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Effect of feeding fortified milk replacer on post-weaning health performance in crossbred calves#

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Abstract

Fourteen seven-day old pre-ruminant crossbred calves of either sex were randomly distributed to T1 and T2 groups. Calves were fed whole milk (T1) and fortified milk replacer (T2) at a rate of 1/10th of body weight during the first six weeks, 1/15th during the following four weeks, 1/20th during the final two weeks. The milk replacer was formulated using skim milk powder, dried whey and soy protein isolate as protein sources, refined coconut oil as energy source and was fortified with vitamins, minerals, and essential amino acids. The milk replacer was reconstituted by mixing one part of the dry powder with seven parts of warm water. At the time of feeding, a probiotic powder containing Lactobacillus rhamnosus (0.2 × 10^{9} CFU) and lysolecithin (4 g) was added to the reconstituted milk replacer for each calf daily. Final body weight and total body weight gain (TWG) were similar between the two groups. However, the average feed cost per calf was significantly lower (P<0.01) for T2 compared to T1. Faecal consistency scores were comparable between the groups, with no incidences of diarrhea observed. Hematological and biochemical parameters were within normal ranges and did not differ significantly (P>0.05) between the groups.

Keywords: *Fortified milk replacer, crossbred calves, blood biochemical parameters, faecal consistency score*

In optimising dairy calf management, proper nutrition is crucial for health, growth and future productivity (Barry *et al*., 2019). While colostrum and whole milk have traditionally been the main sources of nutrition for newborn calves, high market demand often limits the ability to provide sufficient whole milk. Consequently, milk replacers have emerged as a practical alternative. Typically derived from dairy proteins, these milk replacers (MR) can be cost-effectively substituted with plant proteins, though they may lead to lower performance due to variability in crude protein and fat content, as well as potential amino acid imbalances, indigestion, and reduced growth rates. To address these issues, fortified milk replacers have been developed to better meet the specific nutritional needs of young calves. Enriched with essential vitamins, minerals, probiotics, and emulsifiers these advanced formulations aim to closely replicate whole milk's nutrient profile, supporting immune function, optimal weight gain, and overall development during the critical early stages of life. This study focuses on effect of fortified milk replacer on the health and haemato-biochemical parameters in crossbred calves.

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Materials and methods

Fourteen seven-day-old crossbred calves of either sex were selected from the University Livestock Farm and Fodder Research and Development Scheme (ULF and FRDS), College of Veterinary and Animal Sciences, Mannuthy, in Thrissur. They were randomly divided into two groups of seven animals each, assigned to one of two dietary treatments, T1 and T2, using a completely randomized design. The calves were housed individually in well-ventilated, clean, dry pens and maintained under a uniform system of feeding and management throughout the experimental period of 120 days.

Experimental period and feeding schedule

The experimental trial started from 8th day of the age and continued for a period of 120 days. Feeding schedule followed in both T1 and T2 group experimental calves were similar. Calves were fed whole milk (T1) and reconstituted fortified milk replacer (T2) at a rate of 1/10th of body weight during the first six weeks, 1/15th during the following four weeks, 1/20th during the final two weeks. Throughout the study, all experimental calves were provided calf starter (23% CP, 70% TDN) and green fodder (Hybrid Napier CO3) as per ICAR (2013) standards. Fresh drinking water was offered *ad libitum*.

The milk replacer (23% crude protein) was formulated using skim milk powder, dried whey and soy protein isolate as protein sources, refined coconut oil as energy source and was fortified with vitamins, minerals, and essential amino acids. The milk replacer was reconstituted by mixing 1 part of the dry powder with 7 parts of warm water. At the time of feeding, probiotic powder containing *Lactobacillus rhamnosus* (0.2×10^9 CFU) and lysolecithin (4g) were added to the reconstituted milk replacer, then fed to each calf per day.

Feeding trial

Weighed quantity of whole milk, reconstituted fortified milk replacer, calf starter, chaffed green grass were offered twice daily at 9.00 AM and 3.00 PM to each animal.

Analysis of feed

Proximate analysis of the calf starter, green grass was done according to standard procedures (AOAC, 2016) and milk and reconstituted milk replacer samples were analysed for total solids, protein (AOAC,2016), fat and solids not fat (IS: 1224.1977).

Body weight

Body weight of the animals was recorded at fortnightly intervals using electronic weighing balance.

