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Effect of Feeding Sorghum Hay, Maize Stover and Areca Sheath Based Total Mixed Ration Feed Block (TMRfb) on Nutrient Intake, Digestibility and Cost Economics in Growing Lambs

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ABSTRACT

A comparative study on sorghum hay, maize stover and areca sheath based total mixed ration feed block (fb) on voluntary feed intake, digestibility, growth performance and rumen fermentation parameters was conducted in growing lambs. Eighteen non-descript lambs aged 4-6 months with an average body weight of 17±0.9kg were randomly allotted to three experimental diets with roughage to concentrate ratio of 60:40. The T1- diet comprised of sorghum hay based TMRfb, T2-diet comprised of maize stover based TMRfb and T3- diet comprised of areca sheath based TMRfb. The average DMI (g/d) of TMRfb varied significantly ($P<0.01$) from 480.81 (T2) to 738.19 (T1) with 34.86 percent lower intake in maize stover based group compare to control. The ADG (g/d) was significantly ($P<0.01$) higher in T1 (85.2), compared to T3 (64.3) followed by T2 (35.9). The digestibility of DM, OM, and CF was higher in T3 compared to T1 and T2. Digestibility of CP was ($P<0.01$) higher in T1 and T3 compared to T2. The intake of DCP (g/d), TDN (g/d) and ME (MJ/d) intake were significantly ($P<0.01$) higher in T1 (69.77, 531.87 and 9.03) as compared to T2 (30.82, 367.07 and 5.39) and T3 (32.85, 362.36 and 5.33). It was observed that sorghum hay based TMR had better feed intake and average daily gain compared to maize stover and areca sheath-based groups. However, cost per kg gain was 36.90 percent higher in areca sheath based TMR groups compared to sorghum hay based group.

KEYWORDS: Average daily gain, Cost economics, Digestibility, Feed block, Hay, Lambs, Rumen parameters, Total mixed ration.

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INTRODUCTION

Crop residues are bulky in nature and to facilitate easy transportation and storage with minimum input, densification technologies are useful. Crop residues and agro industrial by-products play an important role as a source of feed for ruminants, but the utilization of these feeds is limited because of poor nutrient content and digestibility. To make crop residues quality roughage for ruminants feeding, various processing methods like grinding, pelleting, treatment with chemicals like ammonia (Reddy and Reddy, 1985) and sodium hydroxide (Ben-Ghedalia et al., 1982) have been tried to improve the nutritive value. The concept of feeding complete rations or total mixed ration with use of locally available crop residues seems to be ideal and promising for improving the utilization of poor-quality fibrous crop residues.

Total Mixed Ration stabilizes the environment for rumen fermentation, minimizes fermentation losses, and reduces fluctuations in ammonia release, thus enhancing the utilization of low-grade roughages (Venkanna et al., 1997). Further, one of the options for effective utilization of the crop residues is by processing technologies for the commercial manufacture of straw-based complete feed for ruminants. The manufacture of densified total mixed ration blocks (DTMRB), also known as densified complete feed blocks (DCFB), is an innovative technology for supplying balanced feeds to dairy and other livestock farmers in the tropics. The study conducted at ICAR-NIANP on use of areca sheath as dry fodder has shown promising results (Gowda et al., 2016). This study was undertaken with objective to prepare sorghum hay, maize stover and areca sheath based total mixed ration and to evaluate feeding of these blocks on voluntary feed intake, average daily gain, nutrient digestibility and rumen liquor profile.

MATERIALS AND METHODS

The animal trial was conducted at Department of Animal Nutrition, Veterinary College, Shivamogga, Karnataka, India.

Source of roughage for TMR block preparation:

Sorghum hay was grown in fodder plots of Veterinary College, Shivamogga. The hay was harvested at 75 days, chaffed, sun dried for 6 days and were ground by using shredder (8mm sieve size) and stored in gunny bags. Dried Maize stover was ground by using shredder and stored in gunny bags. Areca sheath trimmings were collected from nearby areca sheath plate industry. The sheath was dried for 2 days under sun light. Once it was completely dried, ground by using shredder and stored in gunny bags. The compounded feed mixture comprising maize, DORB, cotton seed cake, ground nut cake, salt, mineral mixture and urea were procured from local market. The molasses premix was done at M/S Sri Devi Feeds, Honnali, Karnataka, India Composition of ingredients in depicted in Table 1.

