3. Body condition score (BCS)

The body condition score was recorded weekly from 3 weeks pre-partum to 3 weeks post-partum. The body condition score have been recorded at 5-point scale as per Praveen et al. (2024) (Table 3)

2.3.4. Birth weight of calves

The body weight of the calves at birth was taken in weighing balance after cleaning and drying the body surface.

2.3.5. Colostrum yield

Average daily yield of colostrum for first 4 days was recorded in kg.

2.3.6. Milk yield

The daily morning and evening milk yield was recorded in kg and daily average was calculated in every week.

2.3.7. Blood biochemical parameters

Total blood protein and calcium were estimated by using commercial kits as per standard methods once in pre-partum (2ndweek) and once in postpartum (2^{nd} week).

Table 3: Body condition score (BCS) chart

Body condition scores	Tuberosity-appearance		Thurl shape	Ligaments-appearance		Appearance of spinous processes
	Ileal	Ischeal		Coccygeal	Sacral	
<2.0	angular	angular	V	sharp	sharp	angular and more than 8 cm visible
2.25	angular	angular	V	sharp	sharp	angular and more than 8 cm visible
2.5	angular	angular	V	sharp	sharp	angular, 6-8 cm visible
2.75	angular	rounded	V	sharp	sharp	angular, 6-8 cm visible
3	rounded	rounded	V	sharp	sharp	angular, 6-8 cm visible
3.25	rounded	rounded	U	sharp	sharp	angular, 4-6 cm visible
3.5	rounded	rounded	U	blunted	sharp	rounded, 4-6 cm visible
3.75	rounded	rounded	U	not visible	blunted	rounded, 0-2 cm visible
4	rounded	rounded	U	not visible	not visible	rounded, 0-2 cm visible
>4.00	rounded	rounded	flat	not visible	not visible	rounded, not visible

3. RESULTS AND DISCUSSION

3.1. Feed/Dry matter (DM) intake

The overall average daily DM intake during pre-partum and postpartum was 6.76±0.24 and 10.39±0.35 kg in T_1 and 6.93±0.21 and 11.45±0.38 kg in T_2 groups, respectively (Table 4). The average daily DM intake differed significantly between T_1 and T_2 groups during postpartum. The DM intake was significantly higher in T_2 group which is supported by findings of Amirabadi Farahani et al. (2019), Cardoso et al. (2021) and Kerwin et al. (2019). Husnain and Santos (2019) also reported that increasing prepartum dietary CP content increased pre-and postpartum DMI in nulliparous cows. The average daily DM intake was significantly higher during postpartum period than the pre-partum period. As calving approached the dry matter intake gradually reduced and after parturition the dry matter intake increased in both T_1 and T_2 groups. Monteiro et al. (2024) illustrated that the blood concentration of progesterone decreases and blood concentration of estrogen increases towards parturition, which is one of the major factor that decrease the dry matter intake (DMI) around calving.

Table 4: Average (mean±SE) daily feed (DM) intake (kg) of the crossbred heifers during the transition period

Period	Weeks	Treatments		Overall
		T_1	T_2	
Pre-partum	1	7.80±0.20^{Aa}	7.87±0.20^{Aa}	6.85±0.16^{A}
	2	6.90±0.17^{Ba}	6.97±0.15^{Ba}	
	3	5.58±0.17^{Ca}	5.97±0.13^{Ca}	
	Over all	6.76±0.2^{4a}	6.93±0.21^{a}	
Post-partum	1	8.60±0.14^{Aa}	9.53±0.11^{Aa}	10.92±0.27^{B}
	2	10.60±0.17^{Ba}	11.52±0.14^{Ba}	
	3	11.97±0.19^{Ca}	13.30±0.16^{Ca}	
	Over all	10.39±0.35^{a}	11.45±0.38^{b}	

*Means with different superscripts within a column (capital letter) and within a row small letter differ significantly

3.2. Body condition scores (BCS)

The overall average weekly body condition score during pre-partum was 3.42±0.04 and 3.47±0.03 and during postpartum 2.88±0.05 and 3.28±0.04 in T_1 and T_2 groups, respectively (Table 5). There was highly significant effect (p<0.01) of dietary protein level and transition period on the BCS. The average BCS was higher in T_2 than T_1 groups during pre-partum, but significantly higher during postpartum. The BCS was significantly higher during pre-partum than the postpartum period. The BCS apparently increased from 1st to 3rd week during pre-partum in T_1 group. But the BCS was significantly different between 1st and 3rd week during pre-partum in T_2 group. On the other hand the BCS during post-partum significantly decreased from 1st to 2nd week in both T_1 and T_2 groups.

