

Original Research Article

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Effect of Supplementation of Cellulolytic Enzymes on the Performance of Growing Mandya Lambs Fed with Urea Treated Farm Sugarcane Bagasse

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ABSTRACT

The present study was conducted to assess the effect of feeding farm Sugarcane bagasse (FSCB) fortified with cellulase and hemicellulase enzymes on intake, ADG and digestibility in Mandya sheep fed with 3% urea treated finger millet (*Eleusine coracana*) straw as basal diet. Eighteen Mandya sheep (male lambs 6-9 month age) were selected and divided into three groups of six animals in each treatment. The trial lasted for 12 weeks. The sheep of T-1 group were fed with 3% urea treated finger millet straw and concentrated feed mixture (CFM) considered as control group. In T-2 group 50% of finger millet straw was replaced with 0.5% cellulase and hemicellulase treated FSCB. In T-3 group 75% of Finger millet straw was replaced with 0.5% cellulase and hemicellulase treated FSCB. The mean roughage DMI was 338.15, 213.16 and 191.74 g/d in T-1, T-2 and T-3 groups, respectively. The DMI varied significantly ($P < .0001$) between the groups. ADG was 77.14, 51.91 and 55.67g/d for T-1, T-2 and T-3 groups, respectively which was statistically non-significant. The digestibility of different nutrients varied non-significantly among the groups. Results of this study indicate that, even though supplementation of fibrolytic enzyme failed to improve the DMI of FSCB, the growth rate was not affected. This suggests that the urea treated bagasse with little supplementary feed can become a source of alternative roughage. Further study should focus on supplementation of fibrolytic enzymes with urea treatment at effective activity level to promote optimum growth performance and nutrient utilization in sheep.

Keywords

Farm sugar cane bagasse, Mandya lambs, Cellulase, Hemicellulase

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Introduction

Ruminants play an important role in the rural economy of developing country like India. Being able to digest fibrous material and by-products, these are well suited for recycling such material and providing an additional source of income. However, the increased cost of production is causing grave concern to all those involved in this business.

This situation is further aggravated by drought conditions prevalent in one or other parts of India every year. Cereal straws form the major source of bulk and energy for ruminants in developing countries. However in the last few years, the straws have become an expensive commodity. One of the alternatives is use of agro-industrial by-products like sugarcane bagasse. In India, sugarcane production is 281.57 million metric tonnes per year (BS report, New Delhi) and for each 10 tonnes of sugarcane crushed, a sugar factory produces nearly 3 tonnes of wet bagasse.

The efficiency of utilization of crop residues like sugarcane bagasse in ruminants is very low which could be altered by a high rate and extent of digestion in rumen and better availability of microbial nutrients in the feed to support an efficient microbial growth, which could meet 80 to 90 per cent energy and 60 to 70 per cent protein needs. Strategies in improving the utilization of crop residues by rumen manipulation are maximum hydrolysis of lignocellulosic feeds by increased cleavage, through NPN substances in feed. On the other hand, protecting the true protein from microbial degradation could force the microorganisms to use NPN more efficiently (Orskov *et al.*, 1972). According to Sarmiento *et al.*, (2001) although the cellulolytic enzymes is present in the rumen are able to hydrolyze the cellulose there is however, great difficulty to access the same points at which the cellulosic polymer rupture occurs. To

improve the nutritional value of sugarcane bagasse in nature, researchers have made efforts to improve its use in animal feed (Torres *et al.*, 2003). Because of the undesirable features present in the bagasse, its use has been improved using chemical, physical or enzymatic treatment. Torres *et al.*, (2003) pointed out that due to low crude protein content in dry matter, approximately 90 percent of the nitrogen may be unavailable as it is associated with fiber and the acid fiber content of bagasse which has values between 58 and 62%. This results in lower digestibility (25 to 30%) and makes it a food source with low nutritional value. Urea treatment is a better option to improve the nitrogen content thereby improves the protein value of low quality roughages like sugarcane bagasse.

In addition, use of exogenous fibrolytic enzymes has shown to enhance colonization ruminal microorganisms and increase the rate of degradation in the rumen and improve the body weight gains in straw based diets (Balci *et al.*, 2007; Singh and Das, 2009).

