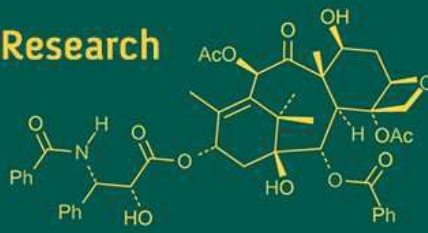
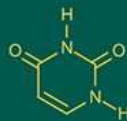
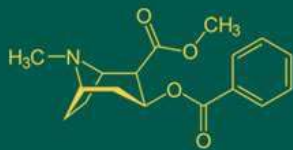


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Effect of rumen protected choline (RPC) on milk yield and composition in crossbred dairy cows

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Abstract

This study investigated the impact of rumen-protected choline (RPC) supplementation on milk production and its composition in early lactating crossbred cows. Ten lactating cross bred cows were selected from cattle section of Livestock Farm Complex, a constituent unit of Tamil Nadu Veterinary and Animal Sciences University, located at Madhavaram Milk Colony, Chennai, Tamil Nadu for this experiment. The length of the experimental period was 35 days. Animals received a basal diet alone for 14 days (pre-supplementation period), followed by 20 g RPC daily for 21 days (post-supplementation), with daily individual measurements of milk yield, fat, and solids-not-fat (SNF) percentages. Pre-RPC means were 4.93 ± 0.30 L milk yield, $4.67 \pm 0.08\%$ fat, and $7.51 \pm 0.07\%$ SNF, compared to post-RPC values of 5.05 ± 0.33 L, $4.81 \pm 0.10\%$ fat and $7.52 \pm 0.09\%$ SNF. While milk yield and SNF showed no significant changes, fat content improved significantly ($p < 0.05$), suggesting that 20 g RPC/day enhances milk fat and economic value without influencing overall production and SNF in crossbred dairy cows.

Keywords: Crossbred cows, milk fat, milk yield, solid not fat, rumen protected choline

Introduction

Choline, also known as trimethyl ethanolamine, is an essential component of mammalian diets as it is required for normal function of cells (Swartz *et al.*, 2022) [9]. Choline is a critical component for synthesis of phospholipids and neurotransmitters, it supports structural integrity and signaling roles in cell membranes, influences cholinergic neurotransmission and cognition, and it is a major source for methyl-groups via betaine for methylation pathways. The dietary choline, betaine, methionine, folic acid, Vitamin B₁₂ all contribute to the body choline content. Particularly in early lactation, choline enhances milk fat synthesis and mitigates fatty liver syndrome post-parturition, a condition linked to elevated hepatic lipid accumulation and compromised reproductive performance (Cooke *et al.*, 2007) [2].

Dietary choline is degraded rapidly by the rumen microorganisms (Neill, 1979; Sharma and Erdman, 1989) [9, 15]; hence, supplementation with choline is not an effective way to increase choline supply. Therefore, rumen-protected forms of choline have been developed to deliver choline to the small intestine for absorption (Elek *et al.*, 2008) [3]. The various protein sources are rich sources of choline but due to rumen degradability (85-95%) the animal will depend on its endogenous choline synthesis for their metabolic needs. Hence, there is need for use of protected choline in the diet of dairy animals for better health and productivity. Microencapsulation is used to protect a substance from degradation in the rumen. Feeding choline in this form not only meets the requirement of choline but also reduces the requirement of methionine and lysine as these two amino acids involved in the endogenous synthesis of choline.

Studies demonstrate that RPC supplementation alleviates fatty liver in transition cows, elevates milk yield, fat, and protein percentages, and improves overall productivity (Hartwell *et al.*, 2000; Zahra *et al.*, 2006) [6, 21]. Despite these benefits, evidence in crossbred dairy cows particularly in smallholder systems remains limited, especially concerning cost-effectiveness amid fluctuating input costs. The present study investigates the effects of RPC supplementation in crossbred dairy cows, with the following objectives: (i) to evaluate its impact on milk yield and composition, and (ii) to assess its cost-effectiveness.

