RESEARCH ARTICLE

Growth Performance of Crossbred Calves Fed Total Mixed Ration with *Moringa Oleifera* Leaves

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Abstract

The experiment was designed to study the effect of *Moringa oleifera* leaves inclusion in total mixed ration on 50% protein base replacement of calf starter on growth, feed intake, digestibility, feed efficiency, and cost of feeding in crossbred calves. The fourteen newborn crossbred calves (75% HF x 25% Kankrej) were sequentially allocated to control (T1) and study (T2) groups. The calves were fed using calf starter and 50% calf starter replaced with *M. oleifera* leaves (MOL, both had equivalent protein %), in T1 and T2 group, respectively. Both TMR were having roughage to concentrate ratio 75:25 and 65:35 during 1-14 and 14-18 weeks of age, respectively. The gain in body weight and body measurements like heart girth, body length was similar in both treatments, except wither height, which was lower in T2 group. The intake of dry matter, crude protein, ether extract, nitrogen free extract, metabolizable energy and water (daily, percent and metabolic body weight basis) was statistically similar in both groups, except percent intake of crude protein, metabolizable energy and energy intake on metabolic body weight which was lower in T2 group. The digestibility of nutrients, and feed conversion efficiency were statistically similar in both groups. The cost of feeding for weight gain was 6.26% higher in 50% MOL inclusion T2 group than the control T1 group.

Key words: Crossbred calves, Digestibility, Feed efficiency, Feeding cost, Growth, *M. oleifera* leaves

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Introduction

Increasing livestock populations pose challenges to feed availability in developing countries. The high feed cost and poor availability aggravate the situation in the ruminant livestock production system. This forces the farmers to feed their animals on poor quality straws with low nutritive values than required, thus lowering growth and milk production (Nasrin *et al*., 2014). It is imperative to introduce cheap and easily available unconventional feedstuffs to support livestock development (Oduro *et al*., 2008) in developing countries and nutrient-stressed parts of the world. The healthy rearing of dairy calves is important to create a future replacement for dairy herds. *Moringa oleifera* is a legume tree, a fast-growing, evergreen, or deciduous tree that grows to 10-12 meters height (Mishra *et al*., 2012) and can tolerate stressed, unfavourable growing conditions prevalent in many developing countries of Asia, Africa, and Latin America. It is promising as a protein source (Soltan *et al*., 2012) with an additional source of bioactive compound. *Moringa* leaves protein is considered an alternative to soybean meal and rapeseed meal protein, additionally with higher rumen degradability (Soliva *et al*., 2005). *Moringa* leaves meals can replace high protein concentrate mixture (Shershiya *et al*., 2021) for growing heifers. The leaves have 20-26% crude protein and higher minerals and vitamins (Soltan *et al*., 2012). This experiment was conducted to study the effect of *Moringa oleifera* leaves inclusion in total mixed ration on protein base replacement of calf starter on growth, feed intake, digestibility, feed efficiency, and cost of feeding in crossbred calves.

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Material and Methods

Animals and Dietary Treatment

The present experiment was conducted at Livestock Research Station (LRS), Anand Agricultural University, Anand (Gujarat, India) for 126 days (0 to 126th day) from July 2022 to February 2023 as per approval of IAEC. The fourteen newborn crossbred calves (75% HF x 25% Kankrej) were sequentially allocated to control (T1) and study (T2) groups, 7 in each group. The new-born calves were weaned at birth and fed 12, 16, 12, 8, and 4% milk of body weight during 1, 2-4, 5-7, 8-10, and 11-13 weeks of age, respectively. The calves were fed colostrum and milk for the first three and later four days of the first week. The calves were allowed to exercise for two hours under a controlled environment in loose conditions. The calves were dewormed with broad spectrum dewormer-fenbendazole/piperazine, on 15th and 30th day in the first month and subsequently at the monthly interval. The calves were fed only calf starter during first week and then TMR. The calves were fed using calf starter (Amul brand) and 50% calf starter was replaced with *M. oleifera* leaves (MOL, since both had equivalent protein %), in T1 and T2 group, respectively during different ages (Table 1). PKM-1 variety of *Moringa oleifera* with leaves and soft twigs were used after proper drying.

