

The Physiological Response and Health Attributes of Crossbred Calves Fed Conventional Feeding System and Total Mixed Ration with different Levels of Concentrate and Roughage

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ABSTRACT: The feeding of dairy calves for higher growth with the economy is challenging for the dairy farmer. Two feeding systems-conventional and total mixed ration (TMR) available, for improving growth and in the TMR system again level of concentrate and roughage needs optimization. The experiment was conducted to evaluate the effect of different levels of concentrate and roughage in a total mixed ration on physiological response and health attributes in crossbred calves. Twenty-four crossbred calves with identical body weights were randomly divided into four treatment groups, each with six animals from the 8th to 91st days of age. Traditionally, the T1 group received concentrate and roughage separately, whereas the T2, T3, and T4 groups received concentrate and roughage in the following proportions of 85:15, 75:25, and 65:35, respectively. The physiological responses *viz.*, rectal temperature, respiratory rate, and pulse rate were assessed at 7:30 am at weekly intervals. The blood was collected from the calves at the beginning, middle, and end of the experiment for the haematology (WBCs, RBCs, haemoglobin, and packed cell volume) and blood biochemical parameters (glucose, calcium, phosphorus, total protein, albumin, globulin, SGOT, SGPT). The faecal consistency of all the calves was observed daily and a score was given. The rectal temperature was significantly higher ($P < 0.05$) under the T1 group as compared to other groups, but was within the normal range. The respiratory rate and pulse rate did not differ significantly among the treatments. The various haematological parameters like WBCs, RBCs, Hb, and PCV were not influenced significantly. The protein and energy nutrition were optimum indicated by levels of total protein, albumin, globulin, and albumin to globulin ratio and were not influenced by different concentrate to roughage ratios. The glucose level was linearly increased with an increased concentrate to roughage ratio. The SGOT and SGPT did not differ with various concentrate to roughage ratios but were found lowest in the conventional feeding system. The calcium and phosphorous did not differ between different treatments. It can be concluded from the finding that feeding of TMR with 85:15, 75:25 and 65:35 concentrate to roughage ratio was found safe for crossbred calves.

Keywords: Crossbred calves, total mixed ration, concentrate: roughage ratio, physiological responses, haematology, serum biochemistry, faecal consistency.

INTRODUCTION

The development of the reticulo-rumen and associated microbial population is important in ruminant calves for adequate utilization of dry and forage-based feeding regimes (Heinrichs and Lesmeister, 2005). A feeding program including roughage and concentrate feed should be useful alongside milk supply to provide early rumen development in the calves (Cozzi *et al.*, 2002). Less roughage and higher concentrate ingestion in dairy calves result in fat deposition in the animal body and

will reduce feed conversion ratios (Basaran and Gurbuz 2000). Roughages could be used for the normal development of the rumen during the preweaning period (Coverdale *et al.*, 2004). The use of roughages during the preweaning period may have arumen developmental effect in calves (Lyford and Huber, 1988). It may improve rumen action, volume, muscularity, support epithelium and papillae development (Tamate *et al.*, 1962). Total mixed ration (TMR) can be described as a mixture of both roughage and concentrate ingredients to meet the needs of the

animal. Concentrate diets have the chance of increasing the risk of rumen disorders and hepatic abscesses because of higher acid production particularly lactic acid depresses rumen pH, kills microbes and produces histamine. Extensive feeding of a high-concentrate diet leads the animal to subacute ruminal acidosis (SARA) in which rumen pH was 5.6 or 5.8 as a result of excessive production of lactic acid and volatile fatty acids (VFA). The acute phase protein (APPs) in peripheral blood increased as a result of SARA induced by a high concentrate diet. The elevated acute phase proteins (APPs) reflect the health condition of animals (Abdel Raheem *et al.*, 2018). The varying level concentrate in ration of the calf has a beneficial or harmful effect on health. The optimum level of concentrate: roughage ratio in the ration is an essential factor for the healthy growth of calves. The present study was planned to investigate the effect of different concentrate to roughage ratios on the physiological responses, blood metabolites, and serum biochemical parameters in preweaned crossbred calves.

