Indian J. Anim. Nutr. 2021. 38 (4): 366-373
doi: 10.5958/2231-6744.2021.00053.0
Indian Journal of Animal Nutrition

Effect of Feeding Rumen Protected Choline and Rumen Protected Fat on Dry Matter Intake and Nutrient Digestibility in Periparturient Gir Cows

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ABSTRACT

The study was carried out on 24 advanced pregnant Gir cows to know the effects of supplementing Rumen Protected Choline (RPC) and Rumen Protected Fat (RPF) alone and in combination on dry matter intake (DMI) and digestibility of nutrients. The cows were divided equally into four treatment groups (T1 to T4; n=6 each). Cows in T1 group were fed with basal diet to meet their nutrient requirement as per ICAR (2013) feeding standard. In T2 group, cows received supplementation of RPC @ 45 g/day, in T3 RPF @ 80 g/d and in T4 with RPC @ 45 g/day + RPF @ 80 g/d along with basal diet of T1, starting from 30 days before expected date of calving to 60 days postpartum. DMI (kg/d) increased significantly ($p<0.01$) in T2 group compared to control. However, no significant differences among the treatment groups were observed in terms of DMI kg/per 100 kg BW or DMI g/kg BW0.75.Digestibility of ether extract was observed significantly ($p<0.001$) higher in T2, T3 and T4 group as compared to control, while that of CP, CF and NFE were not affected in any treatment groups, whereas digestibility of DM and OM significantly increased ($p<0.05$) in T2 group as compared to control. It was concluded that supplementation of RPC significantly improved the DMI and digestibility of DM, OM and EE. Digestibility of EE was also improved by RPF supplementation. However, supplementation of RPF alone or in combination did not have any significant ($p>0.05$) effect on DMI and digestibility of DM, OM, CP, CF and NFE.

Key words: Dry matter, Digestibility, Gir cows, Rumen protected choline, Rumen protected fat

INTRODUCTION

Dairy cows face metabolic challenges during the transition period and also in early lactation. The term “transition period” refers to the period from approximately 3 weeks before calving to 3 weeks after calving during which cows prepare themselves first for parturition and then for lactation along with profound change in their metabolic and endocrine status (Grummer, 1995; Drackley, 1999). The dietary energy intake during this period is not sufficient to meet the demand for maintenance and milk production due hormonal changes and reduction in appetite around calving period (Shahsavari *et al.,* 2016). So during this period, dairy cows show a marked decrease in dry matter intake (DMI) and that is related to physical, behavioural, metabolic and hormonal changes around parturition (Grummer, 2008). Hayirli et al. (2002) also reported that the decline in DMI during the last 3 weeks of pregnancy can reach 32%, with 89% of the decline occurring during the final week. At this time, sudden increase in energy demand, by both foetus and lactogenesis put the animal in negative energy balance (NEB) state (Esposito *et al.,* 2014). Dairy cows try to adapt with NEB by mobilizing adipose tissue reserve through lipolysis resulting in production of non-esterified fatty acids (NEFA) which are drained towards liver (Cooke *et al.,* 2007; Drackley *et al.,* 2014). As a result, TAG accumulates in liver and cow is likely to experience

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fatty liver (FL) syndrome (Bobe *et al.,* 2004). The failure of the liver to use the excessive amounts of NEFA as fuel leads to a ketotic state that is associated with increased production of ketone bodies, primarily ß-hydroxybutyrate (ß-HB) and acetoacetate and to a lesser extent acetone (Goff, 2006). About 50–60% of transition dairy cows experience moderate to severe FL and ketosis, and this remains a major challenge for production, health and welfare of dairy cows (Duffield, 2000).

Choline [(CH3)3N+CH2CH2OH], also called as trimethyl ethanolamine, is a multi-functional B-complex vitamin (Jayaprakash *et al.,* 2016) required for the synthesis of the neurotransmitter, acetyl choline which is involved in the metabolism of FA in the liver and serves as a methyl donor (Shahsavari *et al.,* 2016). Choline plays an important role in very low density lipoprotein synthesis and thereby contributes to fat export from the liver (Acharya *et al.,* 2019b). Choline can indirectly affect DMI in transition cows by restricting the detrimental effects of fatty liver syndrome (FLS) and ketosis on general health (Esposito *et al.,* 2014). As dietary choline gets degraded rapidly in the rumen, it must be supplemented in the protected form (Atkins *et al.,* 1988; Elek *et al.,* 2008). Supplementing RPF to high producing lactating cows can enhance energy density of ration and energy intake in early lactation without compromising rumen cellulolytic bacterial activity (Jenkins and Palmquist, 1984; Thakur and Shelke, 2010) and reduces the deleterious effect of NEB during early lactation (Drackley, 1999; Ganjkhanlou *et al.,* 2009).