Materials and Methods

This experiment was carried out in cattle unit of Livestock farm complex, Madhavaram Milk Colony, Chennai-51 (Geographic coordinates: 1.15° N 80.24°E). Ten early lactating crossbred cows were selected from cattle section of LFC for this experiment. The length of the experimental period was 35 days. During the pre-supplementation period of initial 14 days, the animals were fed with basal diet without rumen protected choline (RPC). Then, during the post supplementation period of next 21 days, they were fed with basal diet along with 20 g rumen protected choline. The animals were housed in well-ventilated sheds, and maintained as per scientific managemental conditions. The animals were fed with basal diet comprising concentrates and green, dry roughages depending upon their body weight and level of production as per NRC (2001) [10]. The concentrate diet was procured from Central feed technology unit (CFTU), a constituent unit of Tamil Nadu Veterinary and Animal Sciences University, Kattupakkam and green, dry roughages were cultivated at LFC.

Table 1: Ingredient composition of the concentrate feed

Ingredients	Inclusion %
Maize	30
Soybean meal	22
Deoiled rice bran	32
Sunflower meal	8
Calcite	5
Mineral mixture	2
Salt	1
Total	100
CP % (calculated)	20
TDN % (Calculated)	70

The rumen protected choline was procured from Kemira Industries South Asia Pvt. Ltd, Chennai. The experimental animals had free access to clean, wholesome drinking water.

The animals were fed with concentrate twice daily, in the morning and in the afternoon before milking. Roughage was fed in three divided lots every day to ensure minimum wastage. The rumen protected choline was top dressed along with concentrate feed at the rate of 20g/animal/day for 21 days. Individual data on milk produced was recorded throughout the experiment.

Data on milk yield of individual animal was recorded daily at morning and evening throughout the experimental period. Milk samples were collected and analysed for its fat and solids not fat (SNF) content by using EKOMILK® digital milk analyser. The cost effectiveness of rumen protected choline feeding for producing per litre of milk was calculated using the data on total milk yield and milk composition during the experimental period.

The data on mean daily milk yield, fat and solids not fat (SNF) content were analyzed statistically (Snedecor and Cochran, 1994) [17] and the comparison of means was done using IBM Statistical Production and Service Solutions (SPSS), version 20.0.

Results and Discussion

Data on milk yield, fat and solid not fat (SNF) contents are presented in Table 2. The mean milk production (litres) pre rumen protected choline supplementation period was 4.93±0.30, and post rumen protected choline supplementation period was 5.05±0.33. There was statistically no significant difference in milk production due to RPC supplementation. But the milk fat content was improved significantly ($p < 0.05$) by RPC. The mean milk fat percentage pre rumen protected choline supplementation was 4.67±0.08, and post rumen protected choline supplementation was 4.81±0.10. Similar to milk yield, the solid not fat (SNF) content had no significant difference statistically pre and post RPC supplementation. The SNF values before and after RPC supplementation was 7.51±0.07 and 7.52±0.09, respectively.

Table 2: Mean (± SE) daily milk yield, fat and solid not fat (SNF) content of lactating cross bred cows during trial period

Particulars	Milk yield (litres)	Milk fat (%)	SNF (%)
Pre RPC supplementation	4.93±0.30	4.67±0.08*	7.51±0.07
Post RPC supplementation	5.05±0.33	4.81±0.10*	7.52±0.09
P value	0.348	0.006	0.780

Each value is a mean of ten observations; Means bearing * differ significantly at 5% ($p < 0.05$)

Pawar *et al.* (2015) [11] reported no significant difference in milk yield of crossbred lactating cows supplemented with 54 g/head/day RPC (16.93±1.57 kg/day) mixed with the basal ration when compared with the control (15.38±0.88 kg/day). Neelima *et al.* (2021) [8] found that supplementation of rumen protected choline @ 20 g/animal in early lactating cows had no significant difference ($p > 0.05$) in milk yield. These results were in accordance with those of the present study. Milk yield was not significantly improved in the present study which may be because the animals selected for the experiment were only medium producers rather than high yielders, length of treatment period and also variations in stages of lactation.

