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# Effect of Supplementation of Exogenous Fibrolytic Enzymes on Intake, Nutrient Utilization Pattern and Economics of Feeding in Weaned crossbred Calves

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**ABSTRACT: The present study was conducted to evaluate the effect of supplementation of exogenous fibrolytic enzymes (EFE) on nutrient utilization pattern and economics of feeding in weaned crossbred calves. Fifteen weaned female crossbred Jersey calves (weight 79.73±3.46 kg; age 234.5±11.33 days) were divided into three equal groups of 5 animals each; namely, Control ($T_0$), Treatment-1 ($T_1$) and Treatment-2 ($T_2$). A digestion trial was conducted with 6 days collection period during the last phase of 90 days growth trial. Total Mixed Ration (TMR) was fed *ad libitum* to each animal under three treatment groups. Animals under $T_0$ group were fed *ad lib.* TMR without EFE supplementation. Animals under $T_1$ and $T_2$ groups were supplemented with two doses of EFE ($T_1$ with cellulase and Xylanase @ 8000 and 16000 IU/kg DM of TMR and $T_2$ with EFE cellulase and Xylanase @ 12000 and 24000 IU/kg DM of TMR). The study revealed that DM and OM intake per unit body weight (kg/100 kg BW and g/kg $W^{0.75}$) were significantly (P<0.05) greater in $T_1$ and $T_2$ groups than the $T_0$ group. The digestibility coefficients (%) of DM were significantly (P<0.001) higher in $T_1$ (62.10) and $T_2$ (62.00) in comparison to $T_0$ group (57.39). Similarly, digestibility coefficients (%) of NDF were 50.79, 55.84 and 56.26 in control, $T_1$ and $T_2$ groups, being significantly (P<0.001) higher in treated animals compared to control ($T_0$). The digestibility co-efficients of total carbohydrate, hemicellulose and cellulose also followed the similar trend. Supplementation of EFE to calves significantly (P<0.01) increased DCP intake/100 kg BW in $T_1$ and $T_2$ compared to control group. Similarly, significantly higher (P<0.001) TDNI/100 kg BW was observed in $T_1$ and $T_2$ groups compared to the control group. DCP and TDN percentage of the diets increased significantly (P<0.001) in enzyme supplemented groups. The feeding cost/kg BW gain in $T_1$ and $T_2$ reduced by 4.73% and 3.56%, respectively, compared to the control group. Therefore, it may be concluded that addition of EFE (cellulase and Xylanase @ 8000 and 16000 IU/kg DM of TMR) resulted in greater nutrients availability for economizing the feeding cost/kg weight gain in cross-bred calves fed with Total Mixed Ration (TMR); however, higher doses (12000 and 24000 IU/kg TMR DM) of the EFE had no added effect.**

**Key words:** Weaned calves, Digestibility, Exogenous Fibrolytic Enzyme, Feeding Cost, Intake, Supplementation.

## INTRODUCTION

India is maintaining 7.4% of the world human population and 10.71% of the world's livestock population with only 2.29% of the land area of the world (GOI, Annual report DADH, 2018-19). As a result, net deficit of green and dry fodder is about 30.65% and 11.85% respectively, for the year 2020 (Vision-2050, ICAR-IGFRI, Jhansi, 2015; Gupta *et al*., 2019). Forage plants are the major source of energy for small and large ruminants in tropical and subtropical farming systems as the fibre fraction forms the major portion in the forage plants dry matter (Mousa *et al*., 2022). Cell wall of the forage plants consists of complex polymers, hence their digestibility and available energy is considered to be low (Hatfiled *et al*., 1999). On DM basis, plant cell wall is made up of 35-50% of cellulose, 20-35% of hemicelluloses and 10-25% lignin (Sticklen, 2008). These intricate structures are thought to act as barriers against microbial invasion and restrict their ability to access plant cell wall networks. Forage cell walls contain different levels of hemicelluloses, cellulose, lignin, pectin, and minerals depending on the plant species and stage of growth

(Carrillo-Díaz *et al*., 2022). The efficiency of utilization of plant polysaccharides by ruminants is still limited (Hatfiled *et al*., 1999) despite of having numerous processing techniques, therefore it has to be enhanced to meet the demands of milk and meat for drastically growing human population (Meale *et al.*, 2014).