Hence, the present study was carried out to record the effects of supplementing rumen protected choline and rumen protected fat alone and in combination on dry matter intake and digestibility of nutrients in periparturient Gir cows.

MATERIALS AND METHODS

The study was carried out during the period from August, 2020 to May, 2021 at the Department of Animal Nutrition, College of Veterinary Science & Animal Husbandry, Kamdhenu University, Junagadh in collaboration with Cattle Breeding Farm, Junagadh Agricultural University, Junagadh (India), following ethical approval by the Institutional Animal Ethics Committee, vide No. JAU/JVC/ IAEC/LA/64/2020. Twenty four advanced pregnant Gir cows in their first to third lactation were randomly selected and divided into four equal treatment groups, T1 (control), T2 (RPC), T3 (RPF) and T4 (RPC and RPF) comprising 6 animals in each on the basis of their parity, body weight and previous lactation yield. In T1 group, cows were fed with basal diet of 250 g maize bhardo, 10 kg green sorghum, mature pasture grass hay ad lib. along with compound cattle feed and cotton seed cake to meet their nutrient requirement as per ICAR (2013) feeding standards. In T2, each cow was supplemented with RPC @ 45 g/d, in T3 with RPF @ 80 g/d and in T4 with RPC @ 45 g/day + RPF @ 80 g/d along with basal diet starting from 30 days before expected date of calving to 60 days postpartum. All the cows were maintained in well ventilated hygienic sheds and ad lib. wholesome drinking water was made available 24 hrs. to them. RPC and RPF were purchased from Kemin Industries South Asia Pvt. Ltd. Daily dry matter intake was calculated by recording the daily feed offered and feed left over during the experimental period. The dry matter of different feed ingredients was recorded fortnightly. A digestibility trial of seven days duration was conducted by total collection method during the experiment to see the effect of RPC and RPF supplementation on nutrient digestibility. All the samples of feed offered. Left over and faeces voided were analyzed for proximate composition as per methods of AOAC (2005).

The data on dry matter intake were analyzed by two way analysis of variance (ANOVA) for treatment and period effects and on nutrient digestibility by one way ANOVA for treatment effect (Snedecor and Cochran, 1994). Pair-wise mean differences between groups were compared by Tukey's post-hoc test for significance at $p<0.05$.

RESULTS AND DISCUSSION

Proximate composition of feeds and fodders offered to experimental cows was recorded (Table 1) and found to be within normal range (Ranjhan, 2001; Garg *et al.,* 2012; NDDB, 2012).

Table 1. Proximate composition of feed ingredients (% DM basis)

Nutrients	Compound cattle feed	Cotton seed cake	Maize bhardo	Sorghum green	Dry mature pasture grass
DM	90.3	92.5	91.0	24.3	92.1
OM	87.6	94.2	97.4	92.1	91.3
CP	20.4	20.7	10.8	5.58	3.10
EE	3.65	8.43	3.41	2.90	1.16
CF	10.6	33.2	2.97	32.0	39.8
NFE	52.8	31.7	80.2	51.6	47.3
Total Ash	12.4	5.79	2.57	7.87	8.61

Data on fortnightly average DMI (kg/d), DMI kg/100 kg BW and DMI g/kg BW0.75recorded in different groups of experimental Gir cows are presented in Table 2 and depicted in Figure 1. The overall mean DMI for T1, T2, T3 and T4 groups were recorded as 8.13 ± 0.25, 9.28 ± 0.29, 8.88 ± 0.47 and 8.77 ± 0.72 kg/d; 2.26 ± 0.14, 2.28 ± 0.11, 2.08 ± 0.08 and 2.31 ± 0.16 kg/100 kg BW and 98.13± 5.04, 102.43± 4.44, 94.35± 3.36 and 101.75± 6.78 g/kg BW0.75, respectively. DMI (kg/d) was significantly ($p<0.01$) higher when cows were supplemented with RPC, while supplementation of RPF alone or in combination with RPC showed non-significant ($p>0.05$) numerically higher values for DMI as compared to control group. The significant effect of the treatment on DMI was observed from 45th day onwards. The DMI was observed significantly ($p<0.05$) lower on the day of parturition in all groups, which significantly ($p<0.05$) increased during 1st fortnight in T2, 2nd fortnight in T3 and 4th fortnight in T1 and T4 groups.No significant differences among the treatment groups were observed in terms of DMI kg/per 100 kg BW or DMI g/kg BW0.75. Further, although the values of DMI kg/per 100 kg BW and g/kg BW0.75 were lowest on the day of calving followed by prepartum phase as compared to postpartum periods, the differences between periods were non-significant ($p>0.05$) in all the groups.

