Effect of Pre-partum Feeding of Crossbred Cows on Growth Performance, Metabolic Profile and Immune Status of Calves

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ABSTRACT : The effects of pre-partum feeding management in terms of birth weight, growth, metabolic profile and immunity of calves were studied using 24 crossbred (*Bos taurus*×*Bos indicus*) cows, divided into three equal groups. The dietary treatments included feeding of either 3.0 kg concentrate/head/d throughout the 60 d pre-partum (T_1), or 3.0 kg concentrate during 60-22 d pre-partum and thereafter at an increased allowance at 0.25 kg/d during the next 21 d till it reached 1% of live weight (T_2). The third group of cows was fed similar to T_2, except that the concentrate feeding during 60-22 d pre-partum was reduced to 2.0 kg (T_3). All the groups had access to *ad libitum* green fodder throughout. The results revealed that the mean daily dry matter (DM) intake by the cows was similar ($p>0.05$) among the three groups during the 60 days of the pre-partum but T2 animals tended to gain more live weight (41.25 kg) than T_1 (38.12 kg) and T_3 (36.25 kg). The body condition score of the cows did not change appreciably over the experimental period. The mean birth weight of the calves was 24.00±1.10, 24.63±1.17 and 23.25±1.19 kg for the three groups, respectively, with the corresponding average daily gain of 154.2, 155.0 and 169.7 g during the subsequent 60 days; both these parameters did not vary significantly ascribable to pre-partum feeding regimens of their dams. The total immunoglobulin (Ig) concentration in the colostrum was 6.31±0.34, 5.80±0.21 and 6.13±0.30 g/dl for the three groups, respectively, showing no influence of dietary treatments. The mean serum Ig levels (T_1 2.10±0.09, T_2 2.05±0.09 and T_3 2.10±0.12 g/dl) of calves at 5 d of age were similar among the dietary groups as was the case with various serum biochemical constituents. It is concluded that the variations in pre-partum dietary management elicited no significant influence on the calf performance including the immune status. ***(Asian-Aust. J. Anim. Sci. 2005. Vol 18, No. 5 : 661-666)***

Key Words : Pre-partum Feeding, Immunity, Crossbred Cows, Calves

INTRODUCTION

Care of the dairy animals starts with the birth of the calf. The animals need ideal conditions to exhibit their inherent genetic capabilities. The birth weight of the calf affects the subsequent growth rate. The heavier calf gains weight at a faster rate than the calf with lower birth weight, even if both are given adequate nutrition. Although the effects of nutrition, housing and health care are of much greater importance, each difference of one kg in birth weight will expand to about 1.5 kg difference by twelve weeks of age (Mudgal et al., 1995). Requirements for pregnancy represent nutrients necessary to support both growth and maintenance of foetus, placenta, uterus and mammary gland. Bovine foetal growth is not linear by gestational age, but exponential (Ferrel et al., 1976; Prior and Laster, 1979) with more than 60 per cent of total foetal weight being accrued during the final two months of gestation. This foetal growth pattern places the greatest nutritional burden on the late pregnant cow. Consequently, last two months of pregnancy needs special care in terms of higher provision of essential nutrients.

Various immunological and biochemical adjustments take place in the dam to meet the metabolic needs of foetus and neonates for growth and development. During foetal life there is maternal protection, and in the post-natal life the neonates are protected and nourished by the colostrum and milk from mother. Calves are immunodeficient at birth because syndesmochorial type of placenta does not permit the transfer of maternal immunoglobulins from dam to the foetus. Colostrum feeding provides passive protection to calves during early life and the level of circulating plasma immunoglobulins is the direct reflection of the immune status of the calves. Calves deprived of colostrum or calves absorbing inadequate amounts of colostral immunoglobulins (Ig) are susceptible to the various diseases (Joshi et al., 1992). Further, maternal nutritional status during late pregnancy is reported to have considerable influence on the colostrum quality and subsequent absorption by the calf (Hough et al., 1990).

