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Effect of Feeding Decorticated Tamarind (*Tamarindus indica*) Seed Based Diet on Intake, Nutrient Digestibility and Growth Performance in Mandya Sheep

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ABSTRACT

A feeding cum digestion trial of twelve weeks duration was taken up to study the effect of feeding partially and completely decorticated tamarind seed based diet on intake, nutrient digestibility and growth performance in Mandya sheep. Eighteen Mandya lambs of about 3-4 months of age with body weight ranging from 6 to 10.5 kg were distributed to three treatments of six each in a completely randomized design. The animals of Treatment 1 (T1) received a compounded feed mixture (CFM) having 30% wheat bran (WB) (control), whereas, Treatment 2 (T2) and Treatment 3 (T3) received CFM with 15% partially decorticated tamarind seeds (PDTS) and 15% completely decorticated tamarind seeds (CDTS) substituting 50% wheat bran in control CFM, respectively. Sorghum (COFS-29) hay was fed ad libitum as a sole source of roughage for the lambs in all the treatments. Chemical composition analyses (%) revealed that both PDTS and CDTS were comparable with wheat bran. Rumen in vitro net gas (ml/200mg/24h) production and energy density (ME, MJ /Kg DM) were similar between the control and test feedstuffs (WB 12.4, PDTS 12.8 and CDTS 12.8 MJ/Kg DM). The difference among the groups in terms of total DMI (as 'g' per day, per cent of body weight and g/kg $W^{0.75}$) through CFM and the sorghum (COFS-29) hay was not significant ($P \geq 0.05$). However there was significant ($P \leq 0.05$/ $P \leq 0.01$) difference in OM, EE and ADF intake. The ADG (g) was statistically significant between T1 and T2 as well as T1 and T3 (T1 - 54.2, T2 - 73.4 and T3 - 65.7). There was significant ($P \leq 0.05$/ $P \leq 0.01$) difference among the three groups in DM, OM and NDF digestibility, whereas the digestibility of other nutrients were comparable. The percent DOMDM (T1-65.5, T2-63.9 and T3-71) was also statistically significant ($P \leq 0.01$) among the treatment groups. It is inferred that the partially decorticated tamarind seed meal could be used as an alternative feed stuff to substitute cereal byproducts in compounded feed mixture of ruminants.

KEYWORDS: Digestibility, Feed intake, Growth, Mandya sheep, Sorghum hay, Tamarind seeds

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INTRODUCTION

The rising cost of conventional feed stuffs due to increasing livestock population and it's deficit supply has made it necessary to explore alternative feed ingredients. At present, the country faces a net deficit of 35.6% green fodder, 10.95% dry crop residues and 44% concentrate feed ingredients (ICAR-IGFRI, Vision, 2050). Acute shortage of protein & energy feeds and economic considerations have attracted the attention of animal nutritionists to tap unconventional feed resources (Vijay et al., 2016). One such unconventional feed resource is Tamarind (*Tamarindus indica L.*) seed available in most parts of India which consists of testa (seed coat; 20-30% dry mass) and kernel (endosperm; 70-75% dry mass) (Limsangouan et al., 2019). Despite of tamarind seed's high (13-14% tannin) anti-nutrient content (FAO, AFRIS, 2013), adoption of pretreatment techniques can make it safe for animal consumption (Bashir et al., 2016). Tannins at low levels may function to suppress internal parasites, decrease bloating, promote protein protection during digestion, increase growth performance and wool growth (Min et al., 2003; Waghorn, 2008; Piluzza et al., 2014). In view of limited research on utilization of decorticated Tamarind seed, the present study was conducted with the objective of assessing the effect of feeding decorticated Tamarind seed based compounded feed mixture on growth and efficiency of feed utilization in Mandya sheep.

MATERIALS AND METHODS

Selection of experimental animals

Eighteen ram lambs (Mandya breed) of about 3 to 4 months of age with body weight ranging from 6 to 10.5 kg were selected from the flock maintained at Livestock Research and Information Centre (S), Nagamangala, Mandya. The lambs were divided into three groups of six each and treatments were allocated randomly to individual group. Permission for using the animals for the trial was duly obtained from Institutional Animal Ethics Committee (IAEC) No. VCH/IAEC/2022/35 as per Article No. 13 of the CPCSEA rules laid down by Government of India.