Table 1.Ingredient composition (% DM basis) of TMRfb

Ingredients	T1 (%)	T2 (%)	T3 (%)
Sorghum hay	60.0	0.00	0.00
Maize stover	0.00	60.00	0.00
Areca sheath	0.00	0.00	60.0
Maize	19.2	19.2	19.2
DORB	4.00	4.00	4.00
Cotton seed cake	5.60	5.60	5.60
Ground nut cake	6.00	6.00	6.00
Mineral mixture	0.80	0.80	0.80
Salt	0.40	0.40	0.40
Urea	0.40	0.40	0.40
Molasses	3.60	3.60	3.60
Total	100.00	100.00	100.00

T1-Sorghum hay based total mixed ration feed block (60:40):(SH-TMRfb)
T2-Maize stover based total mixed ration feed block (60:40):(MS-TMRfb)
T3-Areca Sheath based total mixed ration feed block (60:40):(AS-TMRfb)

Preparation of Total Mixed Ration Feed Block

The TMR was prepared by mixing roughage and concentrate in the ratio of 60: 40 (Table 1). TMR blocks of 500g-1500g was prepared using Commercial Feed Block making machine. This block making machine works on the principle of hydraulic compression. The machine works at a capacity of 3000 psi pressure and equipped with 7.5 HP motor. Blocks were prepared by applying compression pressure at 3000 psi for about 15-20 sec. Blocks of 500g-1500g were stored in plastic bags.

Experimental animals and feeding trial

Eighteen male lambs of non-descript breeds (average body weight of 17±0.9 kg) of four to six months old were divided into three groups in a complete randomized design (CRD). Group I (T1) was fed with Sorghum hay based total mixed ration feed block (60:40): (SH-TMRfb), group II (T2) was fed with Maize stover based total mixed ration feed block (60:40): (MS-TMRfb) and group III (T3) Areca Sheath based total mixed ration feed block (60:40): (AS-TMRfb). Initial adjustment period of two weeks and feeding trial was carried out for a period of twelve weeks followed by a digestion cum metabolism trial for a period of five days was conducted. The ADG and DMI were calculated. Experimental diets were subjected to proximate (AOAC 2016) and Fiber analysis (Vansoest et al., 1991).

Every week body weight of lambs was recorded using digital platform balance before offering feed and water. The average daily gain (ADG) of lambs was calculated on the basis of weekly change in the body weight. Daily intake of TMRfb was recorded. Dry matter intake of lambs was calculated by deducting the left over from the mean daily offered quantities of TM fb.

Statistical analysis

The data regarding DMI and nutrient intake, ADG, digestibility co-efficient, Nitrogen balance and plane of nutrition were subjected to statistical analysis, one way ANOVA by using SPSS statistical software (IBM SPSS Statistics 20).

RESULTS AND DISCUSSION

Chemical composition of experimental diets

The chemical composition of sorghum hay, maize stover and areca sheath are presented in Table 2. The DM, OM, TA and AIA of sorghum hay and areca sheath were similar except CP, CF, EE, NFE, NDF, ADF, HC and C. The CP contents of sorghum hay and areca sheath were similar 4.47 and 4.35, respectively which were similar to the values recorded by Vikas Dharigoud, (2019). The DM, CP, CF, EE and NFE of maize stover were 88.9. The CP (%) content of SH-TMRfb, MS-TMRfb and AS-TMRfb were 10.01, 7.88 and 8.54, respectively. The CP content was different in all the treatment because roughage: concentrate ratio of 60:40 was maintained to prepare a practically and economically feasible feed block. The composition of areca sheath is like the reported values of Gowda et al., (2016).

Table 2. Chemical composition (% on DMB) of CFM, roughages and TMRfb.

Parameter	CFM	SH	MS	AS	T1	T2	T3
DM	89.8	87.8	88.9	87.4	87.5	88.3	86.3
OM	92.2	93.2	93.9	93.0	92.1	93.3	93.0
CP	18.9	4.47	3.41	4.35	10.01	7.88	8.54
CF	10.1	26.7	34.6	38.2	20.7	24.0	21.8
EE	3.10	2.00	1.60	1.40	2.70	2.10	2.40
NFE	60.1	60.03	54.3	49.05	58.7	59.3	60.2
TA	7.80	6.80	6.10	7.00	7.90	6.70	7.00
AIA	1.40	2.60	2.40	2.60	2.60	2.50	1.90
NDF	32.2	44.7	61.3	67.7	42.3	55.2	58.1
ADF	10.5	25.1	35.4	35.7	24.3	28.0	31.4
ADL	3.30	5.30	7.20	5.60	5.30	5.60	5.90
HC	21.7	19.6	25.9	32.0	18.0	27.2	26.7
C	7.20	19.8	28.2	30.1	19.00	22.4	25.5
Ca	2.61	0.30	0.60	0.20	1.20	1.10	1.00
P	1.09	0.14	0.19	0.06	0.50	0.60	0.50
Density (g/cm^3)	-	-	-	-	480.00	540.00	570.00