The limitations of adaptation of physical and chemical methods triggered the applications of biological agents in ruminants (Sujani and Seresinhe 2015; Reddy *et al*., 2016). After all these efforts, still more than 50% of fibrous fraction is considered to be not readily digested. Hence researchers have paid increased attention to the use of exogenous fibrolytic enzymes (EFE) as a biological treatment method and now it is discussed widely by animal nutritionists (McAllister *et al*., 2003; Iannaccone *et al*., 2022). EFE was increasingly used in recent years as a cost-effective means of increasing feed quality (Krause *et al.*, 2003). Cellulose and xylan present in plant cell walls are made up of ß1-4 glycosidic bonds which can be broken by exogenous enzymes specifically fibrolytic enzymes such as cellulases and xylanases, respectively (Beauchemin *et al*., 2003), which further facilitates the structural polysaccharide digestion in the rumen. Some studies showed supplementing EFE to the ruminants enhanced the growth performance (Holtshausen *et al*., 2011; Lourenco *et al*., 2020) and milk production (Holtshausen *et al*., 2011; Lungaria *et al.*,2019). Several researchers reported enhanced fibre digestion; hence, increased availability of nutrients in small ruminants (El-Bordeny *et al*., 2017; Sheikh *et al*., 2017; Abid *et al*., 2020) as well as in large ruminants (Kady *et al*., 2006; Shekhar *et al*., 2010; Salem *et al*., 2013). Therefore, the present study was conducted to evaluate the effect of EFE supplementation on nutrient utilization pattern and economics of feeding in weaned crossbred calves.

## MATERIALS AND METHODS

*A. Site of the Experiment*

Animal trial was performed in the animal experimental farm (Cattle Yard Complex) of Eastern Regional Station of ICAR-National Dairy Research Institute (NDRI), Kalyani, West Bengal, India as per the committee approval of ICAR-NDRI (19-M-AN-06) and all ethical guidelines were followed throughout the period of the animal experiment. The NDRI, ERS, Kalyani is situated at 22$^{o}$58’30"N latitude and 88$^{o}$26’04"E longitude and 9.75 meter above mean sea level.

*B. Experimental Animals and Diets*

Based on their body weight and age, fifteen weaned healthy female Jersey crossbred calves (weight 79.73±3.46 kg; age 234.5±11.33 days) were divided evenly into three groups: Control ($T_0$), Treatment-1 ($T_1$), and Treatment-2 ($T_2$). Before starting the experiment, all experimental calves were dewormed with Albendazole and Ivermectin, and vaccinated against Haemorrhagic Septicaemia, Foot and Mouth Disease and Anthrax. Uniform managemental conditions were provided to all calves which were housed in well-ventilated experimental shed individually.

Two individual preparations of Exogenous Fibrolytic Enzymes (EFE, Cellulase and Xylanase) in powder forms (Brisk Bioscience Ltd., Surat, India) were selected for the experiment. The activity of enzyme powders was 5,00,000 IU/g for cellulase and 1,00,000 IU/g for xylanase. These enzymes were derived from fungal sp. *Aspergillus niger.*

Animals in each experimental group were fed *ad libitum* Total Mixed Ration (TMR) (CP 12%, TDN 65%) individually during the entire experimental period. The TMR (Table 1) was prepared with concentrate mixture, chaffed paddy straw and oat fodder at the ratio of 40:30:30 (on DM basis).

