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Effect of high milk feeding on blood biochemical parameters of early weaned crossbred (HF × K) calves

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Abstract

This study evaluated the impact of high milk feeding on the performance of 25 early weaned crossbred (HF×K) calves for 182 days. Calves were randomly divided into five treatment groups with two males and three females in each. All calves received colostrum for the first 3 days, followed by 4 litters of fresh milk daily for the next two weeks. Thereafter, milk quantities varied among treatment groups totalling 252, 329, 353.5, 378, and 420.5 litters in T₁, T₂, T₃, T₄ & T₅ groups, respectively. The milk feeding was in step up and step-down manner in T₂ to T₅ group. Total Mixed Ration was offered ad libitum to all calves during 15-90 and 91-182 days of age. The study's impact on serum biochemical parameters was evaluated. The results showed that the calves in the T₃ and T₄ groups demonstrated improved metabolic health and immunity, reflected by higher glucose, IGF-1, and globulin levels. The findings suggest that high milk feeding (T₃ & T₄), effectively supports energy status and overall health.

Keywords: High milk feeding, crossbred calves, blood biochemical parameters

Introduction

The dairy calves are the future replacement stock (Fischer *et al.* 2019) [8] at the dairy farm. The suboptimal milk feeding to calves during the initial 90 days results in high mortality, reduced feed intake, and delayed puberty, which adversely affect the economics. The calves are monogastric during their initial life, as the abomasum is the only functional compartment, with 65% of the total stomach capacity, while the rest 25% is the rumen. At age of 3 to 4 months, the rumen contributes 65%, and the abomasum contributes 20% of the total stomach capacity. Therefore, during their early life, the calves require more milk as the primary source of nutrients.

The volume of milk feeding to dairy calves could affect physiological, immunological, behavioral and economic traits. The quantity of milk given to dairy calves during the preweaning stage affects their growth, health, and consumption of dry feed (Appleby *et al.* 2001) [3]. Enhanced nutrient intake stimulates the somatotrophic axis- mainly GH, IGF-1, and IGF-BPs- which supports body and organ development (Breier *et al.* 2000) [5], including the immune system and mammary gland. Higher levels of glucose, insulin, and IGF-1 are seen in well-fed calves, promoting better rumen development. Thus, optimizing nutrition is key to improving calf performance and growth. Based on the aforementioned considerations, the study aims to assess the comparative performance of early-weaned dairy crossbred calves (HF×Kankrej) under various milk feeding regimes.

Materials and Methods

The study was conducted at Livestock Research Station, Veterinary and Animal Science Research & Extension Unit, Kamdhenu University, Anand, Gujarat, after IAEC approval (No. 362/LRS/2022) for 182 days (26 weeks). The total of 25 newborn crossbred calves (75% Holstein Friesian × 25% Kankrej) were grouped into five treatments, comprising two male and three female calves in each. All calves were offered colostrum and milk as per Table 1 in step up and step-down manner. The calves were fed a total mixed ration-TMR1 (75% Concentrate, 15% green Hybrid Napier, and 10% dry Jowar hay) and TMR-2 (65% Concentrate, 15% green Hybrid Napier, and 20% dry Jowar hay) *ad lib.* during 15-90 days and 91-182 days.

Table 1: Feeding schedule for experimental calves

Sr No.	Age (days)	Milk Feeding Regimes (lit/day)					TMR (g)
		T ₁	T ₂	T ₃	T ₄	T ₅	
1	0-3	Colostrum					-
2	4-14	4.0					
3	15-21	4.0	4.5	5.0	5.5	6.0	Ad lib. (15 days onwards)
4	22-28	4.0	5.0	5.5	6.0	6.5	
5	29-35	4.0	5.5	6.0	6.5	7.0	
6	36-42	4.0	6.0	6.5	7.0	7.5	
7	43-49	4.0	6.5	7.0	7.5	8.0	
8	50-56	4.0	6.0	6.5	7.0	7.5	
9	57-63	4.0	5.5	6.0	6.5	7.0	
Total milk offered per calf for 63 day (L)		252	329	353.5	378	402.5	
10	64 to 182	-					

Blood samples were aseptically collected from all calves at 15, 75, 135, and 182 days of age before morning feeding into clot activator vacuttee. Serum was separated by centrifugation and stored at -20°C for further testing. The serum glucose, total protein, albumin, creatinine, Serum Aspartate Aminotransferase (AST)/Serum Glutamic Oxaloacetic Transaminase (SGOT) (U/L) and Serum Alanine Aminotransferase (ALT)/Serum Glutamic Pyruvic Transaminase (SGPT) (U/L) were analyzed using standard Kit on an automatic biochemistry analyzer. IGF-1 and BHBA levels were estimated using ELISA kits from MYBioSource. Globulin and A:G ratio were calculated from total protein and albumin values.