On contrary, several authors reported that supplementation of RPC had positive effect on milk yield of lactating cows. Erdman and Sharma (1991) [4] fed Holstein cows 0, 0.078, 0.156, and 0.234% RPC and found that added choline

resulted in a linear increase in 3.5% FCM and feeding 0.156 and 0.234% choline increased FCM by 2.4 and 1.7 kg/day, respectively, over the control. Pinotti *et al.* (2001) [13], who found that cows consuming 20 g/day RPC produced 3.5 kg/day more milk than the controls. Zahra *et al.* (2006) [21] reported that Holstein cows received 56 g/day of RPC produced on average 1.2 kg/day more milk yield through 60 days compared with those not receiving RPC supplementation. Guretzky *et al.* (2006) [5] fed Holstein and Jersey cows diets which were top dressed once daily with 60 g of RPC product and found that daily yield of 3.5% FCM increased by 2 kg/day compared with the control group. Rumen-protected choline supplementation in lactating Friesian cows led to increased milk yield by 1.32 and 2.24 kg/head/day or 8.75 and 14.85%, for 15 and 30 g RPC compared with un-supplemented RPC, respectively ($p < 0.05$) (Mohsen *et al.*, 2011) [7]

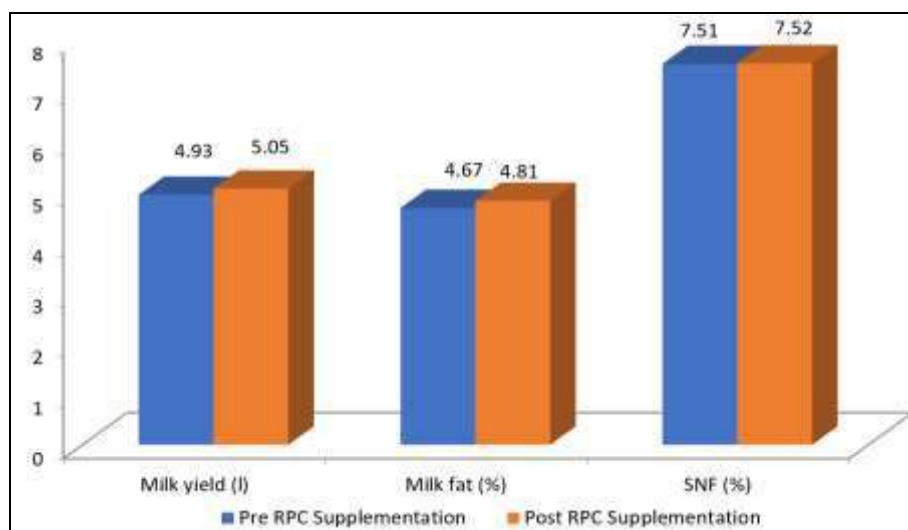


Fig 1: Mean daily milk yield (litre), milk fat and SNF content (%) of crossbred cows on pre and post supplementation of rumen protected choline

The dietary rumen protected choline contributes insignificantly to the choline body pool. Choline facilitates phospholipid synthesis for lipid absorption and transport to the mammary gland, thereby favouring milk fat synthesis. Mohsen *et al.* (2011)^[7] observed that the content of fat was increased significantly ($p < 0.05$) with RPC supplementation. Neelima *et al.* (2021)^[8] found that supplementation of rumen protected choline @ 20g/animal in early lactating cows had significant improvement ($p < 0.05$) in milk fat content fed along with rumen protected methionine. These results were in accordance with the results obtained in the present study.