Dietary treatments and feeding management

The experimental lambs were offered with diet comprising sorghum hay (COFS-29) and compounded feed mixture (CFM) (Table 1). The CFM containing 30% of wheat bran constituted the control diet (T1) while the experimental diets had 15% partially decorticated tamarind seeds (T2) or 15% completely decorticated tamarind seeds (T3), respectively substituting 50% of wheat bran in the CFM. The sorghum hay (COFS-29) was offered at free choice which constituted the sole roughage source. All the experimental lambs were housed in individual pens and provided similar feeding and managemental care. The diets for lambs were provided with adequate energy and protein (to gain 100g body weight per day) as per the standards of ICAR (2013). Sorghum hay (COFS-29) was offered ad libitum while the calculated quantities of CFM was offered twice a day in equal proportions at 9.00 a.m. and 4.00 p.m. The feeding trial was carried out for twelve weeks with an initial adjustment period of ten days and the digestion trial was conducted for six days at the end to assess the digestibility of nutrients.

Sampling, analysis and calculations

Representative samples of individual feedstuff, compounded feed mixture (CFM), ort and dung samples were collected for analysis. Faecal pellets voided by each lamb over 24 hours was weighed at 9.00 am during digestion trial. After proper crushing and mixing, $1/10^{th}$ of total collection was subsampled for dry matter estimation. The six days pooled sample from individual lambs was dried at 100 ± 2^0 C for overnight and ground to obtain a particle size of 1 mm. Sampling for nitrogen estimation was done separately, $1/40^{th}$ of total voided faeces was sub-sampled in a glass air tight container of known weight with 5ml of 25 per cent sulphuric acid (H_2SO_4) added every day as a preservative. Samples of individual feedstuff, compounded feed mixture (CFM), ort and dung samples were analyzed for dry matter (DM), crude protein (CP), ether extract (EE), neutral detergent fiber (NDF), acid detergent fiber (ADF) and total ash (TA) as per procedures of AOAC (2005) and Van Soest et al. (1991). The ME content of individual feedstuff, COFS-29 hay and CFM of all three treatments, was determined by rumen in vitro gas production technique (RIVGPT) according to procedure described by Menke and Steingass (1988).

Statistical analysis

The data on various parameters were subjected to appropriate statistical analysis (One Way ANOVA) according to the procedures described by Snedecor and Cochran (1994) using SPSS (version 16.0). Individual differences between means were tested using Tukey ‘t’ test and results were interpreted accordingly.

RESULTS AND DISCUSSION

Chemical composition and metabolizable energy

The proximate composition, fibre fractions and metabolizable energy of concentrate feed ingredients, compounded feed mixtures (T1, T2 and T3) and Sorghum (COFS-29) hay fed to experimental lambs during the growth trial are presented in Table 1. The composition with respect to proximate principles of completely decorticated tamarind seed was comparable with the values reported by Marangoni et al. (1988). The proximate composition with respect to all nutrients were almost comparable with the values reported by Bhattacharya et al. (1994) and Balaji et al. (2013) except for the ether extract which was higher. The proximate principles of CDTS were in agreement with the values reported by Gitanjali et al. (2020) and Girish (2022) except for the ether extract and crude protein.

The composition with respect to proximate principles of partially decorticated tamarind seed was almost similar to completely decorticated tamarind seed except for the total ash which was higher in PDTS that might be due to the presence of lower levels of TSH/ testa in the sample and ether extract which was slightly lower in PDTS. The proximate principles of Sorghum (COFS-29) hay were in corroboration with the findings of Iyanar et al. (2015) and Senthilkumar et al. (2009).