The data (Mean $\pm$ SE) obtained employing complete randomized design was analyzed by using online OPSTAT Software developed by O. P. Sheoran, Professor Statistics, COBS&H, CCS, HAU, Hisar (Snedecor and Cochran 2014) [20].

Results and Discussion

Blood biochemical parameters

The blood biochemical parameters of experimental crossbred calves are summarized in Table 2. The serum glucose levels (mg/dL) were lower ($P < 0.01$) in T₅ than in T₂ and T₃ groups. The significantly lower glucose level in T₅ indicates a less favourable energy status compared to other groups. The serum glucose (mg/dL) level in crossbred calves was within physiological range (Hussein *et al.* 2020) [10]. A decreasing trend was observed with age, from 15 days to 182 days (Fig 1), attributed to the physiological shift from glucose to VFA as the primary energy source with rumen development and increased solid feed intake. These findings align with Babitha *et al.* (2011) [4] and Mirzaei *et al.* (2015) [15], who noted elevated early-life glucose due to glucagon-driven gluconeogenesis from colostrum and milk lactose intake.

The serum levels of total protein (g/dL), albumin (g/dL), and globulin (g/dL) were not influenced ($p > 0.05$) by various milk feeding protocols. The albumin-to-globulin (A: G) ratio was lower ($p < 0.01$) in T₂ and T₃ groups compared to other protocols. A progressive increase in serum total protein and albumin levels was noted over time from 15 days to 182 days (Fig 2 and Fig 3, respectively), likely due to increased starter intake and better health in forage-supplemented calves (Daneshvar *et al.* 2015) [7] and hepatic tissue maturation and increased solid feed intake, as reported by Souza *et al.* (2019) [21] respectively. These findings align with those of Alimirzaei *et al.* (2020) [2], and Jafari *et al.* (2021) [11], who observed that total protein and

albumin concentration remained unaffected by milk feeding methods or quantities. The average value of the serum A: G ratio remained within the normal physiological range (Hussein *et al.* 2020) [10]. A fluctuating trend was noted over time, suggesting dynamic changes in albumin and globulin synthesis during calf development. These findings are supported by the research outcome of Patel (2022) [17] as a 1.26 A: G ratio value under varying feeding methods.

The serum creatinine (mg/dL) level increased ($p < 0.01$) from T₁ to T₄ and were within physiological range (Klinkon and Jezek, 2017) [14], indicating it is safe on kidney functions to feed higher quantity of milk. These findings are consistent with Shukla (2016) [19] and Khan *et al.* (2007a) [13], who observed declining trends with age, whereas Patel (2022) [17] reported a slightly higher mean value (1.44 mg/dL), possibly due to variations in milk feeding strategies.

The liver function as indicated by value of Serum Glutamic Pyruvic Transaminase (SGPT; U/L) and Serum Glutamic Oxaloacetic Transaminase (SGOT; U/L) was without influence of milk feeding protocols and also were within physiological range (Teneva *et al.* 2021) [22]. This indicates it is safe to feed various quantities of milk from T₁ to T₅ to crossbred calves. The SGPT levels were raised after preweaning phase, indicating increased liver enzyme activity in the post-weaning phase. This rise is likely linked to higher dry matter and DCP intake post-weaning. The present findings align with those of Alimirzaei *et al.* (2020) [2], Patel (2022) [17], and Sharma (2023) [18], supporting the trend of increasing SGPT with age and feeding intensity with normal liver function.

The serum level of Insulin Growth factor (IGF-1; ng/ml) was higher ($p < 0.01$) in T₃ and T₄ compared to T₁, T₂ and T₅ groups. The serum level of β -hydroxybutyrate (BHBA; nmol/ml) was also higher in ($p < 0.01$) T₃ and T₄ groups, indicating better growth rate and better fat turnover in higher milk-fed protocols. The IGF-1 levels, a key growth marker, are associated with higher milk intake, likely due to improved nutrient availability and growth. These findings align with Hammon *et al.* (2002) [9], who highlighted the role of nutrition in regulating IGF-1, as well as Kerr *et al.* (1991) [12] and Patel (2022) [17], who also reported increasing IGF-1 levels with calf age and milk intake. The overall mean BHBA level was increased with age, with a notable rise after weaning. BHBA levels, reflective of rumen fermentation and VFA utilization, were also significantly ($p < 0.01$) higher in T₃, T₁, and T₄, suggesting more active energy metabolism. This increase reflects a physiological shift from liquid to solid diets, enhancing rumen development (Nemati *et al.* 2015) [16]. These results align

with Cheema *et al.* (2016) [6] and Abbasa *et al.* (2017) [1]. In summary, T₃ and T₄ consistently showed favourable biochemical indicators, suggesting better metabolic and growth performance under this milk feeding regime.

