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ORIGINAL ARTICLE

Effect of pre-partum and post-partum concentrate supplementation on milk yield and quality, calf birth weight and post-partum heat period of Holstein-Friesian crossbred COWS

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ABSTRACT

Twelve Holstein-Friesian crossbred cows were selected for an on-farm study in a completely randomized design to exemplify the effects of pre- and post-partum concentrate supplementation on calf birth weight, milk production and composition; and post-partum resumption of ovarian cyclicity. Along with green grass (35.0 kg/cow/day) and daily farm allowance of concentrate mixture (2.0 kg/cow/day; regarded as control group – 6 cows), extra amount (500 g) of concentrate supplementation was done in supplemented group (6 cows) using wheat bran (44%), mustard oil cake (44%), common salt (4%) and di-calcium phosphate (8%). Results revealed that calf birth weight was 11% higher ($p=0.26$) in supplemented group compared to the control group. Milk yield was recorded 49% higher ($p=0.001$) in supplemented cows than that of the control cows. Among the milk constituents, only milk protein was found significantly ($p=0.0001$) higher in cows received concentrate supplementation than that of the cows without concentrate supplementation. Moreover, the post-partum heat period was found significantly ($p=0.014$) lower in supplemented group than that of the control group and 83.33% cow in this group returned to heat within 60 days post-partum which was nil in the control group. In conclusion, offering superfluous concentrates (25% of total concentrate) during pre- and post-partum had positive impact on milk yield, milk protein and post-partum heat period.

Keywords: Holstein-Friesian, concentrate, milk, post-partum heat

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1 Introduction

Last three weeks of gestation and the first three weeks of lactation are known as transition period; in which the cow must have accustomed to hormonal and metabolic changes as well as daily routine and diet changes (Grummer, 1995; Drackley, 1999). This period is very critical for the lipid accretion of lipids in the liver and reduced in feed intake (Hartwell et al., 2000). It has been verified that dietary management in the early dry period is vital for maintaining the health and productivity of transition cows (Dann et al., 2006). Post-partum period of dairy cow is characterized by negative energy balance during the recovery status from the parturition event and subsequently for milk production as well as restarting reproduction function (Piepenbrink and Overton, 2003). Protein supply during this period may improve the situation (Gilbery et al., 2006).

According to Randel (1990), insufficient pre- and/or post-calving nutrition reduce the pregnancy rates as well as first service conception rates and extend the post-partum intervals. Most of the dairy cows are under nourished in tropical areas including Bangladesh, because they are unable to supply adequate amount of concentrate due to price hike of the ingredients. As a result, undernourished cow usually have an extended days open, irregularities in breeding, gives birth to an underweight calf and, both the dam and youngster remains as a low producer. Supplementation of concentrate in dairy cattle feeding enhances milk yield and fertility of the cow (Mukasa-Mugerwa, 1989).

If the cow is severely underfed during last three months of gestation then it may cause in-utero death of the calf or decrease the viability at birth, and after birth young lost their body weight (McDonald et al., 1985). During later stage of pregnancy, high levels of feeding enhanced calf birth weights without any calving difficulties as well as reduced post-partum intervals, greater number of animals showed oestrous before the breeding season and tended to have a higher fall pregnancy rate (Bellows and Short, 1978). Khan et al. (2004) also reported that high energy fed cow has gained more before the calving, gives birth of calf with higher body weight and the cow produce more milk than the low energy fed group. However, they did not find any effects on reproduction of the cow. Concentrate supplements are used in diet as a management tool to increase overall dry matter intake (DMI) and milk production (Stockdale, 2000; Bargo et al., 2003). In a previous study, Colazo et al. (2009) reported that pre-partum dietary treatments did not affect calf birth weight, postpartum health disorders, energy balance, or fertility. At this stage, rice straw and green grasses offered to the dairy animals through supplementation with little or no concentrate in tropical countries like Bangladesh. Again, produc-

tive and reproductive performance of cattle is negatively affected in tropical areas by low forage availability, quality and detrimental health effects have been reported by several authors (Hammon et al., 2006; McArt et al., 2013).

The effect of concentrate supplementation on milk fat content is varied and heavily dependent on concentrate composition (Higgs et al., 2013). The use of energy and protein rich supplements in diets could only to mitigate that negative effects in animal body (Lents et al., 2008). On the contrary, there is little information remains regarding the pre- and post-partum concentrate supplementation effects on productive and reproductive performance of Holstein-Friesian crossbred cows in this country.

Hence, this research work was undertaken to scrutinize the effect of pre- and post-partum concentrate supplementation on calf birth weight, changes in milk yield and quality as well as post-partum heat period.

2 Materials and Methods

2.1 Animals and diets

Animal protocols were carried out at the Research Dairy Farm operated by the Department of Dairy Science, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh. Twelve Holstein-Friesian crossbred (HFX) cows (belongs to 2nd parity and 7th months of pregnant) were selected for this study and they were equally divided into two groups (Control, C and Supplemented, S). The total duration of the study was 120 days of which 10 days were for diet adaptation. Each cow was kept in an individual maternity box during 2 month of pre-partum to 1st week of post-partum. Then cows were transferred to the concrete floor stall with manger and water trough in a double rowed face-out stanchion barn.