The utilization of sugar cane and its crop residues by different physical and biological procedures in order to increase its feeding value has determined better animal response in ruminants. The present study was conducted to ascertain the effect of supplementation of fibrolytic enzymes to farm sugarcane bagasse procured from jaggery industry on dry matter intake, digestibility and growth rate in Mandya lambs.

Materials and Methods

The present study was carried out at Livestock Research and Information Centre (Sheep), KVAFSU, Nagamangala to compare urea treated farm sugar cane bagasse fortified with cellulase and hemicellulase enzymes with urea treated finger millet (*Eleusine coracana*) straw.

Experimental design

Eighteen ram lambs of six to nine months of age with uniform body weight were divided into three groups of six animals each in a completely randomized design (CRD). The sufficient farm Sugar cane bagasse (FSCB) was procured from local Jaggery manufacturing plant for the experiment. The concentrate feed mixture (CFM) sufficient for entire duration of study was prepared in a single batch and stored. Cellulase and hemicellulase enzymes were obtained from commercial manufacturer with activity of 23,00,000 unit/g and 5,00,000 unit/g respectively. The feeding trial was carried out for 90 days. The experimental animals were under uniform managemental care. The lambs were housed in a separate pen to facilitate individual feeding and watering.

The experimental diets comprised of finger millet (*Eleusine coracona*) straw (T₁), 50% of Finger millet straw was replaced with 3% urea treated FSCB fortified with cellulase and hemicellulase at the rate of 0.5% (T₂) and 75% of Finger millet straw was replaced with 3% urea treated FSCB fortified with cellulase and hemicellulase at the rate of 0.5% (T₃) as source of roughage.

All the sheep were fed with same concentrate feed mixture (Table 1). The diets for the experimental sheep were formulated individually to meet energy and protein requirement as per ICAR (2013) recommendations. Roughage was treated with urea at the rate of 3 per cent. The required quantity of roughage was weighed and offered to all the individual lambs at different intervals so as to ensure *ad-libitum* feeding. The CFM was offered at 8.00 and 16.00 hours of the day for sheep at divided doses of 125 grams per sheep per time. The free choice of clean water is made available throughout the day.

Parameters studied

Dry matter intake

Daily DMI (Dry matter intake) of forage and CFM of each experimental animal was recorded. Representative samples from fodder offered and leftover were collected daily and the DM (Dry Matter) content of both was estimated to know the actual DMI by each animal.

Average daily body weight gain

All the sheep were weighed before the commencement of experiment in the morning before having any access to either feed or water and it was taken as initial body weight (BW) of the study. The BW was recorded using digital platform weighing balance. Animals were weighed every week and average daily gain was calculated.

Digestion trial and chemical analysis

Digestion trial was conducted for six days at the end of experiment. Dung from each lamb was collected by harnessing with plastic bag tied around the lumbar region of the animal, bags were emptied 3-4 times a day and faecal pellets collected over 24h from each lamb was weighed next day morning. Total collection of the day was crushed and after proper mixing 1/10th of total voided faeces from each lamb was sub sampled for dry matter estimation. The sample collected over six days were pooled and grounded to obtain a particle size of 1mm for further chemical analysis. For estimation of nitrogen 1/100th of total voided faeces was sub sampled in a plastic air tight container of known weight with 5ml of 25 per cent sulphuric acid added every day as a preservative.

The samples of feed, fodder and dung were analysed for proximate constituents (AOAC,

1995) except for the crude fibre. The fibre fractions were analysed as per the procedures described by Van soest *et al.*, (1991).

The Farm samples of sugarcane bagasse (treated and untreated) were collected during digestibility trial of each period for analysis.

Statistical analysis of data

Data was analysed by least square method using GLM procedure using “Statistical Analysis Software” (SAS 9.3), by keeping treatment group as fixed effect. The following linear model was used for the analysis of individual parameters.

$$Y_{ik} = \mu + T_i + e_{ik}$$

Where, Y_{ik} is the body weight, body weight gain, DMI and digestibility of nutrients of n^{th} lamb, μ is the overall mean, T_i is the fixed effect of i^{th} lamb in the treatment group and e_{ik} is the random error to the n^{th} lamb.

