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Effect of Dietary Supplementation of Rumen Protected Calcium Salts of Rapeseed Oil and Encapsulated Rapeseed Oil to Lactating Dairy Cows

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ABSTRACT

This study was conducted to evaluate the effect of dietary supplementation of encapsulated and calcium salts of rapeseed oil (CaRSO) on performance of crossbred lactating cows. Eighteen lactating crossbred cows were randomly divided into three experimental groups *viz.* GI, GII and GIII of six animal each. The rumen protected rapeseed oil was prepared as CaRSO and encapsulated RSO. The control group (GI) animals received ration comprising of forages and concentrate mixture without any rapeseed oil. The animals of experimental group received same ration supplemented with either CaRSO (GII) or encapsulated RSO (GIII) at 20 g per kg of milk per day for a period of 90 days. Dietary supplementation of CaRSO and encapsulated RSO tended to increase ($P<0.05$) milk yield. It was observed that supplementation of encapsulated RSO increased ($P<0.01$) milk fat, 4 % fat corrected milk (FCM) and total solids compared to GII, however, responses were comparable to GI. Feed efficiency in terms of MY/DMI (kg/kg) was similar among GI and GII. The solid not fat (SNF) and protein content of milk was not altered by dietary supplementation of rumen protected rapeseed oil. In conclusion, rumen protected encapsulated rapeseed oil seems to have positive effect on milk production and milk fat content in lactating cows.

Keywords: Encapsulation, Feed efficiency, Milk yield, Milk composition, Rapeseed oil, Rumen protected fat

INTRODUCTION

High yielding dairy cows require increased amount of nutrients for increased milk production, however, there will be reduced dietary dry matter intake (DMI), especially during early lactation (Drackley, 1999). Very particularly, there will be increased energy demand during early lactation but energy supply will be less due to decreased DMI which may adversely affect milk production (Sirohi *et al.,* 2010). In early lactating stage, dairy cows meet energy demand from body reserves by mobilizing the body fat reserves which result in negative energy balance and ultimately decreases body weight and milk yield (Drackley, 1999). To overcome this negative energy balance, energy intake must be increased by enhancing the energy density of ration. Both cereal grains and fats are recommended as energy sources to increase the energy density of dairy cow ration. However, there are limitations in excess incorporation of cereal grains that otherwise compromise the rumen function, dietary fat supplement could be considered as an alternate energy source (Saijpaul *et al.,* 2010). However, dietary fat sources can be supplemented in excess of three per cent (on DM basis) in dairy rations. On the other hand, rumen protected fat can be included up to 6-7 per cent of the ration without affecting dry matter digestibility (NRC, 2001) which may result in improved milk and milk fat production in dairy cows (Naik, 2013). There are other studies which indicate that supplementation of rumen protected fat at a level of 4-6 per cent increased the milk production and milk fat in high yielding dairy cows (Purushothaman *et al.,* 2008, Gowda *et al.,* 2013; Kundu *et al.,*2014). The degradability of calcium soaps of long chain fatty acids in rumen was less and digestibility was high in the intestine, it also acts as source of calcium (Elmeddah *et al.,*1991). Like that, encapsulated vegetable oils used as rumen protected fat have high potential to protect the oil from rumen bio-hydrogenation (Gawad *et al.,* 2015). Considering the efficacy of both the methods of protection of oil, it would not be out of context to make a comparative evaluation of these two methods of protection of rapeseed oil. Specific objective of the present experiment was to study the effect supplementing

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rumen protected rapeseed oil on DMI, milk yield and composition.

MATERIALS AND METHODS

The feeding experiment was conducted at Instructional Livestock Farm Complex, College of Veterinary and Animal Sciences, KVASU, Pookode, Kerala. Eighteen crossbred lactating cows were selected from the farm based on their pariety, milk yield and stage of lactation. They were randomly divided into three groups (GI, GII and GIII) with six animals in each group. The experiment lasted for 90 days, following an adaptation period of 15 days. All experimental cows were supplied with chopped green forage (Hybrid Napier) and concentrate mixture (compounded cattle feed) and fed separately to meet their nutrient requirements. In addition, cows in GII and GIII were supplemented with CaRSO and encapsulated RSO, respectively. The quantity of concentrate mixture and supplements required by each lactating cow was adjusted at every fifteen days interval based on their milk production. The animals were housed in well ventilated, shed with automated drinking facilities.

The CaRSO and encapsulated RSO were supplemented at 20 g per kg milk per day, hand-mixed with concentrate mixture and offered during evening. The milking was done daily at 4.30 AM and 3.30 PM and milk yield was recorded daily at each milking by using an electronic weighing balance. The cows were offered concentrate mixture daily, half an hour before and after milking and green forages daily at 8:30 AM, 2:00 PM and at evening 6:00 PM. The rapeseed oil was prepared as rumen protected fat (RPF) by encapsulation method demonstrated by Gawad *et al.* (2015) and calcium salts of rapeseed oil (CaRSO) was prepared as per Naik *et al.* (2007) and Perez (2009).