Table 1. Chemical composition[1] (% DMB) and energy density[2] of different feedstuffs and compounded feed mixture (CFM)

Attribute	Wheat bran	PDTS	CDTS	CFM			COFS-29 Hay
				T1	T2	T3	
Proximate principles							
Organic matter	94.8	95.1	96.9	94.7	95.1	96.1	90.2
Crude protein	15.5	15.6	16.8	17.6	17.6	18	8.91
Ether extract	3.64	3.87	5.44	3.26	3.52	3.95	2.22
Total ash	5.2	4.89	3.13	5.31	4.87	3.95	9.84
Fibre fractions							
Neutral detergent fibre	50.6	52.2	51.6	50.5	53.8	52.7	73.6
Acid detergent fibre	13.4	14.5	13.3	15.8	18.1	15.8	37.8
Hemicellulose	37.3	37.8	38.9	34.7	35.7	36.9	35.9
In vitro metabolisability							
RIVGP[2] (ml/200mg)	61.9	63.6	62.3	62.7	65.3	62.9	32.9
ME (MJ/Kg DM)	12.4	12.8	12.8	12.7	13.2	12.9	7.31

[1]Mean of two replicates. Variation in duplicate measurements was within ± 3% of the mean
[2]Determined by RIVIGP technique (Menke and Steingass, 1988)
PDTS: Partially decorticated tamarind seed; CDTS : Completely decorticated tamarind seed
COFS-29: Coimbatore fodder sorghum; T1- Wheat bran based CFM (control), T2- Inclusion of 15% PDTS in control CFM to substitute 50% of wheat bran, T3- Inclusion of 15% CDTS in control CFM to substitute 50% of wheat bran; RIVGP: Rumen in vitro gas production

The ME (MJ/kg DM) value (WB-12.4, PDTS-12.8 and CDTS-12.8) and net gas production (ml/ 200mg/24h), (WB-61.9, PDTS-63.6 and CDTS-62.3) obtained were almost comparable among test feedstuff. The ME content of Sorghum (COFS-29) hay was 7.31 MJ/kg DM. Further, the ME content of control, PDTS and CDTS based concentrate supplements was 12.7, 13.2 and 12.9 MJ / kg DM, respectively.

The results are in corroboration with the observations of Bhatta et al. (2001) (T1-11.1, T2-11.3 and T3- 11.1) but, the values are slightly higher in the present study because of variations in the ingredient composition of compounded feed mixture. According to Bhatta et al. (2001), there was depression in gas production in TSH containing diets. In contrast, the value for gas production was slightly higher in T2 (PDTS containing CFM) in the present study when compared to T3 (CDTS based) and T1 (wheat bran based) compounded feed mixtures which might be due to the presence of lower amount of TSH in T2 when compared to observations of Bhatta et al. (2001) who incorporated 7.5% of TSH in T3 diet in their study.

Table 2. Daily mean intake of different nutrients during feeding trial

Attribute	T1	T2	T3	SEM	P-value
Dry matter					
g per day	392	421	398	15.71	0.754
% of body weight	3.99	4.04	3.86	0.04	0.217
g/kg $w^{0.75}$	70.7	71.8	69.3	0.887	0.657
Organic matter					
g per day	363	391	373	14.59	0.752
% of body weight	3.70	3.75	3.61	0.04	0.311
g/kg $w^{0.75*}$	65.4^{a}	65.1^{a}	64.0^{b}	0.19	0.001
Crude protein					
g per day	54.3	59.3	56.6	2.181	0.672
% of body weight	0.55	0.57	0.55	0.004	0.131
g/kg $w^{0.75}$	9.73	10.1	9.77	0.105	0.364
Ether extract					
g per day	12.1	13.7	14.1	0.54	0.309
% of body weight*	0.12^{a}	0.13^{b}	0.14^{b}	0.00	0.000
g/kg $w^{0.75*}$	2.18^{a}	2.33^{ab}	2.43^{b}	0.04	0.004
NDF					
g per day	237	263	244	9.97	0.58
% of body weight	2.42	2.53	2.37	0.03	0.141
g/kg $w^{0.75}$	42.7	44.9	42.4	0.65	0.224
ADF					
g per day	99.2	112	98.8	4.38	0.379
% of body weight*	1.02^{ab}	1.09^{a}	0.96^{b}	0.02	0.022
g/kg $w^{0.75*}$	17.9^{ab}	19.2^{a}	17.2^{b}	0.35	0.042

