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Effect of Feeding Milk Replacer on Dry Matter Intake and Feed Efficiency in Holstein x Kankrej Crossbred Calves

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Abstract

An experiment was conducted on HF x Kankrej crossbred calves to study the effect of formulated milk replacer on nutrients intake, feed conversion efficiency, cost of feeding and disease incidence. Eighteen newly born calves of either sex were selected. The calves were fed colostrum up to 3 days and from 4th to 9th day whole milk at the rate of 12.5% of body weight. From 10th day the calves were randomly distributed in to three treatment group. The calves of T1 group received whole milk as per routine farm practice; T2 group was fed whole milk and commercial milk replacer as per manufacturer's recommendation, whereas T3 group calves received formulated milk replacer @ 12.5 % of body weight with upper limit of 4 kg per day. The overall initial (day 10) and final (day 94) body weight of calves were 27.71±6.53 and 44.96±10.60 kg, respectively. Overall average dry matter intake (DMI) per day, as per cent body weight and per kg metabolic body weight ($W^{0.75}$) was 0.52±0.02 kg, 1.45±0.03 kg and 35.34±0.78 g, respectively. The dry matter intake in T1 was significantly higher followed by T2 than T3. Overall intake of total digestible nutrients (TDN) on daily, per cent body weight and per kg $W^{0.75}$ basis was 0.546±0.02 kg, 1.28±0.04 kg and 31.03±0.87 g, respectively. The DM intake for each kg gain was significantly lower in T3 (3.07 kg) and T1 (3.02) than T2 (4.79 kg) calves. The feed conversion efficiency (TDN intake kg/kg gain) was significantly superior in T3 (2.22) followed by T2 (4.23), whereas in T1 (2.95) it was intermediate. The feed cost and total rearing cost were lower ($p<0.05$) for farm formulated milk replacer (T3) than commercial milk replacer (T2) and was highest for milk feeding (T1) group. The feed cost and total rearing cost per unit gain in weight were also lower ($p<0.05$) for farm formulated milk replacer (T3) than other two groups. The disease incidences were intermediate in farm formulated milk replacer (T3). Thus, raising crossbred calves on farm formulated milk replacer can be a better option for economic gain of farmers, health of calves and (sparing) more milk for humans.

Kew words: Crossbred calves, Dry matter intake, Disease incidences, Feed conversion efficiency, Milk replacer and, Economics

Introduction

Dairy animal occupy unique position in national economy of which cow play a key role. Highest cattle population (FAO, 2007) of country indicate the importance of cow in India's development. As cattle population increases, feeding becomes more challenging due to limited availability grazing land. That's why non-producing animals are always neglected by farmers. However, with scientific management of these non-producers, cost of rearing from birth to calving can significantly be reduced. Even in this non-producing stage maximum expenditure is incurred during first 3 months (90 days after birth) as the young one depends only on milk for survival. Milk can be spared for human consumption provided good quality cheap substitute is available for calf. To reduce the cost of calf rearing on whole milk based feeding and to increase the availability of whole milk in the market, a good quality milk replacer would be a better substitute for the young calves (Heinrichs *et al.*, 1995).

The vulnerability of young calves to stress and its reliance on liquid feed presents a problem in finding an alternate to milk. It has proved difficult to find an acceptable alternative to milk protein, a costly ingredient of milk replacer. Soybeans are a source of high quality, relatively inexpensive protein that has potential to be used as milk replacer. However, soybean contain anti-nutritional factor (trypsin inhibitor), which limits its use as protein source in milk replacer (Dawson *et al.*, 1988). The present experiment was therefore designed to test two such milk substitutes to reduce the cost of rearing crossbred calves and improve the profitability of the farmer.

Materials and Methods

The experiment was conducted on 18 HF X Kankrej crossbred calves (9 males and 9 females) from 10 to 94 days of age at Livestock Research Station, AAU, Anand, Gujarat. The experimental calves were tied individually with chain in well ventilated calf shed and having facilities for protection from adverse climate. The faecal samples were tested for parasitic infestation at start and end of experiment. The calves were dewormed at 21 days and 3 months of age as a farm routine.