**Control group ($T_0$):** Calves were fed *ad libitum* TMR without EFE supplementation

**Treatment group-1 ($T_1$):** Calves were fed *ad libitum* TMR supplemented with EFE Cellulase and Xylanase @ 8000 and 16000 IU/kg DM of TMR

**Treatment group-2 ($T_2$):** Calves were fed *ad libitum* TMR supplemented with EFE Cellulase and Xylanase @ 12000 and 24000 IU/kg DM of TMR.

*C. Digestion trial*

After completion of 75 days of the growth trial, a digestion trial was performed with 6 days collection period to assess the availability of different nutrients. Body weights of animals were recorded before and after the digestion trial on two consecutive days before feeding and watering. On a daily basis, the average daily intake of feed offered, residue left and faeces voided by experimental calves were recorded and the nutrient intake and digestibility were determined. Individual calf’s faeces were collected, weighed each day at 9:00 h, and representative samples of the feed offered, the residue left, and the faeces voided were taken for chemical analysis. The N content in feeds, residues and faeces were estimated as per Micro-Kjeldahl method (AOAC, 2012). Feed and residue samples were analyzed for proximate (AOAC, 2012) and cell wall components (Van Soest *et al*., 1991).

*D. Statistical analysis*

The data obtained during the course of investigation on digestibility and availability of nutrients were subjected to statistical analysis (Snedecor and Cochran 1980) using analysis of variance (one way ANOVA) with randomized block design (RBD) using IBM SPSS statistics 20 package. Tukey's HSD test was used to measure the differences of means under three treatments.

## RESULTS AND DISCUSSION

*A. Chemical Composition of Feeds*

The values of chemical composition (on percent DM basis) of different feeds and fodders are enlisted in Table 2. The CP content (%) of concentrate, green fodder, paddy straw and TMR was 20.83, 10.09, 3.45 and 12.60 respectively. The values of NDF (%) and ADF (%) were 32.67 and 11.29; 64.63 and 38.26; 78.39 and 53.34; 55.59 and 31.91 in concentrate, green fodder, paddy straw and TMR, respectively.

*B. Voluntary intake of nutrients*

The average total dry matter intake (TDMI) in control ($T_0$), $T_1$ and $T_2$ groups were 3.64, 4.05 and 4.09 kg/d/calf (Table 3) during digestion trial. TDMI was increased by 11.30% and 12.40% in $T_1$ and $T_2$ groups compared to control group; however, the difference among three groups was non-significant. Whereas, DMI per unit body weight (kg/100 kg BW and g/kg $W^{0.75}$) were significantly (P<0.05) higher in $T_1$ and $T_2$ groups than the control ($T_0$) group. Organic matter intake (OMI) also followed the similar trend as that of TDMI. OMI (kg)/100 kg BW and OMI (g)/kg $W^{0.75}$ were greater (P<0.05) in $T_1$ (3.16kg and 103.60g) and $T_2$ (3.14kg and 103.43g) compared to the $T_0$ (2.91kg and 94.66g). Similarly, numerically higher CP intake (g/day/animal) was seen in $T_1$ (10.90%) and $T_2$ (13.10%) groups compared to control group. Both CPI (g/100 kg BW) and CPI (g/kg $W^{0.75}$) were significantly (P<0.05) higher in enzyme supplemented groups ($T_1$ and $T_2$) compared to the control ($T_0$). The CP percentage was estimated 13.08, 13.02 and 13.13 in $T_0$, $T_1$ and $T_2$, respectively.