Hayirli *et al.* (2002) reported 32% decline in DMI during the last 3 weeks of pregnancy, with 89% of the decline occurring during the final week. Increased DMI in RPC supplemented cows suggests early recovery of RPC supplemented animals from various hormonal and physiological mechanisms that decrease DMI during transition period (Grummer, 1995). Choline had also been reported to affect DMI indirectly in transition cows by restricting the detrimental effects of fatty liver syndrome and ketosis on general health (Esposito *et al.,* 2014). Zom *et al.* (2011) reported significantly increased dry matter intake from 14.4 to 16.0 kg/d in HF cows supplemented with RPC @ 60 g/d (15 g of choline chloride) from week 3 before calving to week 6 after calving. Similarly, Soltan *et al.* (2012) reported 8.4 % increase in the DMI due to RPC supplementation @ 30 g/d in the first 12 weeks of lactation in Holstein cows. Increased in the DMI in RPC supplemented cows was also reported by several other workers earlier (Ardalan *et al.,* 2011; Gupta *et al.,* 2019). A meta-analysis of thirteen studies by Grummer (2012) showed that feeding RPC does not affect feed intake before calving, but increases DMI by 0.8 kg/d in early lactation. However, Acharya *et al.* (2019a) and Anonymous (2020) reported no significant effect of supplementation of RPC on DMI in periparturient dairy cows. Similar non-significant findings were also reported by several other workers (Elek *et al.,* 2008; Rahmani *et al.,* 2014; Pineda and Cardoso, 2015) for dietary supplementation of RPC on DMI in early lactating dairy cows.

Table 2: Effect of feeding RPC and RPF on fortnightly average DMI in periparturient Gir cows (Mean ± SE)

Peripartum Days	Dietary treatment groups			
(kg/d)	T1	T2	T3	T4
-30	7.85AB± 0.35	8.16ABC± 0.16	8.17AB± 0.40	7.94AB± 0.50
-15	7.35AB ± 0.11	7.65AB ± 0.12	7.82AB± 0.55	7.85AB 0.61
0	6.56A ± 0.07	6.72A ± 0.50	6.65A ± 0.30	7.15A ± 0.62
15	8.41AB ± 0.71	9.67BCD ± 0.40	9.19AB ± 0.59	9.54AB± 1.33
30	8.89AB± 0.63	11.0D ± 0.53	10.0B ± 1.01	9.35AB± 0.90
45*	8.57aAB± 0.42	11.2bD± 0.71	10.1abB± 0.70	9.56abAB± 0.82
60	9.29 B ± 0.59	10.3CD ± 0.55	10.1B ± 0.67	9.97B ± 0.94
Overall**	8.13a ± 0.25	9.28b ± 0.29	8.88ab ± 0.47	8.77ab ± 0.72
(kg/100 kg BW)				
-30	1.93± 0.10	1.87± 0.08	1.79± 0.03	1.90± 0.07
-15	1.79± 0.10	1.71± 0.09	1.66± 0.06	1.85± 0.16
0	1.77± 0.11	1.62± 0.15	1.53± 0.09	1.86± 0.20
15	2.38± 0.27	2.35± 0.12	2.18± 0.14	2.50± 0.25
30	2.64± 0.31	2.79± 0.17	2.41± 0.20	2.61± 0.28
45	2.55± 0.17	2.91± 0.24	2.50± 0.22	2.64± 0.18
60	2.74± 0.11	2.73± 0.14	2.47± 0.04	2.79± 0.17
Overall	2.26 ± 0.14	2.28 ± 0.11	2.08 ± 0.08	2.31 ± 0.16
(g/kg BW0.75)				
-30	86.5± 3.33	85.3± 2.67	82.7± 1.91	85.8± 3.19
-15	80.5± 3.32	78.5± 3.40	77.1± 3.29	84.0± 6.65
0	77.6± 3.63	73.0± 6.36	69.7± 3.78	82.3± 7.94
15	102.9± 10.80	105.7± 4.94	98.7± 5.73	110.3± 11.89
30	112.8± 11.65	124.4±7.08	108.6± 9.21	113.4± 11.68
45	108.9± 6.37	129.0± 9.94	112.3± 8.87	115.1± 7.85
60	117.4± 4.99	120.6± 5.93	111.1± 2.87	121.1± 7.84
Overall	98.1± 5.04	102.4± 4.44	94.3± 3.36	101.7± 6.78

T1 Control; T2 RPC; T3 RPF, T4 RPC + RPF. *p<0.05, **p<0.01
Means bearing different small superscripts (a, b) within the row and capital superscripts (A, B, C, D) within the column differed significantly (p<0.05)

Non-significant changes in DMI in cows supplemented RPF alone or in combination of RPC were well supported by study conducted by Garg *et al.* (2012) where they did not find any significant effect on daily DMI in lactating crossbred cows receiving 100 g of RPF alone and along with 10 g of RPC per day as compared to control. Likewise, Shankhpal *et al.* (2016); Kumari *et al.* (2018) and Anonymous (2020) also reported no significant effect of supplementing dairy cows with bypass fat during peripartum period on their DMI. Similarly, Sirohi *et al.* (2010) and Singh *et al.* (2014) observed non-significantly higher DMI in lactating crossbred cows receiving RPF @ 300 g/d and 75 g/d, respectively as compared to control. Thus findings of present study were in agreement with above reports and also earlier findings of various researchers in cows during early and mid-lactation (Strusinka *et al.,* 2006; Theurer *et al.,* 2009; Silvestre *et al.,* 2011).

