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Effect of Inclusion of *Moringa oliefera* Leaf Meal on the Growth Performance, Nutrient Digestibility and Carcass Characteristics of Deccani Lambs

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ABSTRACT

Background: Moringa (*Moringa oleifera*) is a highly valued plant grown in tropical and subtropical countries. Moringa has a high amount of crude protein, a well-balanced amino acid profile, vitamins and minerals and fewer quantities of antinutritive factors.

Methods: Eighteen growing Deccani lambs of uniform body weight (14.22±1.5 kg) and age were randomly allotted to three treatment groups *viz*., 100 per cent groundnut cake (T1), 75% groundnut cake+ 25% *Moringa oliefera* leaf meal (T2) and 50% groundnut cake+ 50% *M. oliefera* leaf meal (T3) as a protein source in the concentrate mixture. The experiment was conducted for 90 days.

Result: No significant difference was found in the fortnightly body weights of the lambs from 1st to 6th fortnights among three dietary groups. Total weight gain and Average Daily gain (ADG) were significant (P<0.01) among the treatment groups whereas DMI (kg/day), per 100 kg and FCR was non-significant. The digestibility coefficients (%) of all nutrients were non-significant (P>0.05) except the NFE. Pre-slaughter weight, empty body weight, hot carcass weights and dressing percent on pre-slaughter weight and empty body weight were comparable among the three groups. Results of the present study indicated that inclusion of 25% *Moringa oleifera* leaf meal in concentrate mixture proved to be superior and improved the growth performance, digestibility of nutrients and carcass traits without any adverse effects on experimental lambs.

Key words: Carcass characteristics, Deccani lambs, Growth performance, *Moringa oleifera* leaf meal, Nutrient digestibility.

INTRODUCTION

The availability of feed and fodder remains a major area of concern; there is a gap between its demand and supply in the country. The utilization of fodder trees and shrubs could be a potential strategy for increasing the quality and availability of feeds for resource-limited livestock farmers during the dry season. In recent years, there has been increased research on alternative protein sources from forage trees and shrubs that can be fed to sheep. Attention has been given to the use of moringa leaf meal (MLM) as a protein source and feed component in animal production (Sarwatt *et al*., 2002; Gerbregiorgis and Negesse, 2011 and Moyo *et al*., 2012).

Moringa (*Moringa oleifera*) belongs to the Moringaceae family and is locally popular as drumstick tree or Miracle tree. Moringa is a perennial plant that can be harvested several times in one growing season, can be easily established in a field, has the good copping ability and has good potential for forage production reaching 12 m height at maturity yielding up to120 tonnes/ha/year, when planted very densely for use as forage (Makkar and Becker, 1997). Moringa as a leaf fodder has been tried as a protein source for livestock (Makker and Becker, 1997; Sarwatt *et al*., 2002) and observed to increase animal performance in many parts of the world. Moringa leaves have negligible content of tannins and no trypsin and amylase inhibitors and cyanogenic glucosides (Makkar and Becker, 1997). Almost

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every part of the moringa tree, *viz*. fruit, flower, seed, bark, root and gum is a rich repository of proteins, vitamins and minerals including potassium, calcium, phosphorous, iron, folic acid as well as b-carotene (Amee Ravani *et al*., 2017). The present study was planned to study the growth performance, nutrient digestibility and carcass characteristics by the inclusion of dried *Moringa oleifera* leaf meal at a different level by replacing the GNC in the concentrate mixture of Deccani sheep.

MATERIALS AND METHODS

The experiment on the inclusion of Moringa (*Moringa oleifera*) leaf meal on growth performance of growing Deccani sheep was conducted at Livestock Farm Complex (ILFC), College of Veterinary Science, Rajendranagar, Hyderabad during the year 2020. Eighteen growing Deccani sheep of uniform body weight (14.19±1.5 kg) and age (4 to 8 months) were randomly allotted to three treatment groups with six lambs in each group (6 × 3) in a completely randomized design. Three experimental diets were prepared *viz*., T1 (control without Moringa), T2 (75% groundnut cake+ 25% inclusion of *Moringa oliefera* leaf meal) and T3 (50% groundnut cake+ 50% inclusion of *Moringa oliefera* leaf meal) as a protein source in the concentrate mixture and offered @ 1% of body weight along with ad libitum green fodder.