SH- Sorghum hay; MS-Maize stover; AS-Areca sheath;

Weekly dry matter intake

The average DMI (g/d) of TMRfb varied from 480.81 (T2) to 738.19 (T1). In terms of *per cent* of bodyweight TMR feed block varied from 2.57 (T3) to 3.64 (T1). The sorghum hay based TMR (T1) fed group of animals has significantly ($P \leq 0.01$) higher voluntary feed intake compared to maize stover (T2) and Areca sheath (T3) based groups because of more ME (MJ/kg DM), CP (%) in T1 group and is more acid detergent lignin (ADL) in T2 and T3 group. Similar observations were recorded by Sivala et al. (2024) where there was a substantial increase in the DMI (g/day) of kids fed with feed block containing very low protein and polyethylene glycol compared to kids fed with low protein and high protein feed block. Raghuvansi et al. (2007) reported that DM intakes of Malpura lambs fed on complete feed block were considerably higher than those animals maintained on grazing followed by supplementing of 250g concentrate mixture.On the contrary, Hozhabri and Singhal, (2009) recorded that DMI and average daily gain (ADG) was similar between the groups fed with wheat straw based complete feed block (CFB), sugarcane bagasse containing CFB and formaldehyde treated rapeseed cake containing CFB. Chaudhary et al. (2017) also reported that, the dry matter intake was comparable between the group fed with paddy straw based complete feed block (733.40 g/d) and kinnow mandarin (*Citrus nobilis x Citrus deliciosa*) waste included paddy straw based complete feed block (733.75 g/d).

Average daily gain (ADG)

The overall gain during the 12 weeks feeding trial was 7.7, 3.2 and 5.8 kg concomitantly 85.2, 35.9 and 64.3 ADG (g/d) for the dietary groups T1, T2 and T3, respectively (Table. 3). The average daily gain of T1 was higher compared to T3 than T2. The T2 group observed significantly lower body weight gain than T3.

The change in body weight (gain/loss) of the lambs was rather inconsistent in the treatments (T2 and T3) during the experimental period. Due to lower intake of CP in both the treatment groups, the animals didn't meet the protein requirement as per the standard specifications (ICAR, 2013). Hence, feeding of crop residue based TMRfb for T2 groups could not support appreciable body weight gain during feeding trial.

Table 3. Body weight changes and Average daily gain of lambs during feeding trial

Parameters	T1	T2	T3	SEM	P value
Initial body wt.(kg)	17.0	17.4	17.0	0.43	0.91
Final body wt. (kg)	24.7^{b}	20.7^{a}	22.8^{ab}	0.69	0.05
Total weight gain(kg)	7.73^{c}	3.22^{a}	5.8^{b}	0.54	0.01
ADG (g)	85.2^{c}	35.9^{a}	64.3^{b}	5.95	0.01

$P \leq 0.05$,Means bearing different superscripts between the columns.

However, such crop residue based TMRfb can be considered to support the requirement of animals with low to medium growth potential and to overcome the feed scarcity situations during Natural calamities like flood and drought conditions. Vikas Dharigoud (2019) reported slightly higher gain compared to present study which might be due to inclusion of CFM was higher (50%) in their total mixed ration diet. Reddy et al. (2018) recorded higher growth rate with feeding of crop residue based total mixed ration.

Nutrient digestibility

The digestibility of DM, OM, CP, CF, EE, NFE, NDF, ADF, HC and C was significantly higher in T3 as compared to T2 and T1, indicating areca sheath was having higher digestibility as compared to sorghum hay and maize stover as the DMI of areca sheath was low and prolonged ruminal stay for effective digestion (Table 4).