The mean values of digestibility (%) for dry matter, organic matter, crude protein, crude fiber, ether extract and nitrogen free extract in different groups of experimental Gir cows were recorded (Table 3).The digestibility of DM and OM were significantly ($p<0.05$) higher in T2 group as compared to T1, while value of T3 and T4 groups were at par with T1 and T2 groups. The digestibility of EE was significantly ($p<0.001$) higher in all the treatment groups as compared to control, while differences among T2, T3 T4 were non-significant. No significant effect of any treatment was observed on digestibility of CP, CF and NFE.

Table 3. Effect of feeding RPC and RPF on nutrient digestibility (%) in periparturient Gir cows (Mean ± SE)

Particulars	Dietary treatment groups			
	T1	T2	T3	T4
DM*	57.5± 0.48[a]	59.4± 0.30[b]	58.3± 0.27[ab]	58.2± 0.15[ab]
OM*	59.8± 0.44[a]	61.8±0.23[b]	60.8± 0.32[ab]	61.4± 0.49[ab]
CP	56.3± 1.41	57.0±0.46	56.5± 0.60	56.3± 0.75
CF	56.8± 1.06	56.7±0.61	56.1± 0.42	56.8± 0.42
EE***	68.7± 1.71[a]	76.5±0.72[b]	77.1± 0.46[b]	76.1± 0.37[b]
NFE	55.8± 0.20	56.8±0.37	55.9± 0.06	56.1± 0.19

T1 Control; T2 RPC; T3 RPF, T4 RPC + RPF. *$p<0.05$, ***$p<0.001$
Means bearing different superscripts within the row differed significantly ($p<0.05$)

Mohsen *et al.* (2011) observed significantly ($p<0.05$) increased digestibility of DM, OM and EE in RPC supplemented group when compared with control. However, digestibility of CP, CF and NFE was also significantly ($p<0.05$) higher in their study, whereas in present study no significant effect of RPC on digestibility of CP, CF and NFE was observed. Significantly increased digestibility of OM, CP and non-significantly increased digestibility of DM and EE were also reported by Gupta *et al.* (2019) due to RPC supplementation. On the contrary, Sai *et al.* (2016) found non-significant effect of RPC on digestibility of DM, OM, CP, EE, NDF and ADF in growing crossbred calves.

In the present study digestibility of EE was significantly ($p<0.001$) higher in the cows receiving RPF as compared to control, while the digestibility of DM, OM, CP, CF and NFE were not affected by RPF supplementation. Sirohi *et al.* (2010) also reported significant ($p<0.05$) increase in digestibility of EE when lactating crossbred cows were supplemented with 300 g RPF/ day, while the digestibility of DM, OM, CP, CF, NDF and ADF was not affected. Similarly, Shankpal *et al.* (2016) did not observe any significant effect of bypass fat supplementation on digestibility of DM, OM, CF and NFE, however, the digestibility of CP ($p<0.05$) and EE ($p<0.01$) were significantly higher in bypass fat supplemented group, as compared to control. Digestibility of EE was also reported to increase significantly without affecting digestibility of other nutrients, when bypass fat was supplemented in the diet of the dairy animals (Naik, 2013; Rajesh *et al.,* 2014).

CONCLUSION

Dry matter intake (kg/d) increased ($p<0.01$) in cows supplemented with RPC alone as compared to control, while supplementation of RPF alone or its combination with RPC did not have any significant effect. However, DMI in terms of kg/ per 100 kg BW or DMI g/kg BW0.75 was not affected by any supplements either alone or in combination. Supplementation of both RPC and RPF alone or in combination improved ($p<0.001$) the digestibility of EE, but it did not have any significant effect on digestibility of CP, CF and NFE. While digestibility of DM and OM increased ($p<0.05$) with the supplementation of RPC alone.

ACKNOWLEDGEMENT

Authors thank the Principal & Dean, College of Veterinary Science & A.H., Kamdhenu University, Junagadh and the Research Scientist, Cattle Breeding Farm, Junagadh Agricultural University, Junagadh for the facilities and cooperation extended.

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