The influence of maternal nutrition on the early growth performance of offsprings is mainly mediated through its influence on the birth weight besides milk yield and quality. Although there are many studies that have demonstrated a positive impact of maternal nutrition on the birth weight of calves (Kale, 1984; Prasad and Tomer, 1995; Khan et al., 2004), its effects in influencing the early growth performance of the calves is often without agreement. There are positive reports of the effect of maternal plane of nutrition on growth performance of calves in Hereford cows (Corah et al., 1975), buffaloes (Usmani and Inskeep, 1989)

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Table 1. Ingredient and proximate composition of the experimental feeds

	Concentrate supplement[1]	Fodders		
		Maize	Cow pea	Sorghum
Dry matter	91.72	16.03	14.93	15.86
Organic matter	91.96	90.40	89.75	91.05
Crude protein	20.75	9.67	13.20	5.80
Ether extract	2.09	1.80	2.65	1.73
Crude fibre	8.96	25.74	25.30	32.50
Nitrogen-free extract	60.16	53.19	48.60	51.02
Total ash	8.04	9.60	10.25	8.95

[1] Contained (per 100 kg): maize 25, wheat bran 42, soybean meal 20, deoiled mustard cake 10, mineral mixture 2 and salt 1 parts.

and crossbred cows (Khan et al., 2002); however there also exists reports to the contrary (Khan et al., 2004).

Although a good deal of information is available on the influence of maternal nutrition on the calf performance, the reports involving crossbred (*Bos taurus*×*Bos indicus*) dairy cows are scarce so as to suggest a comprehensive feeding strategy applicable for optimization of their production potential. In this backdrop, the present study was undertaken to explore the effects of maternal plane of nutrition on the performance, metabolic profile and immune status of neonatal calves.

MATERIALS AND METHODS

The present study was carried out at Cattle and Buffalo Farm, Livestock Production and Management Section of the Institute during May 2002 to February 2003. The farm is situated at an altitude of 564 ft above the mean sea level and at 28.22° North latitude and 79.24° East longitude. The climate of the place touches both extreme cold (approximately 2°C in winter) and hot (approximately 45°C in summer). The relative humidity ranges between 15 and 85 per cent. Average annual rainfall ranges between 90 to 120 cm, most of which is received during July to September.

Experimental animals

The present investigation was conducted on 24 pregnant crossbred (*Bos tauras*×*Bos indicus*) cows in their 2nd to 4th parity. The animals were inducted into the experiment exactly two months before expected dates of calving. The distribution of the cows were balanced for initial body weight, parity and anticipated calving date and were randomly allocated to three treatment groups in a completely randomized block design resulting in eight cows per treatment group. The cows were introduced in the experiment as and when available i.e. on a staggered basis according to the days of pregnancy obtained from the breeding record of animals. On the basis of the available records of gestation period of cow, the experimental animals were inducted into the study 3 to 4 days earlier to the actual date of experiment so that they could adjust to the new environment.

Housing and management

The cows were housed in a naturally ventilated cement floored tie stall with facility for individual feeding and watering from dry off (60 d prior to expected calving) till parturition. One week before the expected date of calving, the animals were shifted to the calving box for parturition where facilities for individual feeding and watering were available. After parturition the calves were separated from the dams and reared individually in calf pen adopting uniform management procedures.

Experimental design and treatments

The first dietary treatment included feeding as per the existing standard adopted in the farm i.e. 3.0 kg concentrate supplement at a flat rate through out the last 60 d gestation along with a*d libitum* green forage (T_1) taken as control. Considering the fact that the existing standard not commensurating the changing requirement over the length of gestation, the second group of animals were fed at 3.0 kg concentrate per head per day from 60 to 22 day prepartum and thereafter the daily concentrate allowance was increased at 0.25 kg/d during the next 21 d till it reached 1% of live weight (T_2). The third group of animals (T_3), on the other hand, were fed initially i.e. 60 to 22 d prepartum at a reduced rate i.e. 2.0 kg concentrate considering the fact that the requirement may be lower initially. However, during the last 21 d the cows were fed additional concentrate supplement as in case of T_2 i.e. an increase of 0.25 kg/head/day till it reached 1% of live weight. All the groups had access to *ad libitum* green fodder in the form of either maize, cowpea or sorghum at different periods of the study duration depending on seasonal availability. The chemical composition of the concentrate supplement along with the fodders is given in Table 1.