The digestibility values obtained in the present study for areca sheath was in concurrence with the reports of Raguvansi et al. (2007a) where OMD and CPD were significantly higher in stall fed goats than goats fed on grazing. Similar observations were also recorded by Reddy et al. (2018). In the present study, higher digestibility of the areca sheath as compared to sorghum hay and maize stover may be attributed to high longer ruminal stay, fiber digestibility consequently higher utilization. Similar observations recorded by Vikas Dharigoud, (2019) where in areca sheath was having higher digestibility as compared to paddy straw. Similarly, the digestibility of cellulose was significantly higher in areca sheath as compared to paddy straw and further confirmed the higher fermentability of areca sheath. On the contrary, Das et al. (2004) fed complete feed in mash form and complete feed in block form to crossbred calves and Babu et al. (2014) fed three complete rations formulated with roughage to concentrate ratio of 60:40 using sorghum stover, maize stover and sweet sorghum stover to Nellore ram lambs reported no significant difference in digestibility of DM, OM, CP, CF, EE and NFE.

Nutrient density and their intake

The DCP, TDN and ME content of T1 rations were significantly higher compared to T2 and T3. Whereas, TDN and ME content of T3 rations were significantly higher compare to T1 and T2. The energy (TDN and ME) and protein (DCP) content of the experimental rations were computed for their intake in which, group T1 animals received significantly higher as compared to T3 and T2 (Table 5).

Table 4. Nutrient digestibility (%) of experimental lambs

Parameter	T1	T2	T3	SEM	P-value
DM	54.48[a]	55.00[a]	65.71[b]	1.57	0.01
OM	55.61[a]	58.42[a]	67.52[b]	1.51	0.01
CP	71.35[b]	58.77[a]	69.41[b]	1.58	0.01
CF	44.01[a]	45.59[a]	56.49[b]	1.77	0.01
EE	73.53[a]	79.43[b]	86.28[c]	1.34	0.01
NFE	57.46[a]	60.48[a]	70.49[b]	1.59	0.01
NDF	50.01[a]	57.32[b]	65.58[c]	1.77	0.01
ADF	50.47[a]	58.05[b]	58.61[b]	1.28	0.01
HC	49.39[a]	56.40[b]	62.21[c]	1.58	0.01
C	53.66[a]	59.62[b]	62.22[b]	1.23	0.01

P<0.01, Means bearing different superscripts between the columns differ significantly.

Table 5. Mean nutrient density and intake of experimental lambs

Parameter	T1	T2	T3	SEM	P
DCP (%)	7.14[c]	4.63[a]	5.93[b]	0.26	0.01
TDN (%)	54.4[a]	52.2[a]	65.4[b]	1.48	0.01
ME (MJ/kg)	9.25[b]	7.99[a]	9.62[c]	0.17	0.01
DCP intake (g/d)	69.7[b]	31.4[a]	32.85[a]	4.44	0.01
TDN intake(g/d)	590.3[b]	352.5[a]	348.4[a]	21.38	0.01
ME intake(MJ/d)	9.03[b]	5.39[a]	5.33[a]	0.45	0.01

P<0.01, Means bearing different superscripts between the columns differ significantly.

In comparison to recommendation of ICAR (2013) for a rams weighing 15 kg with ADG of 100 g/d (DCP intake 65 g/d and TDN intake 373 g/d), the DCP intake was very low in T2 and T3 group which has reflected in lower body weight gain. TDN intake was slightly lower in T2 and T3 than the recommendations. The lower feed formulation of roughage: concentrate in the ratio of 60:40 might affect the plane of nutrition in experimental lambs of T2 and T3 and found to be inadequate.

Cost economics of feeding TMRfb in lambs

The total cost incurred towards feeding of sheep with TMR feed blocks was worked out for unit live weight gain. The average cost of production was found to be Rs.190.2, 200.7 and 120.0 per kg live weight gain in T1, T2 and T3, respectively. The lambs maintained on T3 (RS. 120.0) recorded a reduced feed cost per kg live weight gain compared to lambs fed on T1 (Rs. 190.2) and T3 (Rs. 200.7).

CONCLUSION

Areca sheath-based TMR feed blocks demonstrated better fiber digestibility compared to sorghum hay and maize stover. The cost of feeding per kg gain was 36.9% lower in areca sheath-based TMR feed blocks compared to the sorghum hay-based group. Areca sheath could be conveniently incorporated as a replacement for traditional crop residues in TMR feed blocks, making it suitable for ruminant feeding.

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