[ab]Mean values in a row bearing different superscripts differ significantly ($P \leq 0.05$ / $P \leq 0.01$)
CFM: Compounded feed mixture; COFS-29: Coimbatore fodder sorghum; PDTS: Partially decorticated tamarind seed; CDTS: Completely decorticated tamarind seed; T1- Wheat bran based CFM (control), T2- Inclusion of 15% PDTS in control CFM to substitute 50% of wheat bran, T3- Inclusion of 15% CDTS in control CFM to substitute 50% of wheat bran

Table 3. Average daily gain (g) and feed conversion ratio of experimental lambs during the growth trial

Attribute	T1	T2	T3	SEM	P-value
Initial body weight (kg)	8.03	7.90	8.03	0.36	0.981
Final body weight (kg)	12.6	14.0	13.5	0.46	0.429
Body weight gain (kg)*	4.55^{a}	6.12^{b}	5.50^{b}	0.22	0.002
ADG*	54.2^{a}	73.4^{b}	65.7^{b}	2.61	0.002
FCR*	7.23^{a}	5.65^{b}	6.10^{ab}	0.27	0.041

abMean values in a row bearing different superscripts differ significantly (Pd" 0.05 / Pd"0.01)
CFM: Compounded feed mixture; COFS-29: Coimbatore fodder sorghum; PDTS: Partially decorticated tamarind seed; CDTS: Completely decorticated tamarind seed; T1- Wheat bran based CFM (control), T2- Inclusion of 15% PDTS in control CFM to substitute 50% of wheat bran, T3- Inclusion of 15% CDTS in control CFM to substitute 50% of wheat bran

Table 4. Intake (g / d) and apparent digestibility (%)[1] of different nutrients during the digestion trial

Attribute	T1	T2	T3	SEM	P-value
Dry matter					
Intake	481	552	482	23.03	0.385
Digestibility*	68.2^{ab}	65.8^{a}	72.6^{b}	1.01	0.008
Organic matter					
Intake	448	515	455	21.33	0.396
Digestibility*	70.3^{a}	68.4^{a}	75.2^{b}	1.02	0.008
Crude protein					
Intake	70	80.3	74.3	3.11	0.432
Digestibility	75.1	78.0	75.2	0.96	0.394
Ether extract					
Intake	13.9	16.9	16.7	0.72	0.182
Digestibility	64	57.1	67.6	3.02	0.379
NDF					
Intake	282	336	284	14.87	0.259
Digestibility*	53.5^{ab}	51.6^{a}	60.3^{b}	1.46	0.025
ADF					
Intake	113	138	107	6.77	0.129
Digestibility	20.8	22.7	22	1.94	0.935
DOMDM2*	65.5^{a}	63.9^{a}	71.0^{b}	1.03	0.003

[ab]Mean values in a row bearing different superscripts differ significantly ($P \leq 0.05$ / $P \leq 0.01$)
[1]Each value is mean of six observations; [2]Digestible organic matter in dry matter
CFM: Compounded feed mixture; COFS-29: Coimbatore fodder sorghum; PDTS: Partially decorticated tamarind seed; CDTS: Completely decorticated tamarind seed; T1- Wheat bran based CFM (control), T2- Inclusion of 15% PDTS in control CFM to substitute 50% of wheat bran, T3- Inclusion of 15% CDTS in control CFM to substitute 50% of wheat bran

Dry matter and nutrient intake

The mean intake of DM and other nutrients in different treatment groups are presented in Table 2. Dry matter intake per se or as per cent body weight or g per kg metabolic weight was not significantly different among treatment groups. Mean DMI values of experimental lambs were corroborated with findings of Vijay et al. (2016), who reported similar intake of feed DM in growing kids.

Similarly, the values of the present study with respect to DMI were found to be in agreement with Nunoi et al. (2019) who found that the use of tamarind seed meal in the concentrate portion of diet did not affect ($P \geq 0.05$) feed intake. Identical observations were also noted by Girish (2022) and Bhatta et al. (2000), who found non-significant difference in feed intake among the treatment groups of piglets and lactating dairy cattle, respectively. In contrast, the observed values were not in agreement with Madhukar (2018), who included undecorticated tamarind seeds in CFM in growing kids.