MATERIALS AND METHODS

After receiving approval from the Institutional Animal Ethics Committee (348/LRS/2021), the current investigation was conducted at the Livestock Research Station of the Anand Agricultural University in Anand, Gujarat. Twenty-four crossbred calves with identical body weights were chosen and randomly divided into four treatment groups, each with six animals. Crossbred calves had identical body weights of 31.30 ± 1.67 , 33.10 ± 1.17 , 32.77 ± 0.76 , and 32.80 ± 0.76 , respectively in T1, T2, T3 and T4 groups. From the 8th day of age through the 91st day, the experiment was carried out. In all four treatments, each calf was fed colostrum 4.0 litre per day up to the first 3 days of age. The fresh milk was offered 4.0, 6.0, 4.0, and 2.0 litre per day during 4-15 days, 16-42 days, 43-63 days, and 64-91 days of age of calves, respectively in equal two halves at 06:30 and 17:00 hrs using nipple bucket. Feed ingredients were Hybrid Napier (HN), Jowar hay, and Compounded Concentrate Mixture (CCM). According to traditional practise, the T1 group received concentrate and roughage separately, whereas the T2, T3, and T4 groups received concentrate and roughage in the following proportions: 85:15, 75:25, and 65:35, respectively. The calves in the T1 group (the control) were given concentrate and dry roughage *ad-libitum* starting from the 8th and 15th day, respectively, while chaffed green fodder was given at a rate of 500 g/d starting from the 42nd day. TMR was given *ad-libitum* to calves in T2, T3, and T4 groups from day 8 onwards.

Physiological responses: The physiological responses of calves *viz.*, rectal temperature ($^{\circ}$ F), respiratory rate (counts/min), and pulse rate (beats per minute) were assessed at 7:30 am at weekly interval. A semiotic approach with a stethoscope was used to determine calf pulse rate. The calf was auscultated while standing. From a safe distance, the calf's respiratory rate was recorded by counting the movements of the calf's right flank and lower abdomen. The rectal temperature was measured in degrees Fahrenheit ($^{\circ}$ F) using a clinical digital thermometer inserted into the rectum and kept in contact with the mucosa until it stabilized.

Blood Haematology: The blood was collected from each calf prior to feeding, and watering, at the beginning, middle, and end of the experiment. The blood was collected aseptically in a vacutainer from the jugular vein in vacuette (EDTA and clot activator). The hematological parameters such as WBCs ($10^3/L$), RBCs ($10^6/L$), haemoglobin (g/dl), and packed cell volume (%) were estimated from whole blood using automatic analyzer (Mindray – BC -2800 VET).

Serum biochemistry: The serum biochemical parameters like glucose (mg/dL), calcium (mg/dL), phosphorus (mg/dL), total protein (g/dl), albumin (g/dl), globulin (g/dl), SGOT (U/L), and SGPT (U/L) were estimated using Coral kits in Mindray BS-120 chemistry analyser.

Faecal consistency: The faecal consistency of all the calves was observed daily and a score was given *i.e.*, 1=Normal, 2=Semi-solid, 3=Runny/Spread, 4=Watery (Larson *et al.*, 1977). Experimental data generated using a completely randomized design was analyzed as per Snedecor and Cochran (1994).

RESULTS AND DISCUSSIONS

Physiological Responses: The effects of feeding TMR with different concentrate to roughage ratios on physiological responses, *viz.*, rectal temperature, respiration rate, and heart rate are presented in Table 1. The rectal temperature was significantly higher ($P < 0.05$) under the T1 group as compared to other groups, but was within the normal range. The respiratory rate and pulse rate did not differ significantly among the treatments. These findings indicated that feeding of crossbred calves with conventional system and TMR with varying level of concentrate and roughage has no adverse effect on the health. The reported values were within physiological range as reported by Aiello *et al.* (2016). The present findings were in support with Beiranvand *et al.* (2016) who reported non-significant physiological responses in Holstein calves except rectal temperature which was higher in the control group. The present finding was also in range as reported by Patel (2021) who researched the effect of a high plane of diet on crossbred calves.