Measurements

There was daily recording of feed (DM) intake. Cows were offered weighed quantities of concentrate after recording of residues, if any, at 8:00 h followed by green forages at 11:00 h. The body weight of individual cows was recorded at the onset of experiment and thereafter at weekly intervals up to parturition to estimate the body weight

Table 2. Mean daily feed intake (kg DM basis), live weight changes and body condition score of experimental cows during the pre-partum period

Attributes	Treatments			SEM	Significance
	T_1	T_2	T_3		
Feed (DM) intake					
Concentrate (kg/d)	2.75^B	3.13^C	2.26^A	0.07	p<0.001
Fodder (kg/d)	5.43	4.96	5.82	0.15	NS
Total (kg/d)	8.18	8.09	8.08	0.14	NS
Feed intake (% DM on live weight)	1.80	1.82	1.79	0.03	NS
Live weight changes (kg)					
Initial (60 d prepartum)	426.88	425.63	431.25	7.87	NS
Final (before parturition)	465.00	466.87	467.50	8.01	NS
Net gain at parturition	38.12	41.25	36.25	2.26	NS
Live weight post-calving	407.50	408.13	410.00	7.59	NS
Net loss on calving	53.75	58.75	57.50	2.78	NS
Body condition score[1]					
Initial (60 d prepartum)	2.63	2.68	2.75	0.11	NS
Final (before parturition)	3.75	3.81	3.75	0.11	NS
Net change at parturition	1.12	1.13	1.00	0.06	NS

[1] 1-5 point scale.
Means bearing different superscripts in a row differ significantly.

changes. The body weight loss at parturition was estimated by prepartum body weight and weight after calving (after dropping of the placenta). The body condition of individual cows was estimated by using visual body condition scoring (BCS) developed by Edmonson et al. (1989) adopting a 1 to 5 point scale using 0.5 unit increments.

The newborn calves of the experimental cows were weighed at birth before colostrum feeding and then at fortnightly intervals up to 60 days of age. The calves were fed colostrum at 1/10th of their body weight daily up to 3 days followed by whole pooled milk up to the age of weaning according to the standard schedule of the farm. Besides all the calves had access to calf starter along with green fodders *ad libitum*.

Blood collection and analysis

The blood samples were collected from all calves on 5 d of age through jugular venipuncture into anticoagulated tubes for estimation of haemoglobin and packed-cell volume. Another portion of the blood was collected without anticoagulant and was used for separation of serum. The separated serum was stored at -20°C till its analysis for glucose (Hultman, 1959), total protein (Hiller and Van, 1927), albumin (Gustafsson, 1976), globulin (by difference), urea (Rahmatullah and Boyde, 1980), cholesterol (Zlatkis et al., 1953), calcium (Banginski, 1973) and inorganic phosphorus (Fiske and SubbaRow, 1925) adopting standard procedures. The total immunoglobulin content of serum as well as colostrum was determined by the zinc sulphate turbidity test (McEwan et al., 1970).

Statistical analysis

The data generated were analyzed by analysis of variance (ANOVA). The differences between the means were ascertained by Duncan's Multiple Range Test. All the statistical procedures were carried out as per Snedecor and Cochran (1989) using SPSS package (7.5).

RESULTS AND DISCUSSION

Cow performance

Feed intake : The mean daily intake (Table 2) of concentrate DM varied significantly (p<0.01) among the three groups, apparently as per the plan of the treatments. However, the dietary alterations had no influence on the intake of forage DM. The total DM intake (DMI), both as kg per day or as kg per 100 kg live weight, was also similar across the treatment groups. However, the comparable net DMI in T_3 cows at par with the other two groups in spite of significantly lower concentrate allocation, could be explained by the observed compensatory increase in forage intake (offered *ad libitum*). On an average, the cows in different groups consumed DM in the range of 1.7-1.9% of their live weight; the values fall in the general range observed in prepartum cows (Bertics et al., 1992; Van Saun et al., 1993).