Daily Faecal Scoring

Faecal consistency was observed in all experimental calves while dung was voided in the morning at 8.00 AM, afternoon at 2 PM and evening at 6 PM. The faeces with normal consistency was scored as 1; 2 for slightly liquid faeces; 3 for moderately liquid faeces and 4 for severely liquid faeces as outlined by Larson *et al*. (1977). Faecal consistency score more than 2 was considered as diarrhoea.

Serum biochemical parameters

Blood samples were collected from the jugular vein from all the experimental calves at the end of the feeding trial. Whole blood was used to determine the haemoglobin (cyanmethaemoglobin method). The serum was separated after centrifugation at 3000 rpm for 10 minutes. Blood serum glucose (GOD-PAP methodology), serum protein (Jong and Vegeter, 1950), albumin (Bromocresol green method), blood urea nitrogen (BUN) (modified Berthelot method), calcium (AOAC, 2016); phosphorus (Bernhart and Wreath, 1955) and liver enzymes such as alanine transaminase (ALT) and aspartate transaminase (AST) was estimated using standard kits supplied by M/s. Agappe Diagnostics Limited, Ernakulam, Kerala.

Statistical analysis

Statistical analysis of observations was done as per Snedecor and Cochran (1994) using Software Statistical Package for the Social Sciences (SPSS 24.0) by independent sample t test and fortnight data on faecal consistency score was analysed by Kruskal Walis test.

Results and discussion

Chemical composition of feed

The chemical composition of whole cow milk and reconstituted milk replacer given to the experimental animals are summarised in Table 1. The chemical composition of calf starter and green grass (Hybrid Napier CO3) used in this study are presented in Table 2.

It was observed that the chemical composition of whole milk and reconstituted milk replacer used in the present study was similar to milk and reconstituted milk replacer used by Suresh (2022) and Abhijith (2022). The

Table 1. Chemical composition of whole milk and reconstituted milk replacer fed to experimental crossbred calves, %

Components	Whole milk	Reconstituted MR
Total solids	12.88±0.07	12.37±5.05
Solids not fat	9.26±0.02	9.21±3.76
Fat	3.62±0.02	3.16±1.29
Protein	3.42±0.03	3.21±1.31

Table 2. Chemical composition of calf starter and green grass fed to experimental crossbred calves (%, on DM basis)

Attributes	Calf starter	Green grass
Dry matter	90.21±0.07	20.46±1.00
Crude protein	23.82±0.35	11.90±0.11
Crude fibre	5.89±0.07	29.54±0.05
Ether extract	4.56±0.01	2.07±0.04
Total ash	7.88±0.07	11.02±0.07
Nitrogen free extract	57.85±0.36	45.47±0.18

[1]Mean±SE values of eight replicates

composition of milk replacer was in accordance with the recommended nutrient densities of milk replacer by NRC (2001) and calf starter was in accordance with ICAR (2013) standards.

Body weight

The mean initial body weight, final body weight, total body weight gain, and total feed cost per calf are presented in Table 3. Statistical analysis revealed no significant difference (P>0.05) between the two treatment groups in terms of initial body weight, final body weight, or total body weight gain. However, the total feed cost i.e., combined cost of whole milk, milk replacer, concentrate and green grass per calf was significantly lower (P<0.01) in the milk replacer fed group, showing a 30.77 per cent reduction compared to the whole milk-fed group. These findings are in accordance with the results of studies conducted by Abhijith (2022) and Suresh (2022) in crossbred calves fed either whole milk or milk replacer.

Health parameters

Faecal consistency score

The mean faecal consistency scores (FCS) observed at fortnightly intervals are presented in Table 4. Faecal consistency scores recorded in first fortnight was slightly liquid faeces and similar in both the experimental group animals. However, after the second fortnight of the experimental period the faecal consistency score was normal in all experimental calves. In accordance to the present findings, Huuskonen *et al*. (2005), Quigley *et al*. (2006) and Kamalahasan (2018) reported normal faecal consistency score in milk replacer fed calves.

Table 4. Faecal consistency scores recorded in experimental crossbred calves

Fortnight	Dietary treatment		P value
	T1	T2	
1	1.77±0.15	1.81±0.19	0.880[ns]
2	1.47±0.13	1.53±0.12	0.744[ns]
3	1.23±0.12	1.17±0.06	0.658[ns]
4	1.20±0.06	1.13±0.07	0.659[ns]
5	1.27±0.16	1.16±0.14	0.622[ns]
6	1.24±0.24	1.00±0.00	0.356[ns]
7	1.01±0.01	1.00±0.00	0.337[ns]
8	1.01±0.01	1.00±0.00	0.337[ns]

*Mean±SE values of seven replicates, ns-non significant

Haemato-biochemical parameters

The haemato-biochemical parameters of the experimental crossbred calves such as haemoglobin, serum glucose, serum calcium, serum phosphorus, serum total protein, serum albumin, serum globulin, albumin globulin ratio, blood urea nitrogen and liver enzymes such as alanine transaminase (ALT) and aspartate transaminase (AST) are summarised in Table 5. All blood parameters estimated were within the normal range (Kaneko, 2008) and indicated that health of calves was not affected when fed on fortified milk replacer.