On the other hand, several researchers could not observe any significant effect on milk fat when animals fed with RPC. Piepenbrink and Overton (2003)^[12] observed that increase in yields of milk fat of Holstein cows was fed treatments consisting of 0, 45, 60, or 75 g/d of a rumen-protected choline (RPC). Guretzky *et al.* (2006)^[5] showed that cows fed RPC had increased milk fat, total solids contents and yield. Xu *et al.* (2006)^[20] reported that supplemented RPC at various dose rates (0, 30, 60 and 90 g/d/head) to dairy cattle and found no significant difference in milk composition. Elek *et al.* (2008)^[3] found that milk fat content was not altered by RPC supplementation in Holstein cows, but fat yield was increased by 0.10 kg/day as a consequence of higher milk yield in the RPC-treated group. Likewise, Baldi *et al.* (2011)^[13] observed no difference in milk fat and protein contents when RPC was fed @ 4 g/d in goats during experimental period extending from 4 weeks prepartum to 4 weeks postpartum. Similarly, Suksombat *et al.* (2012)^[18] also did not find any significant difference in milk composition after supplementation of 0, 20 and 40 g RPC/d to dairy cattle. Pawar *et al.* (2015)^[11] reported no significant difference in milk fat content of crossbred lactating cows supplemented RPC.

The mean solid not fat content (percentage) of lactating cross bred cows fed pre and post rumen protected choline supplementation was 7.51 ± 0.07 and 7.52 ± 0.09 respectively (Table 2 and Fig 1). There was statistically no significant difference observed in mean SNF percentage of cows fed with RPC. In line with findings, many researchers reported that RPC supplementation have no significant effect on the contents of protein, lactose, SNF and ash, but their yields increased ($p < 0.05$) significantly (Sharma and Erdman, 1988, b; Erdman and Sharma, 1991; Zahra *et al.*, 2006; Ambrosio *et al.*, 2007)^[16, 4, 21, 1].

On contrary, Rahmani *et al.* (2014)^[14] concluded that feeding TMR top dressed with 90g/day RPC to early lactating Holstein cows had significantly improved the SNF content of milk (8.87 ± 0.05 per cent) when compared to the control (8.67 ± 0.04 per cent). Pawar *et al.* (2015)^[11] revealed that no significant difference in milk composition of crossbred lactating cows supplemented with RPC. Neelima *et al.* (2021)^[8] reported that supplementation of rumen protected choline @ 20 g/animal in early lactating cows had significant improvement ($p < 0.05$) in SNF content as compared to control fed along with rumen protected methionine.

Rumen protected choline supplementation significantly improved ($p < 0.05$) fat percentage. For every additional 0.1% increase in fat content farmer fetches Rs.0.20 paise and 0.1% increase in SNF content, farmer will get Rs. 0.40 paise. From the present study, the milk producer had received additional Rs.0.24 paise per litre by feeding of rumen protected choline because of improved fat percentage (Table 3). The total return was comparatively lower due to difference in their milk yield. This may due to difference in stage of lactation and length of the research period. The current prevailing market price of RPC was higher. However, long-term feeding of RPC may reduce the cost of production and improves animal health.

Table 3: Effect of supplementation of rumen protected choline on cost effectiveness in cross bred cows

Particulars	Pre RPC supplementation	Post RPC supplementation
Mean Milk yield (litres/day/animal))	4.93±0.30	5.05±0.33
Mean Fat content (%)	4.67±0.08	4.81±0.10
Mean SNF content (%)	7.51±0.07	7.52±0.09
Milk per litre cost based on this fat and SNF (Rs.)	30.28	30.52
Total Returns per animal per day (Rs.)	149.28	154.13

Milk procurement price-Base rate for milk have 2% fat and 7% SNF-Rs.22/litre; Cost of green fodder-Rs.2/kg; Cost of dry fodder-Rs.8/kg; Cost of concentrate feed-Rs.30/kg
Cost of rumen protected choline-Rs. 400/kg

Conclusion

Based on the present study findings, it can be concluded that supplementation of rumen-protected choline at the rate of 20 g/animal/day did not result in significant improvements in milk yield or SNF content in lactating crossbred dairy cows. However, it significantly enhanced the milk fat content, which can positively influence the milk price. Therefore, inclusion of rumen-protected choline in the diet is recommended as a strategy to improve milk fat percentage and economic returns for dairy farmers.

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