



Performance and economics of Vrindavani calves fed on various proportions of whole and skim milk

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ABSTRACT

A total of 24 crossbred (Vrindavani) calves were selected and allocated to four groups (6 per group) as control (C), treatment 1 (T1), treatment 2 (T2) and treatment 3 (T3). During the experimental period, the calves in C were fed only whole milk, whereas the calves in T1, T2 and T3 groups were fed skim milk at the rate of 25, 50 and 75% of total liquid feed, respectively from 22nd day of age. Proportion of skim milk was further increased to 50, 75 and 100% of total liquid feed requirement in T1, T2 and T3 groups, respectively from 45th day of age onwards. Finally, in all the treatment groups, 100% skim milk was fed from 64 to 72 days of age. The total body weight gain of calves was 24.90 ± 1.24 , 25.12 ± 3.95 , 25.37 ± 3.02 and 26.42 ± 2.30 kg for control, T1, T2 and T3 groups, respectively which differed nonsignificantly from each other. The average daily gain did not differ significantly for any week during the experiment. The calf starter intake was significantly higher in T3 group compared to C from 4 to 6 weeks of age but both the groups differed non-significantly with T1 and T2. The total dry matter intake and feed efficiency did not differ significantly between the groups. Inclusion of skim milk in replacement with whole milk reduced the feeding cost up to 23.95% in T3 group in comparison to control during milk feeding phase without any adverse effect on growth of crossbred calves.

Key words: Crossbred calves, Dry matter intake, Feeding cost, Growth, Skim milk

Efficient feeding management of calves in early life is essential to their health, welfare and future performance. Feeding of colostrum followed by milk makes complete diet for neonatal calves (Tothova *et al.* 2016). Feeding of whole milk to the calves is not economical as butter fat is the costliest component of milk. In view of obtaining good growth performances economically, the whole milk can be partly or completely replaced with variety of ingredients. Among these the easiest one is skim milk which is a by-product of cream separation and is produced when the fat is removed from the whole milk. It had been reported by various workers that the use of skim milk in calf feeding is economical in comparison with the whole milk (Ranjan *et al.* 1972 and Srivastava 1977). However, most of the studies reported better results when skim milk was supplemented with fat sources (Srivastava 1977) or fed after one month from the birth of the calf (Babu *et al.* 2009). The primary purpose of all feeding regimes is to produce better and healthy calves with lowest possible input cost. However,

the cost of raising calves under modified feeding systems needs to be calculated to explore the profitability without any adverse effect on calf's performance. Keeping the above facts in view, the present experiment was undertaken to study the effect of feeding different levels of whole milk and skim milk on performance and feeding economics of crossbred dairy calves.

MATERIALS AND METHODS

Experimental design and feeding schedule: The experiment was conducted from November 2017 to April 2018 at Cattle and Buffalo Farm of the institute. A total of 24 crossbred (Vrindavani) calves were selected for the proposed study. The calves were separated from the dam on the very first day of their birth and were provided with colostrum from their respective dams for the first three days. The calves were allocated alternately but equally into four groups (6 calves per group), viz. control (C), treatment 1 (T1), treatment 2 (T2) and treatment 3 (T3) based on their birth weight. The birth weight of calves was non-significant between the groups. Distribution of male and female calves was in the ratio of 4:2 in all groups. Calves in C were maintained only on whole milk throughout the experiment after colostrum feeding. In T1, skim milk was introduced from 22nd day of age to the level of 25% of total requirement

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which was further increased to 50% from 45th day of age, likewise the corresponding values for T2 and T3 from 22nd day of age were 50% and 75%, respectively which was further increased to 75% and 100% from 45th day of age. Skim milk completely replaced the whole milk in all treatment groups from 64 days of age onwards. Skim milk had chemical composition of fat 0.23%, protein 3.36%, lactose 4.68%, solids-not-fat (SNF) 8.90%, total solids 9.13% and moisture 90.87%. Calf starter and green fodder were provided *ad lib.* to all the groups from second week of age. Among green fodder mainly chopped maize, oats and berseem were provided based on availability during the season. Feeding schedule of all groups is presented in Table 1.