Supplementation of EFE to the calves through TMR significantly increased (P<0.05) the DMI, OMI, CPI per unit body weight in both enzyme supplemented groups ($T_1$ and $T_2$) compared to control ($T_0$). Increase in uptake of feed is may be due to increased palatability of feed due to release of sugars as a result of hydrolysis of polysaccharides by enzymes (Beauchemin *et al*. 2000; Sheikh *et al*., 2017) and increased fiber degradation rate as a result of synergistic action of EFE with rumen microorganisms (Gado *et al*. 2009; Abid *et al.* 2020). Similar to present study, Gado *et al*. (2009) reported increased DM (18.2 vs. 16.1 kg/day) and OM intake (16.4 vs. 14.1 kg/day) due to supplementation of commercial fibrolytic enzyme ZADO® in lactating Brown Swiss cows. Abid *et al*. (2020) also observed that feeding olive cake sprayed with cellulase and xylanase mix (50:50 by volume) @ 4 or 16 ml per kg OC DM to the lambs significantly increased (P<0.05) DM, organic matter and ME intake in both the groups compared to control without showing any significant difference (P>0.05) between enzyme treated groups. Feeding date palm leaves (DPL) ensiled with probiotics or enzymes to multiparous lactating Farafra ewes increased (P<0.01) both DPL and total intakes compared to control group (Kholif *et al*., 2022).

In contrary, few studies showed that EFE supplementation has no additional benefits on nutrient intake in Granadina dairy goats (González-Garcia *et al*. 2008), buffalo male calves (Kady *et al*. 2006), Baladi Friesian steers (Salem *et al*. 2013) and in lambs (Sakita *et al*. 2022).

*C. Digestibility of nutrients*

The apparent digestibility coefficients (%) of various nutrients are presented in Table 4. Digestibility coefficients (%) of DM and OM were 57.39 and 60.25 in control ($T_0$); 62.10 and 64.39 in $T_1$ and 62.00 and 64.85 in $T_2$ groups, respectively; which were significantly (P<0.001) higher in enzyme supplemented groups ($T_1$ and $T_2$) in comparison to control group. Furthermore, there was no significant difference between $T_1$ and $T_2$ groups. Total carbohydrate digestibility followed the same trend of DM and OM digestibility. However, the digestibility co-efficients of ether extract and crude protein were similar among three groups. Supplementation of exogenous fibrolytic enzymes increased (P<0.01) the digestibility coefficients (%) of NDF, ADF, cellulose and hemicellulose in $T_1$ and $T_2$ groups compared to control (Table 4).

In the present study, supplementation of EFE to calves through TMR significantly increased the digestibility coefficients (%) of DM, OM, TCHO, NDF, ADF, Hemicellulose and Cellulose by 8.20%, 6.90%, 7.80%, 9.90%, 12.70%, 7.90% and 10.90% in $T_1$; 8.00%, 7.60%, 9.00%, 10.80%, 13.20%, 9.20% and 12.40% in $T_2$ groups, respectively compared to the control ($T_0$). This may be due to synergism between exogenous enzymes and hydrolases of the ruminal microbes which led to enhancement in hydrolytic capacity of the rumen microbes (Morgavi *et al*. 2000). Furthermore, EFE have also been reported to maximise the attachment of rumen microbes to the feed particles and hence enhancing the hydrolytic activity of the rumen (Morgavi *et al.* 2000; Wang *et al.* 2001).

The results obtained in the present study corroborated with the findings of different researchers. El-Bordeny *et al*. (2017) supplemented the EFE (6.23 unit protease and 78 unit cellulose/g) @ 2.5 g to Barkey lambs and observed significant improvement in the digestibility of DM, OM, CP, CF, NFE, NDF, ADF, cellulose and hemicellulose due to enzyme addition. Similarly, supplementation of 12 ml Zymogen liquid/100kg body weight to buffalo calves significantly (P≤0.05) increased the digestibility of DM, OM, EE, CF, CP and NFE as compared to control (Marwan *et al*., 2019). Treating tifton-85 hay with fibrolytic enzymes extract 24 hours before feeding to lambs resulted 12% higher ADF digestibility (Sakita *et al*., 2022). In Ossimi lambs similar results were obtained by Mousa *et al.* (2022)

