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Effect of Pre-partum Rumen Protected Choline and Energy Supplementation on the Post-partum Milk Production and Metabolic Profile of Cross Bred Dairy Cows

Devendra Kumar Gupta[1], R.S. Grewal[1*], C.S. Ahuja[2], J.S. Lamba[1], Simarjeet Kaur[2] and S. Saijpaul[1]

[1]*Department of Animal Nutrition, GADVASU, Ludhiana-141004, Punjab, India*
[2]*Department of Veterinary Physiology and Biochemistry, GADVASU, Ludhiana-141004, Punjab, India*
[3]*Directorate of Livestock Farms, GADVASU, Ludhiana-141004, Punjab, India*

**Corresponding author*

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A B S T R A C T

Transition period is a critical period of dairy cow in terms of physiological stress. Rapid body fat mobilization, fatty infiltration of liver and impaired performance are characteristics of late pregnancy and early lactation. Choline acts as a lipotropic factor. The present study was planned to study the effect of high energy levels with or without rumen protected choline before calving on milk production and metabolic profile of crossbred cows. The 24 high milk yielding crossbred cows were selected based upon their parity, lactation milk yield. These cows were divided into four groups keeping 6 cows in each group. Group 1 and group 2 were fed with ration containing high NE_L (8.12 MJ/kg) and Group 3 and Group 4 were fed with ration containing low NE_L (6.81 MJ/kg). Group 2 and Group 4 were supplemented with Rumen Protected Choline (RPC) at a concentration of 750mg per 100g (75 ppm) of concentrate in their ration. The feeding of the 4 groups was started 21 days before expected date of parturition of the cows and continued upto 10 days after calving. After 10 days of calving all the cows were given same lactation diet. RPC supplementation before calving increased the blood glucose and lowered plasma Triglycerides conc. thereby improving the metabolic health status during transition period. Feeding of RPC during transition period starting from -21 d to +10 d improved the average milk yield, peak milk yield and metabolic health status of the high yielding dairy cows in both low and high energy rations.

Introduction

There is significant lipid mobilization from adipose tissue to compensate negative energy balance during transition period which results in higher blood nonesterified fatty acid (NEFA) concentrations (Grummer, 1993). Blood flow to the liver doubles as a cow transitions from the dry period to lactation (Reynolds *et al.,* 2003). NEFA concentration and blood flow are the two biggest factors affecting how much NEFA is taken up by the liver. As a result, daily fatty acid uptake by the liver increases 13 fold at calving, from approximately 100 to 1300 g/day (Reynolds *et al.,* 2003). This high uptake of fatty acids by liver causes impairment of hepatocytes functions which ultimately causes adverse effects upon overall performance of the animals. Feedstuffs for dairy cattle contain free choline and phosphatidylcholine but as the content of these compounds in plants are relatively small and their ruminal degradation is extensive (Sharma and Erdman, 1989) so their intestinal supply is not enough to meet tissue requirements. The present study was planned to study the effect of high energy levels with or without rumen protected choline before calving on the milk production and metabolic profile of crossbred cows.

Materials and Methods

The 24 high milk yielding crossbred cows were selected based upon their parity, lactation milk yield and body condition score. These cows were divided into four groups keeping 6 cows in each group. Animals kept in Group 1 and group 2 were fed with ration containing high NE_L (8.12 MJ/kg) and animals kept in Group 3 and Group 4 were fed with ration containing low NE_L (6.81 MJ/kg). Group 2 and Group 4 were supplemented with Rumen Protected Choline (RPC) at a concentration of 75 ppm in concentrate. The average intake of RPC was 30g per day. The animals were allotted to treatments at 21 days before expected date of parturition of the cows and continued upto 10 days after calving. After 10 days of calving all the cows were given same lactation diet.

Blood sampling was done at 21 and 7 days before calving, at the day of calving and 7, 21 and 90 days after calving. Daily milk yield was noted and milk samples were analyzed fortnightly for Fat%, SNF%, Lactose% and Protein%. After 10 days of calving all animals were fed with same lactation ration having 16.5% CP in TMR.

Blood samples were analyzed using Siemens India Autopack kits on Chemistry analyser RA-50 and Milk samples were analyzed using Milko-Scan.

Statistical analysis: Statistical analysis of all the data found in *in vivo* study was done by using SPSS software and applying statistical design including One way ANOVA, Tuckeys b test and Students t test.