The study was carried out using green grass and concentrate mixture. Para grass (*Brachiaria mutica*) supplied (35.0 kg/cow/day) almost entire pre-partum and German grass (*Echinochloa crus-galli*) was supplied (35.0 kg/cow/day) during the post-partum period in both groups of cow. In both groups, concentrate mixture (2.0 kg/cow/day) includes 82.82% wheat bran, 14.19% mustard oil cake, 2.68% common salt and 0.31% Di calcium phosphate (DCP). This fixed amount of roughages and concentrate mixture supplied to the cows based on existing farm feeding practices.

In addition to this scheduled supply, extra 25% of total concentrate mixture (500 g) was supplied to the S-group which was composed of 44% wheat bran, 44% mustard oil cake, 4% common salt and 8% DCP. Concentrate mixture was supplied at 08:00 am (half of the amount) and 11:00 am (rest of the amount). Green grasses (35.0 kg/cow/day) were supplied once at 11.00 am after the concentrate finished. Proximate

Table 1. Ingredient and chemical composition of dietary groups

	Pre-partum diet		Post-partum diet	
	Control (C)	Supplemented (S)	Control (C)	Supplemented (S)
Ingredient composition (g kg ⁻¹ DM)				
Para grass	792	753	–	–
German grass	–	–	798	754
Wheat bran	170	184	164	183
Mustard oil cake	30.91	49.5	30.6	49.5
Common salt	6.39	8.3	6.7	8.3
DCP	0.7	5.2	0.7	5.2
Chemical composition (g kg ⁻¹ DM)				
Dry matter (DM)	333.86	361.6	331.38	362.43
Crude protein (CP)	105.46	110	106.62	111.45
Crude fibre (CF)	270.33	261.2	266.77	256.89
Ether extract (EE)	25.9	27.58	26.82	28.53
Nitrogen-free-extract (NFE)	498.16	495.42	488.37	486.98
Ash	91.11	90.23	102.33	100.87
ME (MJ kg ⁻¹ DM)†	8.86	9.04	8.74	8.94

† Metabolizable energy (ME) values are estimated according to the equation of [Kearl \(1982\)](#), ME (MJ kg⁻¹ DM) = $[-0.45 + (0.04453 \times \%TDN)] \times 4.184$; TDN is estimated according to the following equations: TDN for roughages (% of DM) = $-17.2649 + (1.2120 \times \%CP) + (0.8352 \times \%NFE) + (2.4637 \times \%EE) + (0.4475 \times \%CF)$; TDN for concentrate (% of DM) = $40.3227 + (0.5398 \times \%CP) + (0.4448 \times \%NFE) + (1.4218 \times \%EE) - (0.7007 \times \%CF)$

Table 2. Effect of diets on calf birth weight, milk yield, milk composition and post-partum heat period

	Diets		p-value
	Control (n = 6)	Supplemented (n = 6)	
Calf birth weight (kg)	19.0 ± 1.78	21.0 ± 3.68	0.26
Milk yield (kg d ⁻¹)	6.80 ± 0.98	10.12 ± 0.49	0.001
pH	6.49 ± 0.01	6.49 ± 0.00	0.76
Milk composition (g kg ⁻¹)			
Total solids	127.13 ± 3.49	130.40 ± 5.92	0.27
Fat	40.01 ± 0.30	40.86 ± 1.34	0.16
Solids-not-fat	87.11 ± 3.2	89.53 ± 6.86	0.46
Protein	32.11 ± 0.31	33.03 ± 0.16	0.0001
Lactose	47.45 ± 3.44	48.76 ± 6.73	0.6
Ash	7.55 ± 0.44	7.73 ± 0.36	0.45
Post-partum heat period (d)	66.83 ± 5.34	55.33 ± 7.78	0.014
Animals return to heat within 60 days post-partum (%)	0.0	83.33	–

content of nutrients of the individual feed items were performed according to [AOAC \(2000\)](#). Ingredients and chemical composition of the diets are given in [Table 1](#).

2.2 Measurement of calf birth weight and milk characteristics

Calf birth weights were recorded using digital weighing balance within half an hour of calving. Milk samples were obtained once weekly (Monday) from two consecutive milking (am and pm separately) till two months of that lactation for measuring milk yield and assaying milk composition. pH value of the milk was measured with the help of pH meter (HANNA instrument, HI 2211PH /ORP meter, UK). Total solids and ash content in milk were obtained by oven drying and incineration method, respectively. Fat percentage of milk was estimated by Babcock method and protein content was measured by formal titration method. Solids-not-fat (SNF) of milk was calculated and lactose content was also estimated by using calculation method. Post-partum heat period of cow was defined as the period of time (days) between calving and the day on which cow showed external signs of heat.