All the calves were weaned at birth, fed colostrum within 40 min of birth and then after @ 10% of birth weight for 3 days in two equal parts. From 4^{th} to 9^{th} day of age calves were fed whole milk @ 12.5% of body weight per day maximum up to 4 kg in two equal parts. From 10^{th} day of age calves were distributed in different treatments and were fed whole milk (T1), commercial milk replacer and milk (T2) and formulated milk replacer (T3, Table 1) as given in Table 2. The liquid milk replacer of T2 and T3 were prepared by dissolving 100 g powder in one litre of boiled water and fed at 38 to 40^{0}C temperature in two equal parts.

Measured quantity of commercial concentrate was offered from 15^{th} day of age of calves in clean and dry plastic bowl starting from 50 g/day between 1000 and 1400 hrs and increased by 50 g/ day after complete intake of offered quantity with the upper limit of 300 g/head/day. Measured quantity of good quality lucerne hay was offered from 20^{th} day of age of calves in clean and dry plastic bowl between 1500 hrs and 1700 hrs with care not to cause diarrhoea due to over eating. The offered quantity of milk/milk replacers were consumed without leftover. Left over of concentrate and lucerne hay were measured at 1400 hrs and 1700 hrs, respectively. Dry matter intake was calculated from individual component at biweekly interval.

Feed conversion efficiency (FCE) was calculated as dry matter intake (kg) per kg weight gain. Digestible energy intake was calculated from TDN value of each component used in feeding. Cost of feeding under different treatment was calculated from the daily feed intake and procurement cost of ingredients. Total cost included feeding and treatment cost; other expenses which were similar in all the three groups were not included. The data generated were analysed statistically using procedures laid down by Snedecor and Cochran (2002).

Results and Discussion

Proximate compositions of milk, commercial and farm formulated milk replacers are given in Table 3. The data on nutrients intake and feed conversion efficiency are presented in Table 4.

Table 1: Composition of formulated milk replacer

Ingredients	Proportion	Cost/kg (Rs/ kg)	Total Cost (Rs)	CP (%)
Milk	15.00	24.70	370.50	3.00
Casein	11.00	499.50	5494.50	75.00
Maize	18.00	15.70	282.60	10.00
Soy meal	18.00	31.60	568.80	38.00
Soy seed	15.00	58.00	870.00	25.00
Molasses	8.00	12.00	096.00	-
Palm oil	12.00	68.00	816.00	-
Minerals & Vitamin	2.00	100.00	200.00	-
Salt	1.00	6.00	6.00	-
Total	100.00		8704.40	
Processing cost for items Maize (18 kg), Soymeal (kg) and soy seed (18 kg) i.e. 51 kg @ 3 Rs/kg			153.00	
Total cost of 100 kg (Rs)			8857.40	
Cost per kg of milk replacer (Rs)			88.57	

Table 2: Feeding schedule of different Treatments

Age in days	Treatment-1 (Farm Practice)	Treatment-2 (Commercial MR)	Treatment-3 (Formulated MR)
10-16	Whole milk @ 4 kg/day	3.0 kg whole milk plus 500 gm milk replacer (As per manufacturer)	Milk replacer @ 12.5 % of b.wt. upper limit 4 kg
17-30		1.0 kg whole milk plus 1.5 kg milk replacer	
31-37		3.5 kg milk replacer	
38 -44		4.5 kg milk replacer	
45 -51		5.0 kg milk replacer	
52- 94		4.0 kg milk replacer	

Dry matter intake:

The daily average total dry matter intake (DMI) of crossbred calves in T1, T2 and T3 was 0.68±0.02, 0.48±0.02 and 0.41±0.02 kg, respectively, during the experimental period of 84 days with significant differences ($P<0.05$). The higher intake in T1 group might be higher intake of milk, concentrate and

Table 3: Proximate composition of different feeds (Dry Matter basis)

Feed	DM (%)	CP (%)	EE (%)	CF (%)	NFE (%)	Ash (%)
Milk	12.85	26.85	29.49	0.00	38.21	5.45
Commercial MR	93.75	19.70	18.62	0.41	53.42	7.85
Formulated MR	90.62	25.25	25.58	1.42	41.46	7.29
Amul Dan	87.42	19.37	4.79	9.43	51.07	15.34
Lucerne Hay	87.82	15.90	2.36	36.37	36.65	8.72

Table 4: Body weight, dry matter and nutrients intake; and feed efficiency of crossbred calves fed milk replacers