Results and Discussion

Chemical composition of experimental diet

The chemical composition of CFM, Farm sugarcane bagasse and experimental feed is presented in Table 2. The FSCB used in this experiment contained (%) 2.15 CP, 0.61 EE, 45.35 CF, 48.35 NEF and 3.12 TA. The CP, EE and TA were lower than the values given by Shakweer, 2003 except CF content. Whereas, Preston (2003) obtained lower CP (1%) and higher CF (49%) than the values reported for FSCB in this study.

The NDF, ADF and AIA content of FSCB were 85.57, 60.24 and 1.98 per cent, respectively, which were almost comparable to the values reported in other studies (Preston, 2003; Shakweer, 2003; Kanji *et al.*, 2006).

Dry matter intake (DMI)

The mean DMI is presented in the Table 3. The mean dry matter intake of concentrate was 231.16 g for all the three treatment groups. There was no left over in all the treatments. The Mean DMI of roughage was 338.15, 213.11 and 191.74 g for T1, T2 and T3, respectively which varied significantly ($P < .0001$). There was higher roughage consumption in T1 group which were fed exclusively on Finger millet. In T2 group with 50:50 Ragi straw: FSCB the DMI was better compared to T3 with the ratio of 25:75. The total DMI of all the three treatment groups varied significantly ($P < .0001$) which was recorded to be 602, 477 and 456 g for T1, T2 and T3, respectively. Sheep of all the experimental groups have not consumed sufficient dry matter intake according to the requirements of ICAR (2013) and NRC (1985) in spite of FSCB treated with 3% urea as well as CFM, however performance was not affected. The findings of this experiment was similar to Gomez *et al.*, (2003) experiment on steers offered with star grass and sugarcane plus urea with fibrolytic enzyme and El-Kady *et al.*, (2006) in buffalo calves fed with pearl millet straw supplemented with cellulase, xylanase, alpha-amylase and polyglacturonase (pectinase) at 0.4% of the diet, in Merino lambs given low and high forage diet with fungal enzymes (Cruywagen and Nanzyl, 2008), lambs fed with urea treated Rhodes hay supplemented with cellulolytic enzymes (Ramu, 2011), whereas addition of enzymes did not improve the palatability and intake in goats and heifers fed with Rhodes hay supplemented with cellulolytic enzymes (Siddaramanna *et al.*, 2011).

Body weight gain

The initial, final and ADG is presented in Table 4. The initial weight of T1, T2 and T3 were recorded to be 16.93, 16.37 and 16.90

kg, respectively which was statistically non-significant. Final weight was 19.63, 18.18 and 18.88 kg for T1, T2 and T3, respectively. Weekly ADG was calculated and the mean ADG during the trial period was 77.14, 51.91 and 55.67 g for T1, T2 and T3, respectively which was statistically non-significant but

numerically T1 had better ADG compared to other two treatment groups. Whereas, Balci *et al.*, (2007) reported significantly higher ($p \leq 0.05$) body weight gain in steers fed with enzyme treated wheat straw for a period of 80 Days.

Table.1 Ingredient Composition (% M/M) of concentrate feed mixture fed to experimental sheep

SL No.	Ingredient	Level of inclusion (%)
1	Maize	41
2	Soybean meal	17
3	Wheat bran	38
5	Mineral mixture	2.0
7	Salt	2.0
	Total	100

Note: The mineral mixture contained Calcium- 22%, Phosphorus- 9%, Manganese sulphate- 0.2%, Potassium iodide- 0.02%, ferrous sulphate- 0.6%, Copper sulphate- 0.5%, Cobalt sulphate- 0.02%, Zinc sulphate- 0.2%, Selenium- 0.02mcg and Yeast- q.s.