The weekly body weight of calves was recorded using an electronic weighing balance prior to feeding and watering. The weekly body weight data were used to decide the milk quantity, and biweekly body weight was analyzed. Body measurements like heart girth, body length, and wither height were taken at biweekly intervals before feeding and watering. The metabolizable energy (ME) of the feeds and fodder were sourced from NRC (2001) and Anonymous (2012). The ingredients whose ME was not available and of TMR were calculated using the formula, ME (Mcal/kg) = TDN (%) × 0.0361 (NRC, 2001). ME of milk was calculated (Hall, 2023) using the formula Energy in milk, Kcal/kg = (291.14 Kcal/kg × kg milk) + (10,944 Kcal/kg × kg milk × fat%).

The digestibility of nutrients of TMR was assessed for seven days after at least seven days of adaptation to 65:35 concentrate to roughage TMR between 14th-16th weeks in the experiment. The representative samples of TMRs, leftover, and faeces were analyzed for proximate constituents as per AOAC (1995) and fibre fractions as per Van Soest *et al*. (1991). The cost of feeding calves was calculated based on feed consumption and the unit price of TMR. The price of TMR with 75:25 and 65:35 concentrate to roughage was ₹ 21.94 and 17.11 of T1 TMR and that of T2 TMR was ₹ 19.95 and 15.99, respectively. The data were analyzed using one-way ANOVA on Web-based Agriculture Statistic Package-WASP 2.0 (Jangam and Wadekar, 2004). The difference between the treatment means was considered significant at $p<0.05$.

Results and Discussion

Growth Performance

The final body weight (kg) and gain in wither height of crossbred calves was significantly lower in T2 than the control T1 TMR group. While the gain in body weight, heart girth, and body length were not influenced by T2 TMR. A similar effect was also noticed on the mean and final measurement of body weight, heart girth, body length, and wither height (Table 2). The gain in body weight was an important parameter and was not influenced by 50% replacement of calf starter with

Table 1: Proportion and Composition of Total mixed ration (TMRs) on dry matter bases

Parameters	TMR 1	TMR 2	TMR 1	TMR 2
Concentrate to roughage ratio	75:25		65:35	
Period of feeding (weeks)	2-13		14-18	
Ingredient proportion (kg)				
Calf starter added with 0.5 % mineral premix	75.00	37.50	65.00	32.50
Moringa oleifera leaves MOL	0.00	37.50	0.00	32.50
Sorghum hay	15.00	15.00	17.25	17.25
Green hybrid napier	10.00	10.00	17.75	17.75
Total	100.00	100.00	100.00	100.00
Composition (%)				
Dry matter	72.04 ±0.81	74.42 ±2.31	62.62 ±3.32	67.75 ±7.55
Crude protein	18.65 ±0.06	17.75 ±0.07	16.34 ±1.15	15.77 ±0.88
Crude fibre	20.89 ±1.10	21.97 ±0.01	22.45 ±0.21	22.08 ±0.05
Ether extract	5.27 ±1.42	5.83 ±0.96	2.35 ±0.03	3.60 ±0.04
Ash	8.67 ±0.13	10.04 ±0.09	9.09 ±0.13	10.29 ±0.17
Nitrogen free extract	46.83 ±0.70	44.41 ±0.18	48.48 ±0.01	46.29 ±0.19
Neutral detergent fibre	50.10 ±0.04	54.07 ±0.27	50.59 ±0.55	54.29 ±0.14
Acid detergent fibre	24.75 ±0.63	26.81 ±0.63	26.06 ±0.13	27.93 ±0.10

MOL in TMR. The result indicates that 50% MOM can be used to replace calf starter (i.e. 50 % protein) in TMR for crossbred calves. This may be due to superior supply of protein for growth with limiting amino acids like lysine and methionine through MOM (Henuk, 2018).

Similarly, a non-significant effect was reported in crossbred heifers fed TMR with 5% and 7.5% *Moringa* meal replacing concentrate mixture (Sherasiya *et al*., 2022). The contrasting higher and lower gain was reported in growing cattle. The higher body weight gain was observed in Murrah buffalo calves (Aharwal *et al*., 2018; Aharwal *et al*., 2019) fed a diet with 5, 10, and 15% *Moringa oleifera* leaf meal replacing calf starter. Similarly, higher body weight gains were also reported by Kekana *et al*. (2021) and Abdel-Raheem and Hassan (2021).