due to Supplementation of Calfo Care® (Probiotics and enzymes) @ 0.5 and 1kg/ton diet DM. Similarly, Kholif *et al*. (2022) reported that feeding of date palm leaves ensiled with EFE and probiotics to Farafra ewes significantly increased digestibility of all nutrients (except NDF for probiotics treatment and EE for both enzyme and probiotics treatments). Salem *et al*. (2013) reported increased digestibility of NDF and ADF by 21.8% and 26.7% due to addition of enzyme ZADO® (cellulase, xylanase, protease, amylase) @ 40 g/head/d to crossbred Baladi Friesian steers through the TMR. Furthermore, Sheikh *et al*. (2017) reported feeding of paddy straw treated with exogenous enzyme (9 g/kg DM) plus urea molasses to Corriedale Sheep significantly (P<0.05) improved the digestibility of DM,CP, NDF, ADF and cellulose. While, digestibility of NFE and hemicellulose was similar among different groups. Similarly, supplementation of enzymes cellulase and xylanases @ of 4000 and 12500 ($T_1$) or 8000 and 18750 IU/kg ($T_2$), respectively to lactating Beetle-sannen crossbred goats significantly improved (P<0.05) the digestibility coefficients of DM, OM, TCHO, CP, NDF and ADF in $T_2$ compared to control. While the difference between T1 and control was non-significant (P>0.05) (Bala *et al.*, 2009).

In contrary to our findings, Abid *et al*. (2020) reported that feeding olive cake sprayed with cellulase and xylanase mix (50:50 by volume) @ 4 and 16 ml per kg DM showed no significant (P>0.05) effect on digestibility of DM, OM and EE in lambs. Moreover, increase in digestibility of ADF and NDF were non-significant (P>0.05) due to Supplementation of EFE (cellulase and xylanase) to dairy goats (González-Garcia *et al*., 2008).

*D. Availability of nutrients*

DCP intake (% of BW) was greater (P<0.01) in $T_1$ and $T_2$ compared to control $T_0$. The values of DCPI (g/100kg BW) were 252.46, 280.85 and 279.06 in $T_0$, $T_1$ and $T_2$ groups (Table 4). The values of TDNI (kg/100kg BW) were 1.85, 2.14 and 2.15 in control, $T_1$ and $T_2$ groups, respectively. Similarly, total DCP (P<05) and TDN (P<0.01) intake of calves were significantly improved in EFE supplemented groups. Supplementation of EFE increased (P<0.001) TDN and DCP value (%) of the diets in $T_1$ and $T_2$ compared to the control ($T_0$). However, CP percentage of the diets under experimental groups were kept iso-nitrogenous (Table 3).

Supplementation of EFE to crossbred calves significantly increased DCP intake in $T_1$ and $T_2$ groups compared to control group ($T_0$), it may be attributed to cumulative effect of increased CP intake through TMR and marginal improvement in digestibility of CP in treatment groups. Similarly, significantly higher TDN intake in enzyme supplemented calves could be due to the cumulative effect of increased digestibility coefficient of different nutrients in EFE treated groups compared to the control group.

The obtained results were in partial agreement with earlier researchers. Shekhar *et al*. (2010) reported significantly higher (P<0.05) TDNI (by 12.53%) in EFE supplemented buffaloes over the control group. Romero *et al.* (2016) reported that supplementation of Xylanase plus @ 1 mL/kg DM of TMR (T1) significantly (P < 0.001) increased the DCP intake (kg/d) in Holstein cows. Similarly, DCPI (kg/day) and TDNI (kg/day) were improved due to supplementation of EFE @ 2.5 g to Barkey lambs fed wheat straw based ration (El-Bordeny *et al*., 2017). DCP% of diet was improved in enzyme (6.23 unit protease and 78 unit cellulose/g of diet) supplemented group (Barkey lambs) (11.23) compared to control (10.98). TDN% of diet was also improved in enzyme supplemented group (74.50) compared to control group (71.30) (El-Bordeny *et al*. 2017). Similarly, supplementation of Calfo Care® (Probiotics and enzymes) to Ossimi lambs @ 0.5 (G2), 1 (G3), and 2 (G4) kg/ton diet DM significantly increased (p ≤ 0.05) DCP and TDN% of diet in G2 and G3 groups compared to control group G1 (Mousa *et al*., 2022). In contrary, Lungaria *et al.* (2019) supplemented a commercial EFE Roxozyme GT® to lactating HF crossbred cows @ 240 mg/kg TMR. They observed no difference in intake of DCP and TDN per unit body weight in enzyme supplemented group compared to control group.