Haematological Parameters: The effects of TMR with different concentrate to roughage ratios on WBCs, RBCs, Hb, and PCV are presented in Table 2. The value of haematological parameters like WBCs, RBCs, Hb, and PCV were not influenced significantly by different treatment. The mean WBCs, RBCs, Hb, and PCV were within the normal range (Aiello *et al.*, 2016) in the normal dairy cows. These findings indicate that feeding conventional and TMR with different concentrate to roughage ratios in the crossbred calves were without pathological effect *i.e.* safe to feed. The present finding was in line with Daneshvar *et al.* (2015); Patel (2021), with regards to normal range of WBCs, RBCs, Hb, and PCV.

Biochemical Parameters: The effect of feeding TMR with different concentrate to roughage ratios on blood biochemical *viz.*, total protein, albumin, globulin, albumin: globulin ratio, serum glucose, SGOT-Serum Aspartate Aminotransferase, SGPT-Serum Alanine Aminotransferase, calcium, and phosphorus are presented in Table 2.

Table 1: Physiological responses of crossbred calves fed TMR with different concentrate to roughage ratio.

Parameters	T1	T2	T3	T4
Rectal temperature (°F)	101.56 ^y ±0.10	101.28 ^x ±0.08	101.10 ^x ±0.09	101.19 ^x ±0.07
Respiration rate/min	39.06±0.83	39.00±0.81	38.86±0.90	38.36±0.79
Pulse rate /min	110.14±1.56	113.72±1.33	113.83±1.29	113.33±1.21

Means with different superscripts (x and y) in row differ significantly (P<0.05)

Table 2: Blood haematology and blood biochemical profile of crossbred calves fed TMR with different concentrate to roughage ratio.

Parameters	T1	T2	T3	T4
Blood haematology				
WBC (10 ³ /μl)	10.27±0.64	11.72±1.27	11.67±0.46	10.90±1.01
RBC (10 ⁶ /μl)	9.33±0.97	9.67±0.65	8.83±0.86	8.71±0.83
Hb (g/dl)	9.92±0.46	10.67±0.46	10.24±0.27	10.09±0.24
PCV (%)	31.15±1.08	32.45±1.39	33.17±0.52	31.77±0.87
Protein and energy nutrition				
Total protein (g/dl)	6.80±0.14	6.52±0.19	6.63±0.19	6.41±0.10
Albumin (g/dl)	2.89±0.16	2.83±0.12	2.89±0.15	2.91±0.14
Globulin (g/dl)	3.91±0.27	3.69±0.31	3.74±0.26	3.49±0.15
Albumin: globulin ratio	0.85±0.10	0.92±0.12	0.86±0.09	0.88±0.07
Glucose(mg/dl)	81.15 ^y ±2.55	84.95 ^y ±2.48	81.04 ^y ±2.15	74.54 ^x ±2.19
Liver functions				
SGOT (U/L)	40.84±3.12	41.19±2.98	42.39±2.69	41.90±2.13
SGPT (U/L)	21.85 ^x ±1.31	25.07 ^y ±1.38	27.10 ^y ±0.92	26.60 ^y ±1.22
Major minerals				
Calcium (mg/dl)	11.54±0.68	11.66±0.55	10.95±0.70	11.95±0.57
Phosphorus (mg/dl)	5.42±0.26	5.48±0.23	5.67±0.37	5.39±0.15

Means with different superscripts (x and y) in row differ significantly (P<0.05)

WBCs- White blood cells, RBCs- Red blood cells, Hb- Haemoglobin, PCV- Packed cell volume, SGOT- Serum glutamic oxaloacetic transaminase, SGPT- Serum glutamic pyruvic transaminase

Energy and protein nutrition: The value of energy and protein nutrition indicators below normal physiological range, indicates below normal nutrition and excessive also have health concerns in growing calves as this period is very important for life time production and welfare. The concentration of serum total protein did not influence by different concentrate to roughage ratio. The total protein did not influence significantly by different concentrate to roughage ratios (Karami *et al.*, 2021) which supports the present finding. However, total protein increased with increased concentrate percentage (Abdel Raheem *et al.*, 2018) which is contrary to the present finding. The serum albumin concentration did not influence by different concentrate to roughage ratio. The albumin did not influence significantly by different concentrate to roughage ratios (Abdel Raheem *et al.*, 2018; Karami *et al.*, 2021) which supported the present finding. The concentration of serum globulin did not influence by different concentrate to roughage ratio. The globulin did not influence significantly by different concentrate to roughage ratios (Karami *et al.*, 2021) which support the present finding. Abdel Raheem *et al.* (2018) found that globulin levels did not differ significantly between concentrate to roughage ratios 80: 20 and 75: 25. However, Singh *et al.* (2018) observed increased globulin level with increased concentrate percentage in the diet which is contrary to the present finding. The ratio of albumin to globulin did not influence by different concentrate to roughage ratio. The albumin: globulin ratio did not influence significantly by