Parameters	Treatments		
	T1	T2	T3
Body weight (kg)	52.72[a]±4.45	38.87[c]±3.53	43.30[b]±3.07
Average Daily gain (g/day)	294.15[a]±26.96	139.58[b]±11.93	184.03[b]±20.64
DMI (kg/head/day)	0.68[a]±0.02	0.48[b]±0.02	0.41[c]±0.02
DMI (kg/100 kg body weight)	1.70[a]±0.04	1.48[b]±0.05	1.17[c]±0.04
DMI (g/kg$^{0.75}$)	42.57[a]±0.74	35.09[b]±1.09	28.36[c]±0.98
DE intake (MCal/head/day)	0.15[a]±0.02	0.10[b]±0.01	0.07[c]±0.02
DMI kg/kg body weight gain	3.02[b]±0.31	4.79[a]±0.62	3.07[b]±0.69
TDN intake (kg/head/day)	0.65[a]±0.02	0.42[b]±0.01	0.31[c]±0.02
TDN intake (kg/100 kg body weight)	1.64[a]±0.04	1.30[b]±0.06	0.89[c]±0.02
TDN intake (g/kg$^{0.75}$)	40.94[a]±0.68	30.70[b]±0.85	21.45[c]±0.62
TDN intake (kg/kg body weight gain)	2.95[ab]±0.33	4.23[a]±0.55	2.22[b]±0.32

Mean values with different superscripts in a row differ significantly (p< 0.05)

lucerne hay due to inherent property of milk being natural food of young one after birth. Similar dry matter intake (0.61 to 0.67 kg/day) was observed when Holstein calves were fed milk replacer with and without probiotics (Meyer *et al.*, 2001), whereas higher DMI was reported on feeding whole milk + skim milk (control) (0.86 ±0.04 kg), whole milk (0.91±0.05 kg) and milk replacer (0.83±0.05 kg) in Karan Fries and Karan Swiss crossbred calves (Bharti *et al.*, 2011). Feeding of high protein low fat (with soymeal) and high protein high fat milk replacers to Holstein calves resulted in 1651g and 1001 g daily DMI, respectively (Hill *et al.*, 2008). The feeding of acidified milk replacer to dairy calves from 14 to 90 days of age resulted in 1.12 to 1.25 kg daily DM intake (Huuskonen *et al.*, 2011). The feeding of milk and milk replacer with different frequency to Belgian blue double muscled calves revealed 0.82 to 0.93 kg total DMI (Fiems *et al.*, 2013).

The DMI of calves on per cent body weight basis was 1.70±0.04, 1.48±0.05 and 1.17±0.04 kg and that on metabolic body weight basis 42.57, 35.09 and 28.36 g for T1, T2 and T3 treatments, respectively (Table 4). The higher per cent DMI in T1 might be due to higher palatability of milk. The present finding is in accordance with report of Mir *et al.* (1991) on feeding milk replacer with soybean meal. The DMI was 1.39 and 1.36 kg/kg $W^{0.75}$ in Holstein crossbred calves fed milk with and without acidifier, respectively (Ribero *et al.*, 2009) which is lower than finding of present experiment. Daily intake of total digestible energy on total, per cent body weight and on metabolic body weight basis followed the same trend of dry matter intake.

Digestible energy intake:

The daily digestible energy intake under T1, T2 and T3 treatments were recorded to be 0.15±0.02, 0.10±0.01 and 0.07±0.02 Mcal, respectively, with significant (p<0.05) differences between treatments (Table 4). This may be due to more consumption of milk, concentrate and lucerne hay by T1 calves owing to intrinsic quality of milk. The feeding of high and moderate amount of milk replacer to Holstein calves resulted in higher (p<0.01) daily metabolic energy (ME) intake of 5.45 Mcal and 4.75 Mcal, respectively (Hill *et al.*, 2015). The ME intake in Holstein calves fed milk replacer with different protein concentration from birth to 28 days of age was in the range of 3.3 to 3.7 Mcal/day and from birth to 56 days of age in the range of 4.6 to 4.9 Mcal/day (Hill *et al*., 2007). These values of energy intake were higher than finding of present experiment.