*E. Economics of Feeding*

The economics of feeding in different groups is illustrated in Table 5. Total feed cost (Rs./d/calf) was 52.98, 57.88 and 59.25 in control, T1 and T2 groups, respectively. Average daily body weight gain (g/d/calf) were estimated 424.02, 486.22 and 491.68 in control, T1 and T2 groups, respectively. Feed cost per kg gain was Rs. 124.95, 119.04 and 120.51 in control, T1 and T2 groups, respectively. Feed cost per kg gain per animal was reduced by Rs. 5.91 in T1 and Rs. 4.44 in T2 over the control group. Therefore, reduction of feed cost over control group was 4.73% and 3.56% in T1 and T2 groups, respectively. It was also observed a profit of Rs. 258.62 and 196.47 in T1 and T2 groups compared to control calves when the calves were fed for 90 days.

Similar to our findings, Lunagariya *et al*. (2019) reported that 15.87% higher return over feed cost due to supplementation of EFE (800 IU/g endo 1,4- β glucanase, 700 IU/g 1(3),4-β glucanase and 2700 IU/g endo 1,4-β xylanase) @ 240 mg/kg total mixed ration (TMR) to HF crossbred cows. Similarly, Mohamed *et al.* (2013) achieved higher net profit by 0.93 US$ per cow due to supplementation of Fibrozyme (EFE) in early lactating dairy cows.

**Table 1: Ingredient composition (on % DM basis) of experimental total mixed rations (TMR).**

| Ingredients | Treatments | | |
|---|---|---|---|
| | $T_0$ | $T_1$ | $T_2$ |
| Maize | 14 | 14 | 14 |
| Wheat bran | 8.4 | 8.4 | 8.4 |
| GNC | 8.4 | 8.4 | 8.4 |
| MOC | 8 | 8 | 8 |
| Mineral mixture | 0.8 | 0.8 | 0.8 |
| Salt | 0.4 | 0.4 | 0.4 |
| Oat fodder | 30 | 30 | 30 |
| Paddy straw | 30 | 30 | 30 |
| Cellulase (IU/kg DM of TMR) | - | 8000 | 12000 |
| Xylanase (IU/kg DM of TMR) | - | 16000 | 24000 |

**Table 2: Chemical composition (on % DM basis) of different feeds and forages used in experiment.**

| Parameters | Concentrate mixture | Mixed green fodder | Paddy straw | Total mixed ration |
|---|---|---|---|---|
| DM | 90.18 | 23.44 | 90.73 | 47.72 |
| OM | 93.58 | 88.42 | 85.08 | 90.18 |
| CP | 20.83 | 10.09 | 3.45 | 12.60 |
| EE | 4.78 | 2.43 | 1.29 | 2.91 |
| TCHO | 67.97 | 75.90 | 80.66 | 74.67 |
| Total Ash | 6.42 | 11.58 | 14.92 | 9.82 |
| NDF | 32.67 | 64.63 | 78.39 | 55.59 |
| ADF | 11.29 | 38.26 | 53.34 | 31.91 |
| Hemicellulose | 21.38 | 26.37 | 25.05 | 23.68 |
| Cellulose | 8.06 | 33.05 | 44.63 | 25.99 |
| Lignin | 3.23 | 5.22 | 8.71 | 5.92 |