Conversely, T₅ generally exhibited lower values in energy-related and growth-related parameters, reflecting comparatively poorer metabolic status.

Table 2: Blood Biochemical parameters of experimental crossbred calves under different milk feeding regimes

Treatments	T ₁	T ₂	T ₃	T ₄	T ₅	P Value
Parameters						
Serum Glucose (mg/dL)	91.35 ^{ab} ± 2.47	94.45 ^b ± 2.85	95.20 ^b ± 3.35	91.30 ^{ab} ± 2.31	85.80 ^a ± 3.29	0.012
Serum total protein (g/dL)	5.55 ± 0.12	5.86 ± 0.15	5.77 ± 0.12	5.69 ± 0.11	5.55 ± 0.14	0.299
Serum albumin (g/dL)	3.34 ± 0.07	3.29 ± 0.07	3.27 ± 0.09	3.41 ± 0.07	3.29 ± 0.07	0.397
Serum globulin (g/dL)	2.21 ± 0.07	2.57 ± 0.15	2.49 ± 0.11	2.28 ± 0.11	2.26 ± 0.13	0.085
Serum A:G Ratio	1.54 ^b ± 0.05	1.35 ^a ± 0.07	1.36 ^a ± 0.06	1.56 ^b ± 0.07	1.55 ^b ± 0.10	0.015
Serum creatinine (mg/dL)	0.46 ^a ± 0.01	0.97 ^b ± 0.08	1.06 ^{bc} ± 0.03	1.20 ^d ± 0.03	1.12 ^{cd} ± 0.04	0.000
SGPT (U/L)	26.01 ± 2.15	24.42 ± 2.23	26.10 ± 1.80	26.10 ± 2.52	22.54 ± 1.58	0.247
SGOT (U/L)	59.54 ± 4.89	53.37 ± 3.46	50.14 ± 4.10	56.94 ± 4.96	52.69 ± 4.10	0.165
IGF-1 (ng/ml)	65.40 ^a ± 2.98	68.22 ^a ± 3.12	81.45 ^c ± 5.05	74.12 ^b ± 4.78	68.04 ^a ± 4.02	0.000
BHBA (nmol/ml)	1666.62 ^{bc} ± 107.31	1328.73 ^a ± 97.79	1677.02 ^c ± 117.72	1502.72 ^b ± 105.91	1200.85 ^a ± 71.43	0.000

Mean with different superscripts in row (abcd) differ significantly, showing treatment effect, respectively. “S”: Significant ($P < 0.05$, $P < 0.01$); “NS”: Non-significant; SGPT (U/L): Serum Glutamic Pyruvic Transaminase; SGOT (U/L): Serum Glutamic Oxaloacetic Transaminase; IGF-1 (ng/ml): Insulin Growth factor; BHBA (nmol/ml): β -hydroxybutyrate

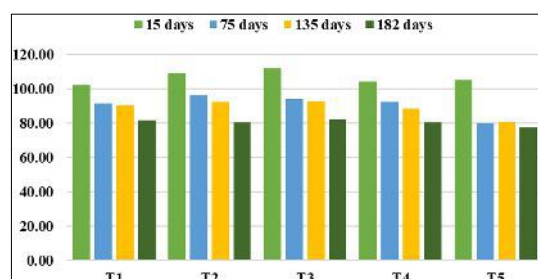


Fig 1: Serum glucose (mg/dL) level in crossbred calves during entire period of experiment

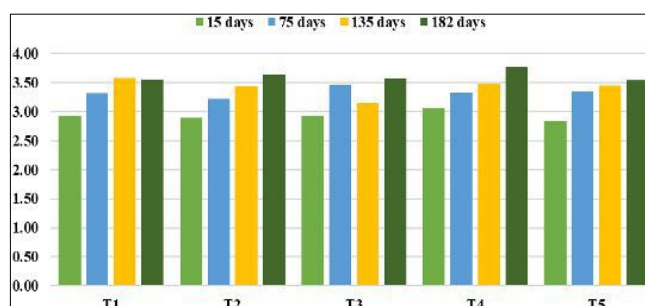


Fig 3: Serum albumin (g/dL) level in crossbred calves during entire period of experiment