2.3 Statistical analysis

The data obtained, were analyzed in Completely Randomized Design (CRD) by SPSS (IBM SPSS Statistics version 20, Chicago, USA). Analysis of co-variance was done and last lactation milk yield was considered as covariate for analyzing the variation in the present milk production of the cows.

3 Results and Discussion

3.1 Calves birth weight

Concerning data are given in [Table 2](#) and which revealed a non-significant ($p>0.05$) higher birth weight in supplemented group than that of the control group. [Prior and Laster \(1979\)](#) stated that supplementary feeding during pre-partum period helps in growth of fetus as over one-half of the fetal growth occurs during last trimester of gestation which enhances birth weight of calves. Similar finding was noted by [Bayemi et al. \(2014\)](#) who concluded that birth weights of calves were higher when cows were supplied with more concentrate feed before calving. [Sihag and Yadav \(2007\)](#); and [Mahiyuddin and Praharani \(2010\)](#) also reported that the calves born to animals under steaming-up ration had higher birth weight than the calves born to animals of the control group. Besides nutrition, genotype of the animal affects the birth weight of the calves ([Bayemi et al., 2014](#)). [Das et al. \(2007\)](#) also suggested that steaming-up had a positive impact to the calf's birth weight.

3.2 Milk yield and composition

Results on milk production and quality are also included in [Table 2](#). The supplemented cow gave 3 kg more milk than that of the control cows which was found statistically significant ([Table 2](#)). This finding is similar to [Broster \(1971\)](#) who concluded that increasing feeding level before calving enhanced milk yields after calving. On the other hand, [Nocek et al. \(1986\)](#) and [Vandehaar et al. \(1999\)](#) explained that feeding pre-calving concentrates had little or no effect on milk production and [Bayemi et al. \(2014\)](#) found similar milk production in pre-partum low level fed cows and high level fed cows; continuation this feeding variation post-partum yielded in the similar milk production trend. However, [Das et al. \(2007\)](#) reported a higher total and per day milk yield in the post-partum supplemented cows than that of the control which agrees with the present findings. Although, [Das et al. \(2007\)](#) offered post-partum concentrate based on the thumb rules considering the maintenance and milk production requirement, whereas, in the present study the supplementation in addition to the scheduled farm allowance was a flat amount from 60 days pre- to 60 days post-partum.

Concentrate supplementation in cows during pre- and post-partum had no significant effect on the milk constituents except milk protein ($p=0.0001$). Both fat and solids-not-fat contents were 0.85 g and 2.42 g higher in concentrate supplemented group, respectively than that of the control group. The increased protein content obtained in the supplemented group is similar to the findings of [Grant and Kononoff \(2007\)](#) who stated that, proper feeding of concentrate in ration enhances milk solids as well as protein in milk. [Treacher et al. \(1986\)](#) and [Singh et al. \(2003\)](#) recorded improved milk quality in cows fed high level of concentrate along with green grass during pregnancy period. Milk pH, fat, solids-not-fat, lactose and ash did not differ significantly in both dietary groups during pre- and post-partum which is supported by [Holcomb et al. \(2001\)](#) who reported that, milk composition data not differed those treated with low and high forage combined with free choice and restricted feeding during pre-partum period. Again, [Hills et al. \(2015\)](#) implied that concentrate supplementation to the grazing dairy cows enhances yields of milk fat, protein and lactose.

3.3 Post-partum heat period

In addition to the aforementioned results, [Table 2](#) also contains the results on post-partum heat period and results indicated that concentrate supplementation had significant ($p=0.014$) impacts on post partum heat period of HFX cows. The supplemented cows showed heat 11 days earlier than control cows. It should be

noteworthy again here that the duration of the concentrate supplementation was from 2 months pre-partum to 2 months post-partum. Moreover, 83.33% cows returned to heat within 60 days post-partum in supplemented group against 0% in control group.

Good pre-partum nutrition shortens the length of post-partum heat period (49.9 ± 7.1 days) in Holstein cows (Cavestany et al., 2003). Bayemi et al. (2014) found a non-significant variation regarding the post-partum heat period of the cows based on pre-partum feeding level (low level feeding and high level feeding: 79 and 70 days, respectively), body condition score at calving (BCS <3 and BCS >3: 69 and 68 days, respectively), genotypes (Traditional, Holstein and Crosses: 76, 55 and 56 days, respectively) and post-partum supplementation (<3 kg and 3 to 6 kg: 61 and 64 days, respectively). Regardless of dietary treatments, post-partum heat period in the current study was larger than what has been reported in previous studies: 31 d (Juchem et al., 2010), 33 d (Caldari-Torres et al., 2011), 32 d (Gümen et al., 2005), and 35 d (Ambrose and Colazo, 2007) which might be due to effects of breed, nutrition and environment as well as animal production system.

4 Conclusions

Considering the above mentioned parameters, it can be concluded that increasing concentrate supplementation during pre- and post-partum improves the milk yield, milk composition (protein to SNF) and reduces the post-partum heat period.

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Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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