Each value is the average of duplicate analysis on dry matter basis
OM-Organic matter, CP- Crude protein, EE- Ether extract, TCHO- Total carbohydrate, NDF- Neutral detergent fibre, ADF- Acid detergent fibre

**Table 3: Voluntary intake in crossbred calves of control and treatment group during digestion trial.**

| Attributes | Groups | | | S.E.M. | Statistical significance (P value) |
|---|---|---|---|---|---|
| | $T_0$ | $T_1$ | $T_2$ | | |
| **Voluntary intake** | | | | | |
| *Dry matter intake (DMI)* | | | | | |
| DMI (kg/d/animal) | 3.64 | 4.05 | 4.09 | 0.09 | 0.118 |
| DMI (kg/ 100kg BW) | $3.22^a$ | $3.50^b$ | $3.47^b$ | 0.05 | 0.030 |
| DMI(g/kg $W^{0.75}$) | $104.67^a$ | $114.60^b$ | $114.28^b$ | 1.77 | 0.039 |
| *Organic matter intake (OMI)* | | | | | |
| OMI (kg/d/animal) | 3.29 | 3.66 | 3.70 | 0.08 | 0.085 |
| OMI (kg/ 100kg BW) | $2.91^a$ | $3.16^b$ | $3.14^b$ | 0.04 | 0.029 |
| OMI(g/kg $W^{0.75}$) | $94.66^a$ | $103.60^b$ | $103.43^b$ | 1.60 | 0.031 |
| *Crude protein intake (CPI)* | | | | | |
| CPI (g/d/animal) | 474.40 | 526.14 | 536.17 | 11.68 | 0.067 |
| CPI (g/100kg BW) | $420.63^a$ | $454.74^b$ | $455.39^b$ | 5.89 | 0.021 |
| CPI(g/kg $W^{0.75}$) | $13.67^a$ | $14.91^b$ | $14.98^b$ | 0.22 | 0.022 |
| CP% of diet | 13.08 | 13.02 | 13.13 | 0.03 | 0.187 |

Values with different superscripts (a ,b) in a row are significantly different

**Table 4: Digestibility (%) and availability of different nutrients in crossbred calves under different treatments.**

| Nutrients | Groups | | | S.E.M. | Level of significance (P value) |
|---|---|---|---|---|---|
| | $T_0$ | $T_1$ | $T_2$ | | |
| *Digestibility of nutrients (%)* | | | | | |
| DM | $57.39^a$ | $62.10^b$ | $62.00^b$ | 0.57 | <0.001 |
| OM | $60.25^a$ | $64.39^b$ | $64.85^b$ | 0.53 | <0.001 |
| EE | 76.42 | 77.29 | 76.98 | 0.33 | 0.561 |
| CP | 59.88 | 61.77 | 61.29 | 0.50 | 0.289 |
| Total carbohydrate | $59.64^a$ | $64.31^b$ | $65.00^b$ | 0.57 | <0.001 |
| NDF | $50.79^a$ | $55.84^b$ | $56.26^b$ | 0.70 | 0.001 |
| ADF | $42.44^a$ | $47.83^b$ | $48.04^b$ | 0.73 | 0.001 |
| Hemicellulose | $62.56^a$ | $67.51^b$ | $68.29^b$ | 0.77 | 0.003 |
| Cellulose | $45.30^a$ | $50.26^b$ | $50.91^b$ | 0.71 | 0.002 |
| **Nutrient availability** | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| *DCP intake (DCPI)* | | | | | |
| DCPI (g/d/animal) | 284.73$^{a}$ | 324.94$^{b}$ | 328.56$^{b}$ | 7.22 | 0.021 |
| DCPI (g/100kg BW) | 252.46$^{a}$ | 280.85$^{b}$ | 279.06$^{b}$ | 3.71 | 0.002 |
| DCP% of diet | 7.85$^{a}$ | 8.04$^{b}$ | 8.05$^{b}$ | 0.02 | <0.001 |
| *TDN intake (TDNI)* | | | | | |
| TDNI (kg/d/animal) | 2.09$^{a}$ | 2.48$^{b}$ | 2.53$^{b}$ | 0.06 | 0.002 |
| TDNI (kg/100kg BW) | 1.85$^{a}$ | 2.14$^{b}$ | 2.15$^{b}$ | 0.03 | <0.001 |
| TDN% of diet | 57.51$^{a}$ | 61.22$^{b}$ | 61.97$^{c}$ | 0.21 | <0.001 |