Results and Discussion

Milk production and composition

There was significant ($P<0.05$) difference in Average milk yield and fat% (Table 1). Milk yield was higher in both treatment groups than control groups and highest Average Milk Yield was found for treatment group fed on low dietary energy concentration. Milk yield was found increased in some previous studies as well (Erdman and Sharma, 1991; Piepenbrink and Overton, 2003; Baldi and Pinotti, 2006; Zahra *et al.,* 2006; Lima *et al.,* 2007).

Fat% was significantly lower in treatment group fed on low energy diet than its control group but no significant difference ($P>0.05$) was there between control and treatment groups fed on high energy ration. This may be due to the fact RPC can reduce non-esterified fatty acid concentration in plasma which contribute majority of fatty acids secreted by the mammary glands in dairy cows (Pinotti *et al.,* 2002; Cooke *et al.,* 2008). Change in Fat% can also be understood by the fact that it is negatively correlated with milk yield.

Peak milk yield was higher for RPC supplemented groups than control groups (Piepenbrink and Overton, 2003; Baldi and Pinotti, 2006; Zahra *et al.,* 2006; Lima *et al.,* 2007) and it was highest in group fed on low energy concentration ration supplemented with RPC. Control group for low energy concentration ration took maximum time to reach peak milk yield. After reaching peak milk yield starts decreasing at around 4th fortnight in all the groups except RPC supplemented group fed on high energy concentration ration where it remains almost constant upto 5th fortnight and then starts decreasing. Highly significant interaction (P<.001) for milk yield was found between number of fortnight and different groups. Trend of milk yield upto 6th fortnight was similar for all the groups and milk yield was first increased, then reached to peak milk yield and then decreased for all the four groups as suggested by De vries and Veerkamp (2000).

Metabolic profile

Blood samples obtained during pre-calving period from in vivo experiment done on crossbred cows with different dietary energy levels (1.26Mcal/kg and 1.50Mcal/kg) and with or without supplemented Rumen Protected Choline at 750mg/100g (75ppm) concentration shows significant changes (P<0.05) in plasma concentration of GGT and Triglyceride while no significant differences (P>0.05) was there in rest of the parameters (Table 2). Significant increase was there in the concentration of GGT in treatment group than control group for low energy diet but this value of GGT was in the normal range. Triglyceride (TG) level of plasma was significantly less (P<0.05) in the treatment group than control for high energy diet which indicates more efficient utilization of fat by liver and less probability for fatty liver syndrome (Piepenbrink and Overton, 2003).

For groups fed on low energy ration there was no significant difference in plasma concentration of TG between control and treatment groups though non-significant decrease was there. However concentration of TG was higher than its normal range for all the groups. Plasma concentration of Glucose was also higher than its normal range for all the groups and it was much higher in the treatment group for high energy diet than control group which may be due to increased rate of gluconeogenesis in the liver as suggested by Cadoniga-Valino *et al.,* (1997).

During post calving period also there was significant increase (P<0.05) in the plasma concentration of GGT in treatment group than control for low energy diet but this increase was also within the normal range of GGT however no significant difference (P>0.05) was there between ALT and AST concentration between control and treatment group and their values were still in the normal range. For high energy ration during post calving period there was significant increase in the plasma concentration of Glucose and significant decrease in the plasma concentration of Triglyceride in treatment group than control (P<0.05).

These results show that RPC supplementation at 75 ppm concentration with high energy ration improves metabolic efficiency of the liver to utilize energy more efficiently in the body of animal (Piepenbrink and Overton, 2003). However as found in pre calving stage, here also TG concentration was higher than the normal range for all the groups and glucose concentration was also higher than normal in all the groups except control group for high energy diet.

Blood samples obtained during pre-calving period show significant difference (P<0.05) in plasma concentration of GGT and Triglyceride while no significant differences (P>0.05) was there in rest of the parameters. Significant increase was there in the concentration of GGT in treatment group than control group for low energy diet but this value of GGT was in the normal range.