Body weight changes : The dietary treatments had no influence on the live weight changes over the prepartum period (Table 2). Although, compared over the entire prepartum period, the T_2 group tended to have more body weight gains (41.25±3.50 kg) than the T_1 (38.12±4.43 kg) and T_3 (36.25±4.09 kg) groups, the dietary treatments apparently did not have much influence on foetal growth. The rates of growth observed in the present study were similar to the earlier observations in crossbred cows (Prasad and Tomer, 1995). Similar to the present observations, a

Table 3. Mean colostrum intake, immunoglobulin intake and growth performance of calves

Attributes	Treatments			SEM	Significance
	T_1	T_2	T_3		
Colostrum intake (kg/d)	2.40	2.46	2.32	0.07	NS
Ig content of colostrum (g/dl)	6.31	5.80	6.13	0.16	NS
Net Ig intake (g/d)	144.63	136.01	139.93	6.19	NS
Live weight changes (kg)					
Birth weight (0 d)	24.00	24.63	23.25	0.75	NS
Final weight (60 d)	33.25	33.93	33.43	1.77	NS
Net change	9.25	9.30	10.18	0.70	NS
Avg. daily gain (g)	154.17	155.00	169.70	7.12	NS

non-significant difference in prepartum live weight gain among the groups of cows supplemented with different levels of concentrate was also found by Kale (1984). On the other hand, another study on the effects of prepartum plane of nutrition in crossbred cows suggested that while feeding at the rate of 80 per cent of the NRC (1989) standards during advanced pregnancy was adequate only to maintain body weight of animals, recommendation above the NRC was conducive to bring about significant body weight gain in crossbred cows (Prasad and Tomer, 1995). The said study revealed that the animals subjected to the higher plane of nutrition (130% energy) prepartum gained maximum body weight (44.13 kg) compared to those in medium (100% energy) or low (80% energy) treatments.

Body condition score : The overall BCS changes during the prepartum period were 1.12±0.08, 1.13±0.08 and 1.00 ±0.13 units for T_1, T_2 and T_3 groups, respectively, which did not vary due to dietary alterations (Table 2). The non-significant gain in BCS was indicative of the fact that the dams maintained their body reserves across the three dietary treatments. Findings on similar lines were also reported by Boisclair et al. (1986), who have observed that the cows consuming 102, 131 and 162% of the energy requirement during the dry period of 56 days exhibited similar BCS prior to the parturition. In the present study the higher, although non-significant, net change in BCS for T_1 and T_2 than T_3 groups could be correlated to the higher amount concentrate feeding over the entire prepartum feeding period of 60 days (Table 2) in the said groups.

Calf performance

Birth weight and growth : Effect of prepartum feeding of cows on birth weight and growth rate of calves up to two months of age are given in Table 3. The mean birth weight of calves was similar among the three groups exhibiting non-significant effect of prepartum feeding treatments. Likewise, Khan et al. (2002) also did not find any difference in birth weights of calves born to dams receiving restricted to *ad libitum* fed diets during the last semester of their pregnancy. Prepartum feeding of crossbred cows at levels ranging between 80 to 130 per cent of NRC energy recommendations failed to influence the birth weights of calves (Prasad and Tomer, 1995). Contrary to this, variable supplementation of concentrate during the last two months of pregnancy has been reported to impart significant differences in the birth weights of their calves (Kale, 1984).

There was no significant difference in growth rate of calves among the treatment groups up to two months of age. The present findings are in agreement with the observations of Khan et al. (2004) in crossbred cows. Likewise, Usmani and Inskeep (1989) also did not observe any difference in growth rate of buffalo calves born to dams fed at varied planes of nutrition during last 75 days of gestation in spite of differences in birth weight of the calves.

Immune status of calves : Calves are immuno-deficient at birth and the colostrum feeding provides passive protection to calves during early life and the level of circulating serum immunoglobulin (Ig) is the direct reflection of the immune status of the calves. The total Ig concentration of the colosrtum was similar among the three groups (Table 3). The amount of colostrum fed to the calves under different treatments did not vary significantly as it was based on their birth weights, which were nearly similar. Further, the concentration of Ig in colostrum is known to influence its apparent absorption efficiency (Scott and Fellah, 1983; Quigley et al., 1998), and hence the Ig concentration in the serum. Many factors influence the serum concentration of Ig in calves, including amount of Ig consumed and colostral quality, among other things; and both these parameters were without apparent variations among the three groups. It was possibly because of these reasons, that the total Ig content of the calf serum (Table 4) did not show any significant variation owing to dietary regimen adopted for the dams during the prepartum period.