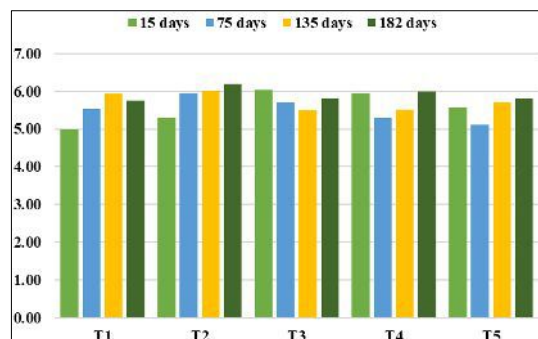


Fig 2: Serum total protein (g/dL) level in crossbred calves during entire period of experiment

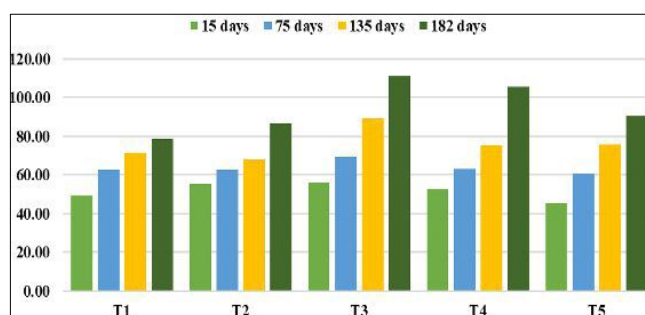


Fig 4: IGF-1 (ng/ml) level in crossbred calves during entire period of experiment

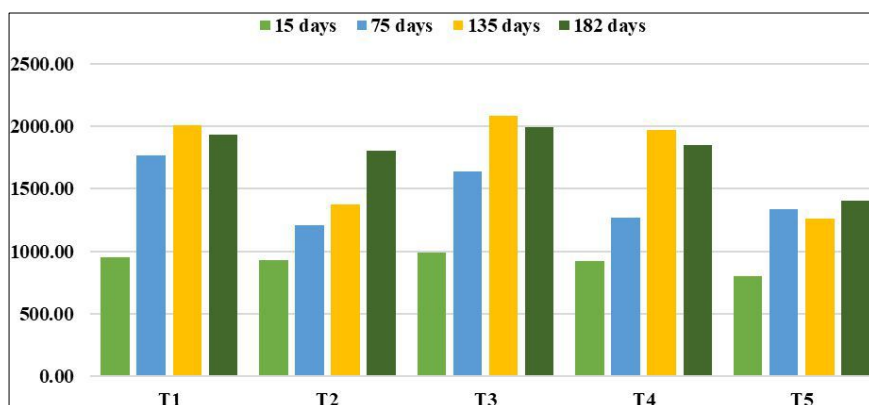


Fig 5: BHBA (nmol/ml) level in crossbred calves during entire period of experiment

Conclusion

The study confirms that optimized milk feeding strategies, particularly those followed in T₃ and T₄, are beneficial for improving metabolic efficiency, growth-related hormonal responses, and rumen development without compromising organ health. These feeding regimes can be recommended for early-weaned crossbred calves to enhance performance, survivability, and long-term productivity under organized dairy farming systems.

Contribution of Authors

N. K. Thakkar: Conceptualization, experimentation, Sample collection, laboratory analysis.

R. I. Kapadiya: Manuscript writing.

P.G. Trivedi: Animal management, data recording.