Table.2 Chemical composition of CFM, FSCB and experimental feed (% DMB)

Parameters	Concentrates	FSCB	T1	T2	T3
OM	90.5	96.88	97.12	96.89	97.32
CP	17.2	2.15	6.15	5.84	5.54
EE	2.34	0.61	0.64	0.53	0.55
CF	6.9	45.35	42.53	43.89	48.63
NFE	63.36	48.77	47.8	46.63	42.6
TA	10.2	3.12	2.88	3.11	2.68
AIA	1.68±0.02	1.98±1.06	1.60±0.04	1.96±1.04	2.45±1.05
NDF	31.33±0.40	85.57 ±1.65	85.52±2.58	86.81±1.95	86.67 ±2.05
ADF	12.38±0.16	60.24 ±1.82	62.00±1.93	61.17±2.88	64.68 ±1.59

Table.3 Mean dry matter intake (g/d) of experimental sheep

Parameter	T1	T2	T3	P Value
Concentrates (g/day)	231.16	231.16	231.16	
Roughage DMI (g/day)	338.15±3.15 ^a (264)	213.11±2.49 ^b (264)	191.74±3.05 ^c (264)	<.0001
Total DMI (g/day)	602.87±7.19 ^a (90)	477.83±4.97 ^b (90)	456.46±4.80 ^c (90)	<.0001

Table.4 Initial, final weight (kg) and gain (g/d) of experimental sheep

Parameters	T1	T2	T3	P value
Initial Weight (kg)	16.93±0.65 (6)	16.37±0.54 (6)	16.90±0.38 (6)	0.7072
Final Weight(kg)	19.63±0.24 ^a (6)	18.18±0.46 ^b (6)	18.88±0.23 ^{ab} (6)	0.0234
ADG(g)	77.14±13.50 (6)	51.91±3.86 (6)	55.67±6.78 (6)	0.1432

Table.5 Mean digestibility of nutrients (%) of experimental sheep

Digestibility (%)	T1	T2	T3	Treatment effect
DM	59.18 ±1.05	58.72± 1.94	58.03 ±1.23	NS
OM	61.28±1.10	61.03±0.74	59.11± 1.21	NS
CP	74.21±2.81	73.51±1.02	70.25±1.43	NS
EE	71.81±1.16	69.71±2.11	68.62±1.10	NS
CF	55.27±0.77	53.58±2.17	51.48±1.01	NS
NFE	61.41±1.60	59.92±1.13	57.15±0.42	NS
NDF	49.11±2.21	47.64±1.18	46.08±1.21	NS
ADF	36.91±1.31	40.15±1.00	40.54±1.12	NS

Note: NS- non-significant.

Digestibility of nutrients

The mean digestibilities of nutrients of experimental sheep are given in Table 5. The mean apparent digestibility (%) of nutrients for T-1, T-2 and T-3 groups with respect to DM, OM, CP, EE, CF, NFE, NDF and ADF were 59.18, 58.72 and 58.03; 61.28, 61.03 and 59.11; 74.21, 73.51 and 70.25; 71.81, 69.71 and 68.62; 55.27, 53.58 and 51.48; 61.41, 59.92 and 57.15; 49.11, 47.64 and 46.08; 36.91, 40.15 and 40.54, respectively. The differences among the groups with respect to nutrient digestibility were non-significant. However, additions of enzymes have improved the digestibility of the FSCB on par with the finger millet. This marginal improvement in the utilization of nutrients over basal diet (3% urea treated finger millet) without enzymes is a indicative of further chances of improving the utilization of nutrients in FSCB by optimising the level of cellulase and hemicellulase. Similar results were also

obtained when Nali rams fed solely with 4% urea treated jowar straw (Sheela *et al.*, 2004). An addition of fibrolytic enzymes to some of the crop residues like wheat straw fed to sheep (Pinos-Rodriguez *et al.*, 2007), oat hay fed to goats (Singh and Das, 2008) and Rhodes hay fed to lambs (Ramu, 2011) showed significant improvement in the digestibility of nutrients.

Supplementation of fibrolytic enzymes to urea treated FSCB did not improved palatability and dry matter intake in Mandya lambs however, the performance of the lambs were analogous to conventional roughages.

This suggests that the urea treated bagasse with little supplementary feed can become a source of alternative roughage. Further study should focus on supplementation of fibrolytic enzymes with urea treatment at effective activity level to promote optimum growth performance and nutrient utilization in sheep.

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