different concentrate to roughage ratios (Singh *et al.*, 2018) which supported the present finding. Abdel Raheem *et al.* (2018) found that albumin: globulin ratio did not differ between concentrate to roughage ratios of 80: 20 and 75: 25 but significantly (P < 0.05) lower than 60: 40 and 55: 45 ratios. The serum glucose was improved with an increased concentrate to roughage ratio. The serum glucose level was increased with an increased concentrate to roughage ratio (Abdel Raheem *et al.*, 2018; Singh *et al.*, 2018; Karami *et al.*, 2021) which supported the present finding. However, Zhang *et al.* (2018) did not find the influence of concentrate to roughage ratio on the glucose level.

The parameters indicating energy and protein nutrition of crossbred calves were within normal physiological ranged as reported by the Aiello *et al.* (2016); Kaneko (2008), showed that feeding of crossbred calves with conventional feeding or TMR with concentrate to roughage ration was useful to maintain good health of crossbred calves. The feeding of T4 TMR with 65:35 concentrate to roughage ratio improved serum glucose level has health benefitting effect in young calves.

Liver function test: The serum levels (U/L) of glutamic oxaloacetic transaminase (SGOT) and glutamic pyruvic transaminase (SGPT) did not influence by feeding system and levels of concentrate and roughage in TMR. This indicated that feeding system (conventional and TMR) and levels of concentrate and roughage in TMR has no adverse effect on liver functions, as liver is central to metabolic activity of body. The various TMR with different

concentrate to roughage ratios not influenced level of SGPT and SGOT in buffalo calves (Abdel Raheem *et al.*, 2018), supports the present finding.

Major minerals: The serum calcium and phosphorus levels of crossbred calves were non-significantly influenced by the various treatment protocol. The value reported in present study were within normal physiological range (Aiello *et al.*, 2016), indicating no adverse effect on health of crossbred calves.

Faecal Consistency: The daily faecal score, and mean percentage faecal score of faeces of crossbred calves

are represented in Table 3. The numerical improvement was recorded in daily faecal score of crossbred calves, indicating health improvement owing to TMR feeding against conventional system of feeding. The faecal score of one was higher in TMR feeding system also indicating beneficial health effect. Karami *et al.* (2021) found that daily faecal score did not differ with different concentrate to roughage ratio in Holstein female calves which supports the present findings.

Table 3: Daily faecal score and mean percentage faecal score crossbred calves fed TMR with different concentrate to roughage ratio.

Parameters	T1	T2	T3	T4
Daily faecal score	1.13±0.05	1.07±0.01	1.09±0.02	1.09±0.02
Mean percentage faecal score				
1 = Normal	74 (88.10 %)	78 (92.86 %)	77 (91.67 %)	77 (91.67 %)
2 = Semi-solid	9 (10.71 %)	6 (7.14 %)	7 (8.33 %)	6 (7.14 %)
3=Runny/Spread	1 (1.19 %)	0	0	1 (1.19 %)
4 = Watery	0	0	0	0

Note: Score no. 4 was not observed in any treatment group

CONCLUSION

The feeding conventionally and TMR with different concentrate to roughage ratio did not have any adverse effect on physiological responses (rectal temperature, pulse rate, and respiratory rate), haematological parameters (WBCs, RBCs, Hb, and PCV), protein and energy nutrition (serum total protein, albumin, globulin, glucose), liver function (SGOP, SGPT) and major minerals (serum calcium, phosphorus). It can be concluded that feeding of TMR with 85:15, 75:25 and 65:35 concentrate to roughage ratio found safe to crossbred calves.

FUTURE SCOPE

The feeding of total mixed ration is beneficial for growth improvement of crossbred calf and roughage level up to 35% is also safe to feed. The further increase in roughage level need to be investigated.

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Conflict of Interest. None.

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