The daily DMI from feed and roughage was recorded. Individual animal's milk samples (20 ml) were taken weekly and kept at 4^{o} C for further analysis. The monthly pooled milk sample of individual animal was analysed for protein, fat (IS; 1223:2001), SNF and total solids (IS 12333:1997).The samples of concentrates, forages and experimental ration offered were analysed for chemical composition (AOAC, 2016) and presented in Table 1. Milk yield was converted into four per cent fat corrected milk (FCM). Every month, 7 body check points were examined for body condition score (BCS) as elaborated by Mishra *et al.* (2016). The data was analysed statistically according to methods suggested by Snedecor and Cochran (1994).

RESULTS AND DISCUSSION

The findings of this study indicated that the voluntary DMI was significantly (P<0.05) increased in animals supplemented with CaRSO and encapsulated RSO as compared to control group (GI) (Table 2). Earlier researchers like Sirohi *et al.* (2010) reported non-significant increase in intake of DM in lactating crossbred cows. Similarly, Kumar *et al.* (2017) also reported a non-significant increase in DMI (kg/day) of lactating Murrah buffaloes supplemented with prill fat at a level of two per cent of DMI. Other researchers, Naik *et al.* (2009) and Harish *et al.* (2018) reported that supplementation of CaRSO and commercial bypass fat had no significant effect on DMI (kg/day). Significantly (P<0.01) lower relative DMI (per cent BW

Table 1. Nutrient composition of concentrates, green forages and experimental rations

Nutrient	Concentrate	Green forage	Experimental ration		
			GI	GII	GIII
Dry matter	86.87±0.43	26.55±0.38	47.93±0.6	51.84±0.17	52.45±0.13
			on % DM Basis		
Crude protein	22.03±0.13	10.52±0.15	15.36±0.05	15.48±0.22	15.69±0.15
Crude fibre	13.27±0.51	36.15±0.26	31.11±0.23	27.79±0.29	29.25±0.33
Ether extract	2.34±0.10	1.43±0.036	2.07±0.05	3.57±0.021	3.14±0.061
Total ash	12.31±0.14	8.19±0.18	5.04±0.01	6.13±0.039	6.07±0.03

Table 2. Effect of supplementation of rumen protected rapeseed oil on body condition score and dry matter intake in lactating cows

Particular	Group I	Group II	Group III	P-Value
Body condition score	3.021±0.06	3.13±0.046	3.00±0.06	0.272
DMI from roughage (kg/day)**	3.33 ^{b}±0.03	3.41 ^{a}±0.028	3.27 ^{b}±0.03	P<0.01
DMI from concentrate mixture (kg/day)**	6.77 ^{c}±0.05	7.16 ^{b}±0.055	8.23 ^{a}±0.05	P<0.01
Total DMI (kg/day)**	10.10±0.06	10.57±0.062 ^{b}	11.50±0.06 ^{a}	P<0.01
DMI(kg/100kg BW)**	3.73 ^{c}±0.03 ^{a}	2.74 ^{c}±0.034	3.31 ^{b}±0.03	P<0.01
DMI (g/kg $W^{0.75}$)**	150.56 ^{a}±1.15	120.90 ^{c} 1.176	142.63 ^{b}±1.15	P<0.01

$^{a\,b\,c}$ Means with different superscripts in the same row differ significantly; *Significant at 5% level, **Significant at 1% level, ^{ns} non-significant

and g/kg $W_{0.75}$) were reported in CaRSO supplemented group as compared to encapsulated RSO and control group (Table-2). This corroborates with findings of Mane *et al.* (2017) who supplemented protected fat of palm fatty acids given at level of 10 g/litre of milk in crossbred cattle and observed lower DMI expressed as per cent BW. On the other hand, Ranjan *et al.* (2013) observed significant (P<0.05) increase in DMI (kg/100 kg BW) in lactating Murrah buffaloes fed with bypass fat of palm oil (PO) distillate included at a level of 200 g/day. The response of supplementation of rumen protected fat often varies between studies might be due to palatability, inclusion level (Naik *et al.,* 2009) and its solubility and melting point in the rumen (Purushothaman *et al.,* 2008).

BCS was similar in among all experimental animals (Table 2), comparable to findings of Naik *et al.* (2009) in early lactating cross breed cows fed with calcium soaps of rice bran oil. In contrast to present findings, Kundu *et al.* (2014) and Sharma *et al.* (2016) reported that supplementation of rumen protected prill fat to lactating cows and buffaloes had significantly (P<0.05) improved the BCS. Garg and Mehta (1998) also reported an improved BCS of HF cows supplemented with CaRSO. The additional energy supplied by rumen protected rapeseed oil in this study might have been utilized for increase in MY, thereby causing no change in BCS.