Table 5: Average (mean±SE) body condition score (BCS) of the crossbred heifers during the transition period

Period	Weeks	Treatments		Overall (μ)
		T_1	T_2	
Prepatum	1	3.33±0.08^{A}	3.38±0.06^{A}	3.44±0.03^{A}
	2	3.42±0.05^{A}	3.46±0.04^{AB}	
	3	3.5±0.06^{A}	3.58±0.05^{B}	
	Over all (μ)	3.42±0.04^{a}	3.47±0.03^{a}	-
Postpar-tum	1	3.08±0.08^{A}	3.21±0.04^{A}	2.98±0.04^{B}
	2	2.83±0.08^{B}	3.04±0.04^{AB}	
	3	2.71±0.04^{B}	3.00±0.06^{B}	
	Over all (μ)	2.88±0.05^{a}	3.28±0.04^{b}	-

* Means with different superscripts within a column (capital letter) and within a row small letter differ significantly

Praveen et al. (2024) suggested that the BCS of dairy cows at calving should be 3.00 to 3.50 and at early lactation 2.50 to 3.00 at 5 point scale for better productive performance of the cows. Live body weight varies from 17 kg to 41 kg for each unit of BCS lost in primiparous and multiparous Holstein-Friesian dairy cows, respectively. As reviewed by Roche et al. (2018), changes in the body condition score in the transition period are expected and can be used as a proxy to determine how dairy cows mobilize their body reserves to support the increased nutrient demands of the transition period. Manríquez et al. (2021) stated that BCS serves as a vital indicator of the nutritional status of cattle, reflecting the adequacy of the diet over time and also reported that dairy cows fed with high protein diet up to 23.1% CP, losses their BCS in their early lactation period. However, BCS started to increase towards the mid lactation period. The significantly increased BCS during pre-partum period might be due to more subcutaneous fat reserve in the body. The better dietary protein level also impacts the BCS due to efficient utilization of energy diet in the heifers (Husnain and Santos 2019, Cardoso et al., 2021).

3.3. Birth weight of calves

The average birth weight of calves was found to be 21.00±1.92 and 24.33±1.20 in T_1 and T_2 groups, respectively. The average birth weight of T_2 group was apparently higher than the T_1 group. The t-test revealed

that birth weight of the claves did not vary significantly due to feeding of different dietary protein levels which is supported by the findings of Akhtar et al. (2022) and Cook et al. (2024). However, calves from the heifers fed with high protein diet than those fed with low protein diet grew at a faster rate over the six month period (Miguel-Pacheco et al., 2017 and Husnain and Santos, 2019).

3.4. Colostrum yield

The overall average daily colostrum yield was 5.67±0.34 and 6.17±0.38 kg in T_1 and T_2 groups, respectively. There was non-significant effect of dietary protein on the colostrum's yield of crossbred cows. Mann et al. (2016), Amirabadi Farahani et al. (2019) and Akhtar et al. (2022) reported that colostrum's yield did not differ significantly with levels of protein in the diet during dry period which supports the present study. In the present investigation, the average colostrum yield increased gradually from 1st to 4th day might be due to more efficient galacto poietic hormone prolactin (Cook et al., 2024).

3.5. Milk yield

The overall average daily milk yield was 10.95±0.43 and 12.43±0.47 kg in T_1 and T_2 groups, respectively. The present findings shows that there was highly significant (p<0.01) effect of dietary protein on the average daily milk yield of crossbred cows. The milk yield was significantly higher in T_2 than T_1 group which is supported by findings of Husnain and Santos (2019) and Amirabadi Farahani et al. (2019). Cardoso et al. (2021) reported that Holstein cows fed different levels of protein yield more milk in high protein fed cows than low protein fed cows during first 45 day of lactation. They also reported that feeding more protein to late-gestation primigravid cows to increase maternal reserves at calving may provide potential for mobilization of tissue amino acid to contribute to yields of milk. Sucak et al. (2017) investigated the effects of two dietary levels of CP (15% and 18%) and revealed that milk and protein yield were higher (p<0.05) with higher dietary CP level.

3.6. Blood biochemical parameters

The blood calcium concentration during pre-partum and postpartum was 7.67±0.23 and 7.24±0.21 mg dl^{-1} in T_1 group and 8.04±0.29 and 7.31±0.23 mg dl^{-1} in T_2 group, respectively. The ANOVA revealed that there was highly significant (p<0.01) effect of period and non-significant effect of treatment on the blood calcium concentration of crossbred heifers during transition period. Immediately after calving milk synthesis starts in the udder and blood calcium concentration drops compared to late gestation. Kerwin et al. (2019) and Crookenden et al. (2020) reported that with onset of lactation calcium demand dramatically increases and the risk of clinical and subclinical hypocalcemia is also increased if blood calcium concentrations is not normocalcemic during early postpartum period.

The average total blood protein concentration during pre-partum and postpartum was 6.85±0.14 and 7.40±0.12 g dl^{-1} in T_1 group and 6.85±0.17 and 7.55±0.10 g dl^{-1} in T_2 group, respectively. The ANOVA revealed that there was highly significant effect (p<0.01) of period and non-significant effect of treatment on the average total blood protein. Keeping similarity with the present study Cardoso et al. (2021) reported non-significant difference in blood calcium and protein concentration during pre and post-partum period while feeding with high and low protein diet. In present investigation, total blood protein concentration was significantly higher during postpartum to support the milk production (Stolcova et al., 2023).

4. CONCLUSION

In view of above findings, it may be concluded that feeding crossbred heifers with higher dietary protein during transition period increased DM intake, improved their performance in respect of birth weight of calves, colostrum yield, milk yield and also helped in maintaining the optimum BCS of the crossbred heifers. Therefore, higher protein level in concentrate ration during transition period may be suggested for the feeding of crossbred heifers.

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