Feed conversion efficiency:

On an average the crossbred calves consumed 3.02±0.31, 4.79±0.62 and 3.07±0.69 kg DM for each kg weight gain under treatments T1, T2 and T3, respectively. The feed conversion efficiency was lowest (p<0.05) in T2 calves than T3 followed by T1. Dry matter intake per kg gain was highest in T2 followed by T3 and T1. The formulated milk replacer (T3) showed better feed conversion efficiency compared to commercial milk replacer (T2). The feed conversion efficiency differed significantly in Holstein crossbred calves from birth to three months of age. It was observed to be 2.08±1.14 (control), 1.68±0.06 (whole milk) and 2.49±1.14 (milk replacer) kg DMI/kg gain in weight (Bharti *et al*., 2011). The feed conversion efficiency (kg DM/kg gain) of Red Sindhi male calves was significantly superior when fed weaning diet having 16% CP and 2.8 Mcal ME/kg than feeding whole milk, while feed conversion efficiency (2.96, 3.05 and 2.87) was only numerically superior when fed weaning diet having 16±3.0, 18±2.8 and 18±3.0 CP%±ME Mcal/kg, respectively (Javaid *et al*., 2015). The non-significant difference in DMI/kg gain was observed in Belgian Blue double-muscled female calves fed milk replacer having whey protein and wheat starch (Fiems *et al*., 2013).

Economic efficiency:

The daily feed cost and total rearing cost per head/day and per kg weight gain differed significantly (P<0.05) in different treatment groups; the lowest being in T3 than T2 and the highest in T1 (Table 5). However, T1 and T2 groups were at par for gain in weight. The cost per kg gain in T3 calves was lower than T1 by 40.46 % and T2 by 36.54 %. Low feed cost in T3 group was due to inclusion of low cost plant protein in place of milk protein. The total cost of feeding of Karan Fries and Karan Swiss calves from birth to 3 month of age on whole milk + skim milk, whole milk and milk replacer was observed to be Rs. 5197.85±383.40, 5973.03 ±374.90 and 3272.21±304.10, respectively (Bharti *et al.*, 2011), which supports the present findings of lower feed cost in farm formulated milk replacer (T3). The lower cost of feeding and total rearing cost per kg weight gain in dairy calves on feeding milk replacer has also been reported by Bhatti *et al.* (2012), Khan *et al.* (2012) and Fiems *et al.* (2013).

Table 5: Feeding economics of crossbred calves fed milk replacers

Parameters	Treatments		
	T1	T2	T3
Feed Cost (Rs./head/day)	100.76^{a}±0.54	42.06^{b}±2.08	34.25^{c}±0.88
Feed Cost (Rs./kg body weight gain)	489.25^{a}±84.39	446.13^{ab}±82.16	294.83^{b}±81.27
Total Cost (Rs./head/day)	101.16^{a}±0.29	43.06^{b}±1.8	34.89^{c}±0.63
Total Cost (Rs./kg body weight gain)	491.87^{a} ±60.32	461.46^{ab} ±61.74	342.84^{b} ±72.89

Mean values with different superscripts in a row differ significantly (p< 0.05)

Incidences of disease:

The incidences of diseases in T1, T2 and T3 groups, *viz.* Diarrhoea (4, 7 & 5%), respiratory diseases (1, 2 & 1%), bloat (0, 1 & 0%) and total incidences (5, 10 & 5 %, resp) were found to be lower under T3 groups of calves than T2 and lowest under T1 group. The cost of treatments (Rs. 16, 42 and 24, resp) followed same trend. Lower incidences of disease may be due to higher digestibility of T1 (milk) and T3 milk replacer in comparison to T2 milk replacer. Similar lower incidences of diseases were observed on milk feeding in Sahiwal calves (Bharti *et al*., 2012), in Jersey calves

(Uys *et al.*, 2011) and Holstein crossbred calves (Kmicikewycz *et al.*, 2013) than feeding the milk replacers. The feeding amount of milk replacer to Holstein calves had significant effect on medical days (Mir *et al.*, 1991). Relatively lower incidences of diseases and lower cost of treatment in formulated milk replacer indicated that formulated milk replacer can be used for calves without any detrimental effect on their health.

Conclusion

The nutrient intake, feed conversion efficiency, cost of feeding and incidences of diseases and treatment cost indicated that farm formulated milk replacer could be effectively used, and was beneficial for feeding calves in comparison to feeding commercial milk replacer for better economic returns and saving precious milk for human consumption.

Authors' Contribution:

SV Shah and PR Pandya conceptualized, designed and supervised the study. Ravi Shukla executed study, carried out measurement and laboratory analysis. PM Lunagariya monitored health of calves, drafted and revised the manuscript. Monika Parmar helped in measurement and BS Divekar helped in data analysis and verification.

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Conflict of Interest: All authors declare no conflict of interest.

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