Results of this study clearly demonstrated that added extra energy through CaRSO and encapsulated RSO supplementation might had been used for milk production that was reflected in significant (P<0.05) increase in MY (Table 3) compared to control. The best response, however, was observed in GIII in terms of FCM yield. The feed efficiency (MY/DMI (kg/kg) observed in the present study was better significantly (P<0.05) in CaRSO group than GIII group and similar to control. Purushothaman *et al.* (2008) reported protected fat supplementation caused poorer feed efficiency, whereas, Ranjan *et al.* (2013) reported

Table 3. Effect of supplementation of rumen protected rapeseed oil on milk yield and composition

Particular	Group I	Group II	Group III	P-Value
MY (kg/day)*	10.34 ^{b} 0.04	10.65 ^{a}±0.09	10.65 ^{a}±0.14	0.041
4 % FCM, kg/day **	10.55 ^{b}±0.05	10.75 ^{b}±0.10	11.18 ^{a}±0.15	P<0.01
MY/DMI (kg/ kg)**	1.03 ^{a}±0.006	1.02 ^{a}±0.009	0.91 ^{b}±0.009	P<0.01
Milk composition (%)				
Fat **	4.23 ^{a}±0.121	3.80 ^{b}±0.126	4.56 ^{a}±0.121	P<0.01
Protein ^{ns}	3.34±0.117	3.36±0.122	3.21±0.117	0.627
SNF ^{ns}	8.18±0.089	8.12±0.093	8.15±.089	0.895
Total solids**	12.41±0.185 ^{a}	11.78±0.192 ^{b}	12.71±0.185 ^{a}	P<0.01

$^{a\,b\,c}$ Means with different superscripts in the same row differ significantly *Significant at 5% level, **Significant at 1% level, ^{ns} non-significant increased (P<0.05) feed efficiency in treatment group, compared to control group in lactating Murrah buffaloes. Similarly, dietary supplementation of protected fat (Purushothaman *et al.,* 2008; Gowda *et al.,* 2012; Kowalski *et al.,* 1999; Naik *et al.,*2009) resulted in significant (P<0.05) increase in MY in dairy cows. Similar response was also observed in Murrrah buffaloes (Shelke *et al.,*2012; Harish *et al.,* 2016). However, no significant responses were observed in mid lactating cross breed cows (Kundu *et al.,* 2014).

Perusals of the data of milk composition reveals that there was influence of protected fat supplementation on milk fat and total solids content, whereas, SNF and protein content were not affected. In the present study, CaRSO supplementation had significantly (P<0.01) reduced milk fat (per cent) compared to the control and GIII treatment group. These results were in agreement with the studies of Kowalski *et al.* (1999) who reported that CaRSO supplementation decreased milk fat content by 1.9 g/kg in dairy cows as compared to control group. The reasons might be decreased *de novo* synthesis of synthesis of short and medium-chain fatty acids in the mammary gland due to CaRSO supplementation (Kowalski *et al.,* 1999). There was no significant difference in milk fat content of encapsulated RSO (GIII) as compared to control group animals. Similar findings were reported by Ranjan *et al.* (2013), Kundu *et al.* (2014) and Veena *et al.* (2018) in dairy animals. It seems that supplementation RSO did not cause any adverse impact on crude fibre digestibility and acetate to propionate ratio (Ranjan *et al.,* 2013). However, some other studies have reported increased milk fat content due to feeding of protected fat in dairy cows (Naik *et al.,* 2009; Sirohi *et al.,* 2010; Ansar *et al.,* 2014 and Meshram *et al.,* 2016) and buffaloes (Shelke *et al.,* 2012; Harish *et al.,* 2016). It was explained that feeding of protected fat increased availability of fatty acids in the intestine and mammary gland for milk fat synthesis (Shelke *et al.,* 2012).

Milk protein and SNF content were not affected by supplementation of CaRSO and encapsulated RSO protected fat in this study (P>0.05) (Table 3) Similar results were reported by Sirohi *et al.* (2010) and Kundu *et al.* (2014). In contrary, CaRSO supplementation decreased milk protein and SNF content (P<0.05) when Calcium salts of rice bran oil were supplemented (Veena *et al.,* 2018) and increased milk protein values were reported by Ranjan *et al.* (2013). Regarding the total solid content of milk, CaRSO protected fat supplementation in this study shown decreased values (P<0.05) as compared to other groups. But Ranjan *et al.* (2013) and Harsha *et al.* (2016) mentioned that rumen protected fat (prill fat) did not affect the total solid content of milk (P<0.05).

CONCLUSION

From the present study, it may be concluded that supplementation of either encapsulated or calcium salts of rapeseed oil in the diet of lactating cows would increase the average daily milk yield and 4% FCM yield.

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