Table.1 Various milk parameters for different groups

Parameters	HEC	HECh	LEC	LECh	SEM
Milk Yield (kg/d)	17.66 [a]	18.75 [b]	17.04 [a]	19.09 [b]	0.12
Fat %	3.98 [a]	3.80 [a]	4.51 [b]	3.74 [a]	0.06
Fat Yield (kg/d)	0.70 [a]	0.71 [a]	0.77 [b]	0.71 [a]	0.02
SNF %	8.17	8.16	8.26	8.25	0.03
Protein %	3.32 [ab]	3.53 [a]	3.15 [a]	3.16 [a]	0.04

Different superscripts in a row vary significantly ($p<0.05$)

Table.2 Blood metabolic profile of dairy cows before calving

Parameter	Group 1	Group 2	Group 3	Group 4	± SE
ALT	23.20	24.86	24.00	19.80	1.41
AST	82.30	99.71	111.00	89.60	6.17
GGT	15.82 [ab]	15.07 [ab]	10.50 [a]	17.77 [b]	0.91
Glucose	78.1	104.07	96.88	92.00	6.45
Triglyseride	47.77 [b]	38.58 [a]	42.46 [a]	38.63 [a]	0.92
Cholesterol	91.12	64.21	68.25	79.60	4.08
Creatinine	1.29	1.56	1.52	1.38	0.039

Different superscripts in a row vary significantly ($p<0.05$)

Table.3 Blood metabolic profile of dairy cows after calving

Parameter	Group 1	Group 2	Group 3	Group 4	± SE
ALT	23.10	31.21	25.81	28.35	1.63
AST	103.10	136.96	132.19	111.80	5.30
GGT	18.87 [b]	18.00 [b]	11.62 [a]	18.33 [b]	0.72
Glucose	57.00 [a]	105.64 [b]	80.56 [ab]	79.65 [ab]	4.08
Triglyseride	43.52 [b]	37.04 [a]	37.07 [a]	35.07 [a]	0.76
Cholesterol	74.12 [c]	65.00 [bc]	49.18 [a]	57.90 [ab]	2.20
Creatinine	1.26	1.32	1.28	1.27	0.011

*Different superscripts in a row vary significantly ($p<0.05$)

Table.4 Blood parameters prepartum and postpartum

Parameter	Pre partum	Post partum
ALT	22.965 ± 1.108	27.118 ± 1.735
AST	95.653 ± 6.238	120.988 ± 8.106
GGT	14.115 ± 1.24	16.705 ± 1.704
Glucose	92.763 ± 5.48	80.713 ± 9.937
Triglyceride	41.86 ± 2.169	38.175 ± 1.842
Cholesterol	75.795 ± 6.06	61.55 ± 5.29
Creatinine	1.438 ± 0.063	1.283 ± 0.013

Triglyceride (TG) level of plasma was significantly less ($P<0.05$) in the treatment group than control for high energy diet which indicates more efficient utilization of fat by liver and less probability for fatty liver syndrome (Piepenbrink and Overton, 2003). For groups fed on low energy ration there was no significant difference in plasma concentration of TG between control and treatment groups though non-significant decrease was there. However concentration of TG was higher than its normal range for all the groups. Plasma concentration of Glucose was also higher than its normal range for all the groups and it was much higher in the treatment group for high energy diet than control group which may be due to increased rate of gluconeogenesis in the liver as suggested by Cadoniga-Valino *et al.,* (1997).

During post calving period also there was significant increase ($P<0.05$) in the plasma concentration of GGT in treatment group than control for low energy diet but this increase was also within the normal range of GGT however no significant difference ($P>0.05$) was there between ALT and AST concentration between control and treatment group and their values were still in the normal range (Table 3).

For high energy ration during post calving period there was significant increase in the plasma concentration of Glucose and significant decrease in the plasma concentration of Triglyceride in treatment group than control ($P<0.05$). These results show that RPC supplementation at 75 ppm concentration with high energy ration improves metabolic efficiency of the liver to utilize energy more efficiently in the body of animal (Piepenbrink and Overton, 2003). However as found in pre calving stage, here also TG concentration was higher than the normal range for all the groups and glucose concentration was also higher than normal in all the groups except control group for high energy diet. Comparison between pre partum and post-partum plasma concentration of various parameters show no significant difference ($P>0.05$) for any of the above measured parameters (Table 4).

RPC supplementation before calving increased the blood glucose and lowered plasma Triglycerides conc. thereby improving the metabolic health status during transition period. For different groups irrespective of the number of days around calving, no significant difference was there in the values of BCS.

Feeding of RPC during transition period starting from -21 d to +10 d improved the average milk yield, peak milk yield and metabolic health status of the high yielding dairy cows in both low and high energy rations.

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