Table 2: Growth performance of crossbred calves

Parameter	T1	T2	P value
Initial body weight (kg)	29.86±2.07	30.31±1.05	0.847
Final body weight (kg)	117.17±2.76^{a}	108.00±3.05^{b}	0.046
Body weight gain (kg)	87.31±3.53	77.69±2.88	0.056
Mean body weight (kg)	69.91±1.58	68.71±1.99	0.802
Mean daily body weight gain (kg/day)	0.693±0.03	0.617±0.02	0.220
Initial heart girth (cm)	75.05±1.39	76.21±1.06	0.526
Final heart girth (cm)	117.43±1.58	114.79±1.30	0.221
Gain in heart girth (cm)	42.36±1.88	38.57±0.72	0.084
Mean heart girth (cm)	98.26±1.58	97.87±1.51	0.859
Initial body length (cm)	68.21±1.60	66.86±1.79	0.583
Final body length (cm)	105.29±1.20	101.93±1.01	0.054
Gain in body length (cm)	37.07±1.65	35.07±1.73	0.419
Mean body length (cm)	88.25±1.43	86.22±1.33	0.300
Initial wither height (cm)	73.14±1.41	74.57±1.60	0.516
Final wither height (cm)	104.57±1.20	102.07±1.39	0.198
Gain in wither height (cm)	31.43±1.00^{a}	27.50±1.39^{b}	0.041
Mean wither height (cm)	91.30±1.19^{a}	90.52±1.09^{b}	0.631

Feed and Nutrient Intake

The percent intake of crude protein-CP and metabolizable energy-ME as well as ME intake on metabolic body weight was significantly lower in 50% MOL (T2) TMR than in control (T1) TMR, while intake of dry matter (DM), ether extract (EE), nitrogen free extract (NFE), and water (daily, percent and metabolic body weight basis) had a non-significant effect of MOM inclusion in TMR. The daily intake of CP and ME as well as CP intake per kg metabolic body weight also followed the same trend. The age of nibbling of calves also did not differ on MOM inclusion in TMR (Table 3).

The lower intake of energy may be due to the combined effect of lower DMI and NFE content of T2 TMR. Similar results on non-significant intake were reported in the crossbred heifers (Sherasiya *et al*, 2022), in growing Bali males (Fattah *et al*., 2017), in Murrah buffalo calves (Aharwal *et al*. 2018; Aharwal *et al*. 2019), and in dairy cows (Shankhpal *et al*., 2019). Contradictory to the present findings, significantly higher DM and nutrient intake was observed by Parmar *et al*. (2021), Kekana *et al*. (2021), and Yang *et al*. (2019) in various category of dairy animals, while lower intake was reported by Elaidy *et al*. (2017) in the suckling buffalo calves fed calf starter with 5, 10 and 15% *M. oleifera* leaves.

Table 3: Dry matter and nutrient intake of crossbred calves during the experiment

Parameter	T1	T2	P value
DM (kg/day)	1.580±0.065	1.443±0.088	0.422
DM (kg/100 kg BW)	2.097±0.049	1.978±0.073	0.195
DM (g/kg $W^{0.75}$)	60.82±1.70	56.99±2.38	0.286
CP (kg/day)	0.322±0.013	0.290±0.016	0.245
CP (kg/100 kg BW)	0.453^{a}±0.008	0.424^{b}±0.012	0.041
CP (g/kg $W^{0.75}$)	12.94±0.31	12.02±0.41	0.061
EE (kg/day)	0.159±0.006	0.166±0.007	0.424
EE (kg/100 kg BW)	0.292±0.003	0.299±0.003	0.824
EE (g/kg $W^{0.75}$)	7.82±0.14	8.05±0.14	0.752
NFE (kg/day)	0.708±0.030	0.626±0.041	0.327
NFE(kg/100 kg BW)	0.906±0.022	0.830±0.034	0.141
NFE (g/kg $W^{0.75}$)	26.56±0.77	24.12±1.10	0.210
Cal. ME (Mcal/day)	4.960±0.198	4.346±0.241	0.133
Cal. ME(Mcal/100 kg BW)	6.917^{a}±0.136	6.318^{b} ±0.188	0.001
Cal. ME(Kcal/kg $W^{0.75}$)	198.04^{a} ±4.98	179.20^{b}±6.25	0.008
Water intake (l/day)	5.389±0.232	6.310±0.500	0.370
Water intake (l/ 100kg BW)	6.234±0.286	7.122±0.439	0.348
Water intake(ml/$W^{0.75}$)	2958.75±124.26	3337.26±220.55	0.416
Age of nibbling (days)	7.57±1.78	8.14±1.91	0.831

Where DM=Dry matter; CP=Crude protein; EE=Ether extract; NFE=Nitrogen free extract; ME=Metabolizable energy