In this study, haemoglobin levels were within normal range, not differed significantly (P>0.05) between the treatment group calves and no anaemic conditions were observed. Similarly, Shahin *et al*. (2018) also reported normal range of haemoglobin levels in buffalo calves fed with milk replacer at different levels.

The present findings on serum glucose revealed milk replacer and whole milk fed group calves had similar values. Lee *et al*. (2008) observed a similar blood glucose level between the calves fed milk replacers containing different amounts of energy and protein. In contrast, Smith *et al*. (2002) observed increased serum glucose levels

Table 3. Summarised data on body weight, total body weight gain and total cost of feed of experimental crossbred calves maintained on two dietary treatments

Parameters	Dietary treatments		P value
	T1	T2	
Initial body weight (kg)	34.49±2.17	34.57±1.33	0.974[ns]
Final body weight (kg)	78.11±2.71	80.20±4.98	0.719[ns]
Total body weight gain (kg)	43.63±3.02	45.63±3.85	0.690[ns]
Total cost of feed (Rs/calf)	17236.87±602.401	11932.56±415.62	0.000[**]
Reduction in cost (%)	-	30.77 %	-

Table 5. Serum biochemical parameters[1] of the crossbred calves

Parameters	Dietary treatment		P value
	T1	T2	
Haemoglobin (g/dL)	12.41±0.77	11.61±0.50	0.397^{ns}
Serum glucose (mg/dL)	73.43±2.95	75.43±1.30	0.552^{ns}
Serum calcium (mg/dL)	11.19±0.28	11.41±0.14	0.312^{ns}
Serum phosphorous (mg/dL)	6.74±0.22	6.40±0.41	0.465^{ns}
Serum total protein (g/dL)	6.38±0.05	6.34±0.09	0.977^{ns}
Serum albumin (g/dL)	3.54±0.07	3.48±0.04	0.533^{ns}
Serum globulin (g/dL)	2.80±0.05	2.87±0.11	0.585^{ns}
Albumin : Globulin	1.27±0.05	1.22±0.05	0.495^{ns}
BUN (mg/dL)	11.58±0.27	12.11±0.21	0.137^{ns}
ALT (U/L)	14.23±0.25	15.85±1.13	0.19^{ns}
AST (U/L)	67.98±1.31	68.42±1.31	0.83^{ns}

[1]Mean values of seven replicates with SE

ns-non significant (P>0.05)

in whole milk offered calves because of higher lactose intake.

Thamothiran *et al*. (2020) investigated the impact of replacing whole milk by skimmed milk powder-based milk replacer on health performances in crossbred dairy calves and reported similar serum albumin levels.

Serum calcium and serum phosphorus were also similar and within the normal range in both treatment groups. Kamalahasan (2018), Abhijith *et al*. (2023) and Suresh (2022) conducted studies in crossbred calves fed on whole milk and formulated milk replacer and their studies also reported similar serum calcium and serum phosphorus levels.

In this study, concentration of BUN was within the normal range and similar (P>0.05) between the treatment groups. Lee *et al*. (2008) studied the blood metabolites and health of Holstein calves fed milk replacers containing different amounts of energy and protein and reported BUN values as 14.1 mg/dL in low energy milk replacer and 12.8 mg/dL in high energy milk replacer. The variation in BUN values reflect protein and dietary amino acid balance (Stanley *et al*., 2002).

Similar to the present findings, Yang *et al*. (2015) observed similar ALT and AST values at different levels of milk replacer in lambs and Mirzaei *et al*. (2018) also reported milk intake and weaning age were not affecting ALT and AST values in dairy calves.

Conclusion

It can be concluded that fortified milk replacer can be offered as an economical alternative to whole milk from the 7th day of age to crossbred calves, following a feeding schedule based on their body weight, without compromising health or haemato-biochemical parameters during the post-weaning period.

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Conflicts of interest

The authors declare that they have no conflict of interest.

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