The result of this experiment agrees with the earlier finding of Hough et al. (1990) and Lone et al. (2003). Nocek et al. (1984) reported that feeding high quality (total Ig≥6 g/dl) colostrum within first four days of life resulted in higher weight gain during this period and overall reduction of calf scour severity and duration compared with calves fed low quality (total Ig≤4.5 g/dl) colostrum. However, considering the fact that the mean total Ig concentration in the present study was in the range of 5.80-6.31 g/dl, the colostrum of none of the three groups could be classified to

Table 4. Haemato-biochemical profile and serum total immunoglobin of calves at 5th day of age

Attributes	Treatments			SEM	Significance
	T_1	T_2	T_3		
Haemoglobin (g/dl)	10.68	12.37	11.18	0.33	NS
PCV (%)	30.96	35.70	32.10	0.94	NS
Glucose (mg/dl)	85.98	81.83	85.80	3.45	NS
Urea (mg/dl)	31.66	31.84	28.51	1.25	NS
Cholesterol (mg/dl)	103.54	101.74	100.75	1.21	NS
Total protein (g/dl)	5.36	4.65	5.03	0.12	NS
Albumin (g/dl)	3.16	3.04	3.05	0.05	NS
Globulin (g/dl)	2.19	1.61	1.98	0.09	NS
A:G ratio	1.48	1.89	1.57	0.06	NS
Calcium (mg/dl)	8.73	9.79	9.57	0.35	NS
Phosphorus (mg/dl)	6.37	6.15	6.21	0.13	NS
Total Ig (g/dl)	2.10	2.05	2.10	0.05	NS

be of low quality, rather at par with the levels reported for Holstein cows (Santos et al., 2001). Lone et al. (2003) observed that with a total Ig content of buffalo colostrum of 4.82±2.60 g/dl, the total Ig content of calf serum varied between 1.90±0.37 to 1.80±0.32 g/dl during the first seven days after birth. However the higher range observed in the present study in the calf serum (Table 4) could be explained on the basis of higher range of Ig in the colostrum itself.

Metabolic profile : The mean concentration of various haemato-biochemical variables of calves at 5th day of their age are presented in Table 4. The mean concentration of all the metabolites were within the normal physiological range as reported by Jain (1986) and Radostits et al. (1994) besides Pattanaik et al (1999). Further, none of the variables differed significantly (p>0.05) ascribable to the dietary treatments. Subsequent to the maternal protection during the foetal life, the neonates are protected and nourished by the colostrum and milk from mother in the early post-natal life. Hence, assessing the blood metabolites in the early neonatal life would signify whether the nutrient supply through colostrum, milk and above all through placenta was adequate or not.

The variation of any metabolites beyond the normal physiological range indicates that the newborn calves are undergoing many adaptive changes in relation to either maintenance of homeostasis or nutrient intake (Kunz and Willett, 1991), which apparently was not the case in the present study. When the performance of the calves was compared, neither the birth weight nor the growth rate up to 2 months of their age exhibited any significant effect of variable feeding of concentrate during prepartum period. Intake of colostrum brings about considerable adaptive changes during the early postnatal calves, mediated primarily through various metabolic, gastro-intestinal and endocrinal effects. The plasma concentrations of various blood metabolites in such a situation is greatly influenced by the quality and quantity of colostrum made available to the neonate (Blum and Hammon, 2000). In this backdrop, the absence of any difference in the metabolic profile of the calves under different groups could be attributable to the lack of variation in the quality and quantity of colostrum consumption.

CONCLUSION

Based on the findings it could be concluded that the scale of manipulation of prepartum nutrition of crossbred cows employed in the present study did not impart any significant influence on the cow performance as well as the birth weight, immunity and growth of their calves. In such a scenario, the T_3 treatment offers an economic alternative considering it used the least quantity of concentrate supplement to attain a performance at par with the other two groups. However, further research is needed to optimize the prepartum nutrition as applicable to crossbred dairy cows in the tropics.

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