Values with different superscripts (a ,b, c) in a row are significantly different

**Table 5: Economics of feeding in different treatment groups.**

| Attributes | | $T_0$ | $T_1$ | $T_2$ |
|---|---|---|---|---|
| A. Feed intake (Fresh basis) | a) Concentrate mixture in 90 days (kg/animal) | 125.35 | 135.33 | 137.72 |
| | b) Total mixed fodder in 90 days (kg/animal) | 344.91 | 372.38 | 378.97 |
| | c) Total straw intake in 90 days (kg/animal) | 93.44 | 100.88 | 102.67 |
| | d) Total cellulase intake in 90 days (g/animal) | 0 | 4.88 | 7.45 |
| | e) Total xylanase intake in 90 days (g/animal) | 0 | 48.82 | 74.52 |
| B. Feed cost (Rs.) | a) Total cost of concentrate mixture @ Rs. 28.66/kg fresh basis (Rs./90 days/animal) | 3991.12 | 4308.89 | 4385.15 |
| | b) Total cost of mixed fodder @ Rs. 2/kg fresh basis (Rs./90 days/animal) | 689.83 | 744.75 | 757.93 |
| | b) Total cost of straw @ Rs. 5.2/kg fresh basis (Rs./90 days/animal) | 485.90 | 524.59 | 533.87 |
| | d) Total cost of cellulase in Rs. @ Rs. 550/kg (Rs./90 days/animal) | 0 | 2.68 | 4.10 |
| | e) Total cost of xylanase in Rs. @ Rs. 1200/kg (Rs./90 days/animal) | 0 | 58.58 | 89.42 |
| | f) Total feed cost (Rs./90 days/animal) | 4768.24 | 5209.14 | 5332.51 |
| | Total cost (Rs./day/ animal) | 52.98 | 57.88 | 59.25 |
| C. Total weight gain (kg/animal/90 days) | | 38.16 | 43.76 | 44.25 |
| D. Average daily gain (g) | | 424.02 | 486.22 | 491.68 |
| E. Feed cost per kg gain (Rs.) | | 124.95 | 119.04 | 120.51 |
| F. Profit over control group (Rs./kg weight gain) | | - | 5.91 | 4.44 |
| G. Feed cost reduce over control (%) | | - | 4.73 | 3.56 |
| H. Profit over control group (Rs./animal/90days) | | - | 258.62 | 196.47 |

## CONCLUSION

From this study, it may be concluded that supplementation of EFE (cellulase and xylanase @ 8000 and 16000 IU/kg TMR DM; and 12000 and 24000 IU/kg TMR DM) significantly increased intake of DM, OM and CP per unit body weight and apparent digestibility of DM, OM and fibre fractions (NDF, ADF, hemicellulose and cellulose) of the TMR fed to crossbred calves. Apart from this EFE supplementation also increased availability of nutrients (DCP and TDN) and nutritive value of feed (DCP% and TDN%); hence, more nutrients were available for higher growth performance in calves resulting in reduction of feed cost per kg weight gain. However, higher level of EFE (12000 and 24000 IU/kg TMR DM) had no added advantage. Therefore, it may be concluded that supplementation of EFE (cellulase and xylanase @ 8000 and 16000 IU/kg TMR DM) may boost voluntary intake, digestibility of nutrients and reduced the cost of feed per kg weight gain of crossbred calves.

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