K. N. Wadhvani: Technical guidance.

P. M. Lunagariya: Manuscript review & Technical guidance.

References

- Abbasa W, Shaikat A, Bhattia MS, Khana NS, Hassan M, Warriach PW, *et al.* Effect of weaning age and milk feeding volume on growth performance of Nili-Ravi buffalo calves. *Ital J Anim Sci.* 2017;16(3):490-499.
- Alimirzaei M, Alijoo YA, Dehghan-Banadaky M, Eslamizad M. The effects of feeding high or low milk levels in early life on growth performance, fecal microbial count, and metabolic and inflammatory status of Holstein female calves. *Animal.* 2020;14(2):303-311.
- Appleby MC, Weary DM, Chua B. Performance and feeding behaviour of calves on ad libitum milk from artificial teats. *Appl Anim Behav Sci.* 2001;74(3):191-201.
- Babitha V, Philomina PT, Dildeep V. Effect of extended colostrum feeding on the plasma profile of insulin, thyroid hormones, and blood glucose of crossbred pre-ruminant calves. *Indian J Physiol Pharmacol.* 2011;55(2):139-146.
- Breier BH, Oliver MH, Gallaher BW. Regulation of growth and metabolism during postnatal development. In: *Ruminant physiology: digestion, metabolism, growth and reproduction.* New York (NY): CABI Publishing; 2000. p. 187-204.
- Cheema AT, Bhatti SA, Ghulam AB, Wynn PC, Ghulam MD, Warriach HM, *et al.* Effect of weaning age and milk feeding level on pre- and post-weaning growth performance of Sahiwal calves. *Anim Prod Sci.* 2016. doi:10.1071/AN15719.
- Daneshvar D, Khorvash M, Ghasemi E, Mahdavi AH, Moshiri B, Mirzaei M, *et al.* The effect of restricted milk feeding through conventional or step-down methods with or without forage provision in starter feed on performance of Holstein bull calves. *J Anim Sci.* 2015;93(8):3979-3989.
- Fischer AJ, Villot C, Van Niekerk JK, Yohe TT, Renaud DL, Steele MA. Invited review: nutritional regulation of gut function in dairy calves: from colostrum to weaning. *Appl Anim Sci.* 2019;35:498-510.
- Hammon HM, Schiessler G, Nussbaum A, Blum JW. Feed intake patterns, growth performance, and metabolic and endocrine traits in calves fed unlimited amounts of colostrum and milk by automates starting in the neonatal period. *J Dairy Sci.* 2002;85:3352-3362.
- Hussein HA, Thurmann JP, Staufenbiel R. 24-h variations of blood serum metabolites in high-yielding dairy cows and calves. *BMC Vet Res.* 2020;16:327. doi:10.1186/s12917-020-02551-9.
- Jafari A, Azarfar A, Gibson MA, Gholam RG, Mehdi M, Amir F, *et al.* Milk feeding quantity and feeding frequency: effects on growth performance, rumen fermentation, and blood metabolites of Holstein dairy calves. *Ital J Anim Sci.* 2021;20(1):336-351. doi:10.1080/1828051X.2021.1884504.
- Kerr DE, Laarveld B, Fehr MI, Manns JG. Profiles of serum IGF-I concentrations in calves from birth to eighteen months of age and in cows throughout the lactation cycle. *Can J Anim Sci.* 1991;71:695-705.
- Khan MA, Lee HJ, Lee WS, Kim HS, Ki KS, Hur TY, *et al.* Structural growth, rumen development, and metabolic and immune responses of Holstein male calves fed milk through step-down and conventional methods. *J Dairy Sci.* 2007;90(7):3376-3387.
- Klinkon M, Jezek J. Values of blood variables in calves. In: Perez-Marin CC, editor. *A bird's-eye view of veterinary medicine.* Rijeka: InTech; 2012.
- Mirzaei HO, Khorvash M, Ghorbani GR, Moshiri BMM, Pezeshki A, Ghaffari MH. Effects of the step-up/step-down and step-down milk feeding procedures on the performance, structural growth, and blood metabolites of Holstein dairy calves. *J Dairy Sci.* 2015;98:7975-7981.
- Nemati MH, Amanlou MK, Moshiri BMM, Khan MA, Ghaffari MH. Rumen fermentation, blood metabolites, and growth performance of calves during transition from liquid to solid feed: effects of dietary level and particle size of alfalfa hay. *J Dairy Sci.* 2015;98:7131-7141.
- Patel JH. Performance of pre-weaned crossbred (HF × Kankrej) calves under different milk feeding methods and frequencies under intensive production system. Gandhinagar: Kamdhenu University; 2022.
- Sharma MM. Performance of pre-weaned crossbred calves (HF × K) on protein-based replacement of calf starter with Moringa oleifera leaves. Gandhinagar: Kamdhenu University; 2023.
- Shukla R, Shah SV, Pandya PR, Lunagariya PM, Parmar M, Divekar BS. Impact of feeding milk replacer on growth rate and blood parameters in Holstein × Kankrej crossbred calves. *Int J Sci Environ.* 2016;5(6):3847-3855.
- Snedecor GW, Cochran WG. *Statistical methods.* 8th ed. Ames (IA): Iowa State University Press; 2014.
- Souza DC, Silva DG, Rocha TG, Monteiro BM, Pereira GT, Fiori LC, *et al.* Serum biochemical profile of neonatal buffalo calves. *Arq Bras Med Vet Zootec.* 2019;71(1):187-196. doi:10.1590/1678-4162-10176.
- Teneva A, Stoimenov G, Hristov K, Koynarski T, Stoimenov A. Analysis of blood biochemical profiles of dairy cows and their calves from Bulgarian Brown cattle breed. *Tradit Modern Vet Med.* 2021;2(11):78-83.