Management of calves: After colostrum feeding, calves were fed with whole milk and skim milk as per the experimental design. Milk and skim milk were boiled and cooled down to body temperature before feeding and each calf was fed twice daily at morning (8:00 AM) and evening (5:00 PM). The calves were housed individually in well ventilated, clean and dry cemented concrete pens for 20 h (from 2:00 PM to 10:00 AM) throughout the experimental period. They were let loose for 4 h (10:00 AM to 2:00 PM) daily in an open paddock for exercise and also to facilitate washing, cleaning and drying of calf pens. Free access to fresh, clean and wholesome water was given to the calves.

Parameters recorded: The body weight (kg) of calves was recorded at weekly interval from birth till the end of the experiment using digital weighing balance. Based on the difference in body weights at different intervals, the weight gain, average daily gain (ADG) and total weight gain (TWG) of calves were calculated. Dry matter intake (DMI) from all feed sources was calculated separately and then all were added to find out the total DMI for all calves. Feed samples were collected at fortnightly interval for dry matter estimation. Dry matter content of calf starter and green fodder was analyzed as per the standard procedure (AOAC 2005). Chemical composition of milk and skim milk was measured using automatic milk analyzer (Lactoscan®). Feed efficiency was calculated as gain in body weight (kg) per unit kg dry matter intake.

Calculation of feeding cost: The total cost of feeding per calf was calculated on the basis of prevailing market price of all the feed sources on fresh matter basis, viz. whole

milk @ ₹ 45/kg, skim milk @ ₹ 25/kg, calf starter @ ₹ 22/kg and green fodder @ ₹ 3/kg at the time of experiment. Cost of feeding was estimated in terms of total average cost as per calf and total cost of feeding per unit kilogram (kg) gain in body weight.

Statistical analysis: The data generated in this study was analyzed as per standard procedures (Snedecor and Cochran 1994) using SPSS version 22.0 software. The one way analysis of variance (ANOVA) was used to see the level of significance for all the parameters.

RESULTS AND DISCUSSION

Body weight gain of calves: The mean birth weight of calves in C, T1, T2 and T3 was 22.68±1.48, 22.60±2.46, 22.92±0.58 and 22.83±2.18 kg, respectively (Table 2). The mean birth weight of calves was not significantly different from each other in groups. The final body weight of calves at the end of experiment was 50.62±2.28, 51.17±6.88, 52.07±3.91 and 53.67±4.67 kg for control, T1, T2 and T3 groups, respectively. The final body weight was higher in T3 followed by T2, T1 and control, but the difference was non-significant. The present findings were in agreement with previous studies (Jenkins and Bona 1987, Babu 2000) where similar final body weight was reported when milk was replaced by skim milk by 50% of total requirement.

Table 2. Average body weight of calves (Mean±SE)

Weeks	Control	Treatment-1	Treatment-2	Treatment-3
At birth	22.68±1.48	22.60±2.46	22.92±0.58	22.83±2.18
1	24.24±1.65	23.73±2.77	24.15±0.57	24.16±2.63
2	24.45±1.31	24.32±2.69	25.40±0.72	25.23±2.81
3	25.72±1.38	26.05±2.98	26.70±0.96	27.25±2.68
4	28.83±1.49	28.25±3.40	31.08±1.59	31.17±3.21
5	31.17±1.66	30.62±3.93	33.83±2.12	33.75±3.09
6	34.08±1.70	33.82±4.51	36.83±2.55	37.17±4.06
7	36.83±1.74	36.83±5.04	39.67±2.64	40.67±4.62
8	40.83±2.32	40.72±5.67	42.83±2.75	44.17±4.69
9	44.67±2.33	45.08±6.12	47.17±3.68	48.92±4.89
10	50.62±2.28	51.17±6.88	52.07±3.91	53.67±4.67
TWG*	24.90±1.24	25.12±3.95	25.37±3.02	26.42±2.30
Overall ADG*	0.488±0.024	0.492±0.077	0.497±0.059	0.518±0.045

*TWG and ADG were calculated from 4th week of age.