Nutrient Digestibility

The digestibility of dry matter, organic matter, crude protein, ether extract, nitrogen freed extract as well as fibre components like neutral detergent fibre, acid detergent fibre, and nutritive value of TMR (DCP%, TDN%, Mcal ME/kg diet) was statistically similar in both treatment groups (Table 4). The optimum supply and digestibility of nutrients from MOM maintained digestibility in T2 TMR. In accordance with our findings, Fattah *et al*. (2017), and Sherasiya *et al*. (2022) reported the non-significant influence of MOM inclusion on the digestibility of nutrients in various categories of dairy animals. However significantly higher nutrients digestibility in the diet was reported by Elaidy *et al*. (2017), and Malik *et al*. (2019), whereas Cohen Zinder *et al*. (2016) reported reduction in digestibility nutrients. The nutritive value of the TMRs fed in the later phase of growth with 65:35 concentrate: roughage ratio, was also having a non-significant difference. The DCP

content of T2 TMR was numerically lower, may be the reason for numerically lower body weight gain of crossbred calves.

Table 4: Nutrient digestibility (%) and nutritive value (%) of TMRs

Digestibility Parameter	T1	T2	P value
Dry matter digestibility	64.56±1.49	66.37±1.78	0.451
Organic matter digestibility	63.43±1.53	64.73±1.84	0.597
Crude protein digestibility	64.48±2.41	61.66±1.53	0.343
Ether extract digestibility	69.01±2.47	71.56±2.24	0.459
Nitrogen free extract digestibility	70.24±1.90	71.04±2.82	0.818
Crude fibre digestibility	50.66±3.21	55.46±1.94	0.224
Nuetral detergent fibre digestibility	62.26±2.30	62.20±5.24	0.991
Acid detergent fibre digestibility	42.63±4.63	51.25±3.66	0.156
Nutritive Value of 65:35 concentrate: roughage ratio TMR			
Digestible crude protein (%)	12.03±0.45	10.94±0.27	0.062
Total digestible nutrients (%)	60.40±1.34	61.87±1.68	0.506
Metabolizable energy (Mcal/kg diet)	2.18±0.05	2.23±0.06	0.505

Feed Conversion Efficiency and Feeding Economics

The feed conversion efficiency on the bases of dry matter, crude protein, and metabolizable energy was non-significant between the treatment groups (Table 5). Moreover, higher values in T2 group were indicative of the numerically reduced efficiency to convert feed nutrients into body mass. In line with the present study, a non-significant effect of *Moringa* inclusion was noted in crossbred heifers (Sherasiya *et al*., 2022) and in Gir calves (Parmar *et al*., 2021), while improvement was reported in buffalo calves (Elaidy *et al*. (2017; Abdel-Raheem and Hassan, 2021), and in dairy cattle (Khalel *et al*., 2014).

The cost of feeding for weight gain was also statistically similar in both groups and it was 6.26% higher in 50% MOL inclusion T2 group compared to the control T1 group (Table 5). Similarly, Sherasiya *et al*. (2022) observed an increase in the feed cost per kg gain in body weight of the crossbred heifers fed TMR with 5% MOM. While reduced feed cost per unit body weight gain in buffalo calves (Elaidy *et al*., 2017; Aharwal *et al*., 2019), and in Gir calves (Parmar *et al*., 2021) was reported on feeding diet with various levels of Moringa.

Table 5: Feed conversion efficiency and cost of feeding in experimental group of crossbred calves

Parameter	T1	T2	P value
Feed Conversion Efficiency			
kg DM/ kg gain	2.35±0.20	2.68±0.14	0.213
kg CP/ kg gain	0.51±0.05	0.56±0.03	0.280
Calculated ME Mcal / kg gain	7.63±0.67	8.24±0.44	0.411
Feed cost			
Total feed cost (Rs./ calf)	18799.24±678.87	17937.19±755.52	0.413
Daily feed cost (Rs./day/calf)	149.20±5.39	142.36±6.00	0.413
Feed cost (Rs./kg gain)	218.06±14.74	231.72±9.27	0.448
Change over control		+13.66	
Percent change over control		+6.26%	

Conclusion

The feeding TMR with calf starter, in which 50% protein was replaced with *M. oleifera* leaves, maintained body weight gain, nutrient intake, digestibility of nutrients, and feed conversion efficiency with a higher cost of feeding for weight gain in crossbred calves.

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