Mean intake of organic matter (OM), NDF, ADF, CP and EE over 12 weeks of growth trial are presented in Table. 2. Intakes of CP and NDF were not significant, whereas the intakes of OM, EE and ADF were found to be significant among the treatment groups. In all the three groups the NDF and ADF intake was adequate, for optimum ruminal fermentation (Van Soest et al., 1991).

Body weight gain and feed conversion ratio

The average daily body weight gain (ADG) for T1, T2 and T3 groups during the experimental period was 54.2, 73.4 and 65.7, respectively (Table 3). The ADG (g) was significantly ($P \leq 0.01$) different between the treatment groups, T1 and T2 as well as T1 and T3 but, it was non-significant between T2 and T3. The ADG was found to be highest in T2 as compared to T1 and T3 which might be due to the inclusion of tannin containing PDTS in diet which has been shown to improve body weight, wool growth, milk yield and reproductive performance (Patra and Saxena, 2011) and condensed tannins in particular, when consumed at low to moderate levels (2–4% of dry matter) in animal feed, have been found to improve ruminant protein metabolism, lessen bloating, and have an anti-helmintic impact on intestinal parasites (Muir et al*.,* 2011).

The present values of ADG were in agreement with the observations (T1- 222, T2 - 231 and T3 - 325) of Bhatta et al. (2000) in a study on effect of feeding tamarind seed husk (TSH) as a source of tannin in crossbred lactating dairy cows who observed that tannin present in TSH when incorporated at the 7.5% level in the concentrate mixture (T3) alters the rumen fermentation beneficially, resulting in improved performance. The body weight gain observations (T1–4.55, T2–6.12 and T3– 5.5 kg) in present study are found to be higher when compared to values (T1-3.99±0.53, T2-4.10±0.50 and T3-3.90±0.65 kg) reported by Vijay et al. (2016). These differences could be due to incorporation of undecorticated tamarind seed in the ration. Although, diet [CFM and COFS-29 hay] for the treatment groups (T1, T2 and T3) in the present study was formulated to achieve a target gain of 100 g per day (ICAR, 2013), individual variations were observed with respect to intake, digestibility and efficiency of utilization in growing Mandya lambs which are sensitive to any change in feeding regimen. The mean FCR for T1, T2and T3group was 7.23, 5.65 and 6.1, respectively (Table 3). The overall FCR between the treatment groups T1 and T2 was found to be statistically significant ($P \leq 0.05$) which might be due to the highest body weight gain in T2.

Apparent digestibility of DM and its nutrients

The apparent digestibility of DM, OM, CP, NDF, ADF and EE are presented in Table 4. The digestible organic matter in dry matter (DOMDM) (%) was significant ($P \leq 0.01$) among the treatment groups (T1- 65.5, T2- 63.9 and T3- 71). There was significant difference in the apparent digestibility of different nutrients viz. DM, OM and NDF among the experimental groups. The nutrients digestibility (%) values reported by Nunoi et al. (2019) in dairy steers are comparable with observed values of digestibility for DM and NDF but, other values are not comparable as they differ significantly and are higher in the present study.

The observed values are not comparable with the findings of Bhatta et al. (2000) who found non-significant difference among the treatment groups in the digestibility of all nutrients except for the CP digestibility. The present values are comparable with respect to ADF digestibility among the treatments however, the digestibility of all the nutrients are higher in the present study due to better intake and composition of both roughage and concentrate supplement. The observed digestibility values are not comparable with the reports of Vijay et al. (2016) for DM among treatments. However, the observed values of digestibility of nutrients are comparable with the values reported by Wang et al. (2017) except for EE digestibility which is lower in the present study.

In the present study, the DM, OM and NDF digestibility was highest in T3 compared to T1 and T2 because of more availability of organic matter in CDTS based diet than PDTS and WB based diets. However, the digestibility of other nutrients was similar to the control group. Hence, the digestibility of both PDTS and CDTS based diets was almost comparable.

CONCLUSION

It is inferred that, the partially decorticated tamarind seed fed lambs performed significantly better than either wheat bran or completely decorticated tamarind seed fed lambs in terms of organic matter intake, average daily gain and feed conversion efficiency. Thus, PDTS is more nutritious and cost effective substitute for conventional sources such as cereal byproducts in the compounded feed mixtures (15%, w/w) of ruminants.

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