Table 1. Feeding schedule of calves

Days	Amount (of BW)	Control (C)	Treatment 1 (T1)		Treatment 2 (T2)		Treatment 3 (T3)	
		W M	W M	S M	W M	S M	W M	S M
4-21	1/10 th	100%	100%	Nil	100%	Nil	100%	Nil
22-44	1/10 th	100%	75%	25%	50%	50%	25%	75%
45-56	1/10 th	100%						
45-63			50%	50%	25%	75%	Nil	100%
57-63	1/20 th	100%						
64-72	1/40 th	100%	Nil	100%	Nil	100%	Nil	100%

WM, Whole milk; SM, Skim milk; BW, Body weight.

The total body weight gain of calves in C, T1, T2 and T3 was 24.90 ± 1.24 , 25.12 ± 3.95 , 25.37 ± 3.02 and 26.42 ± 2.30 kg, respectively which differed non-significant from each other. The body weight gains did not differ significantly for any week during the experiment. The overall ADG of calves in C, T1, T2 and T3 was 0.488 ± 0.024 , 0.492 ± 0.077 , 0.497 ± 0.059 and 0.518 ± 0.045 kg, respectively which differed nonsignificantly from each other. The ADG did not differ significantly for any week during the experiment. Present results were in conformity with the findings of Ranjhan *et al.* (1972) who found that average weight gain of calves fed with different levels of milk and skim milk for varying period was not significantly different. Similar results were also obtained by other researchers when skim milk was supplemented with any energy source like jaggery (Sharma and Tripathy 1978) or lard (Srivastava 1977). The value of overall ADG obtained in present study was similar to the results of Terosky *et al.* (1997) and Lammers *et al.* (1998).

Dry matter intake (DMI): The total dry matter intake (TDMI) of calves at the end of experiment was 55.51 ± 3.67 , 57.48 ± 9.67 , 61.26 ± 7.83 and 65.53 ± 5.19 kg for C, T1, T2 and T3 groups, respectively. The TDMI was higher in T3 group followed by T2, T1 and C group, but the difference was statistically non-significant between the groups. This was supported by previous studies (Bharti *et al.* 2012, Huuskonen 2017) in which researchers reported non-significant between control and treatments groups. The TDMI increased throughout the experimental period without any decline in all the groups till the end of experiment. Overall contribution of dry matter from liquid feed was 31.12, 27.17, 24.50 and 21.41% of TDMI in C, T1, T2 and T3, respectively whereas it was 68.88, 72.83, 75.50 and 78.59% of TDMI in C, T1, T2 and T3, respectively for solid feed. DMI from milk was highest in C and lowest in T3 and DMI from skim milk was highest in T3 because of the experimental design. Overall DMI from calf starter and green fodder was non-significant between the groups; however it was higher in T3 group. The weekly calf starter intake on DM basis was significantly ($P < 0.05$) higher in T3 compared to C but T1 and T2 were non-significant to either C or T3 during fourth week of age. At fifth and sixth weeks of age also, the starter intake was significantly ($P < 0.05$) higher in T3 group compared to C but, both C and T3 did not show any significant difference as compared to T1 and T2 group (Fig. 1). The starter intake

Table 3. Dry matter intake and feed efficiency of calves

DMI in kg	Control	Treatment 1	Treatment 2	Treatment 3
(4–10 weeks of age)				
Milk	17.27 ± 0.82	10.69 ± 1.21	6.63 ± 0.38	2.34 ± 0.23
Skim milk	—	4.92 ± 0.68	8.38 ± 0.52	11.69 ± 1.12
Calf starter	27.55 ± 1.89	30.67 ± 5.57	34.14 ± 5.07	38.33 ± 2.62
Green	10.68 ± 1.02	11.20 ± 2.30	12.12 ± 1.97	13.18 ± 1.60
Total DMI	55.51 ± 3.67	57.48 ± 9.67	61.26 ± 7.83	65.53 ± 5.19
Feed fodder efficiency	0.45 ± 0.02	0.44 ± 0.01	0.42 ± 0.02	0.40 ± 0.01

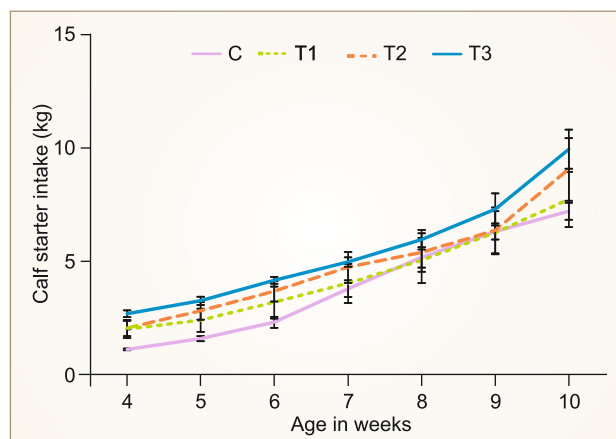


Fig. 1. Weekly calf starter intake (kg) of calves on DM basis.

did not show any significant difference between the groups from 7 to 10 weeks of age. The result in present study was in agreement with Jenkins and Bona (1987) who observed a 23% increase in starter consumption in skim milk group over the control group. Khan *et al.* (2007) reported that calves fed lower milk ration attempted to compensate with increased intake of calf starter, especially after 4 weeks of age.

Feed efficiency (FE): The overall feed efficiency of calves was 0.45 ± 0.02 , 0.44 ± 0.01 , 0.42 ± 0.02 and 0.40 ± 0.01 for C, T1, T2 and T3 groups, respectively. The overall feed efficiency was higher in C followed by T1, T2 and T3, but the difference was non-significant. Range of feed efficiency in present experiment was comparable with a study in which high protein and low energy milk replacer on feed efficiency was compared with low protein and high energy milk replacer (Lee *et al.* 2008). The feed efficiency obtained in present study was comparable with Huuskonen (2017) who fed calves with skim milk based milk replacer.

Feeding economics of calves: Feeding economics per calf was calculated based on the feed intake of calves on fresh matter basis.

The mean cost of feeding from 4 to 10 weeks of age (experimental period) was highest in C (₹ 6904.54) followed by T1 (₹ 6,058.53), T2 (₹ 5704.41) and lowest in T3

Table 4. Total cost (₹) of feeding per calf

Particular	Control	Treatment 1	Treatment 2	Treatment 3
Whole milk	5988.75	3706.31	2299.50	811.69
Skim milk	0.00	1347.60	2294.17	3200.94
Calf starter	687.74	765.48	851.97	956.63
Green fodder	228.06	239.14	258.77	281.37
1 to 3 weeks	1970.55	1970.55	1970.55	1970.55
4 to 10 weeks	6904.54	6058.53	5704.41	5250.63
Overall (1 to 10 weeks)	8875.09	8029.08	7674.96	7221.18
Cost per kg gain (4 to 10 weeks)	277.80 ^a	249.21 ^{ab}	235.87 ^{ab}	199.56 ^b

^{ab}Means bearing different superscripts within a row differ significantly ($P < 0.05$).

(₹ 5250.66). This reveals that feeding cost from 4 to 10 weeks of age was 12.50% lower in T1, 17.38% lower in T2 and 23.95% lower in T3 in comparison to C group. The difference in the total cost of feeding appeared to be due to the fact that the calves maintained on skim milk has lowest input cost from liquid feed compared calves maintained only on whole milk. Likewise the cost of feeding from concentrate was higher in T3 because of higher calf starter consumption from the group. But this has caused mild increase in total cost compared to whole milk fed group. The cost of feeding per kg weight gain (Table 4) in calves was lowest in T3 (₹ 199.56) followed by T2 (₹ 235.87), T1 (₹ 249.21) and highest in C (₹ 277.80). These results show that we can get a higher rate of daily gain as well as economize the calf feeding by replacing the whole milk with skim milk at the rate of 75% from 22nd days of age. The findings in present study were in agreement with earlier report (Thorat and Nagpaul 1982) where conventional Indian whole milk feeding and with partial or total replacement of milk by skimmed milk was compared in Karan Swiss calves. Bharti *et al.* (2011) reported that the total cost of feeding per calf was significantly higher in whole milk group than skim milk and milk replacer group.

From the present study it can be concluded that replacement of whole milk with skim milk from 22nd and 45th days of age at the rate of 75% and 100%, respectively had comparable growth performance and reduced feed cost up to 23.95% with respect to whole milk feeding in crossbred calves.

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