All the lambs in the experiment were provided with a floor space of 1 m^2/lamb in the covered area with an asbestos roof. The experimental lambs were ear-tagged for proper recording of the data. All the lambs were dewormed with Albendazole @ 10 mg/kg body weight before the start of the experiment and once in the middle of the trail in both systems of management.

Chaffed Paragrass was offered *ad libitum* in the morning and evening for 90 days to meet the nutrient requirements of the lambs in an intensive system. Leftover feed and fodder, if any, was recorded the next day morning at 24 hourly intervals to calculate total dry matter consumption per day. Clean, wholesome and fresh drinking water was made available to each animal in water troughs throughout the experimental period.

The body weights of lambs were weighed by using an electronic digital balance at the fortnightly interval before offering feed and water in the morning throughout the experiment period. At the end of the growth trial, a seven-day digestibility trial was conducted on all lambs by keeping them in a completely randomized design (CRD) to assess the nutrient utilization of experimental diets.

The animals were kept in clean, well-aired individual metabolic cages with feeding and watering arrangement. During the collection period of seven days, daily feed consumption, leftover feed as well as faeces voided were recorded. Faeces were collected using faecal bags harnessed to the lambs. Representative samples of three experimental diets and green fodder were collected daily during the collection period before offering to animals and kept for dry matter estimation and pooled for seven days.

The faeces voided during 24 hrs were collected and weighed daily for 7 days. For dry matter determination, aliquots of 1/10th of daily faeces were taken from each animal in previously weighed Petri dishes and dried overnight in a hot air oven at 100±5°C. For further chemical analysis, faecal materials were dried, ground through a 1 mm screen in a Wiley mill and preserved in airtight bottles. The proximate analysis of feeds was performed as per the procedures described by AOAC (2005). Fiber fractions in feeds were analyzed as per the method described by Van Soest *et al*. (1991).

The representative animals were slaughtered by 'Halal' methodology after 18 hours of starving. The live weights before slaughter were recorded. Stripping, legging, dressing and evisceration were performed by adopting the standard procedures described by Gerrand (1964). The data of the present study were analyzed as per the method of Snedecor and Cochran (1994).

RESULTS AND DISCUSSION

Growth performance

Fortnightly body weights

The fortnightly body weight changes of growing Deccani lambs in an intensive farming system are presented in Table 1. A perusal of the table reveals there was no significant difference in the fortnightly body weights of the lambs from 1st to 6th fortnight among three dietary groups. However, there was a linear increase in body weights in all three treatment groups. Relatively higher body weight was observed in Moringa-based diets (T2 and T3 groups) and lowest in control (T1 group) throughout the experiment. The numerically higher values in the group supplemented with moringa leaf meal show that it could contribute towards better livestock performance in terms of body weight changes and high yield of good-quality products as it contains an appreciable level of essential nutrients. The results of the present study are in concurrence with the findings of Damor *et al*. (2017), Syed Ali (2017) and Yosuf *et al*. (2018) who reported non-significant body changes in goats. In contrast to the present findings, Tono *et al*. (2014) and Sultana *et al*. (2015) found a significant gain in body weight of goats fed on diets with different levels of inclusion of *Moringa oleifera* leaves.

Total weight gain

Significantly ($P<0.01$) highest weight gain was observed in T2 group lambs than T1 lambs. However, there was no significant difference between T1 and T3 groups and the T2 and T3 groups. This could be due to the positive effect of Moringa on intake, digestibility and nitrogen balance in T2 as compared to T3. The present results are similar to the findings of Sultana *et al*. (2015) and Damor *et al*. (2017) who reported a significant increase in total body weight gain in goats fed with different levels of Moringa olifera leaves. Dissimilar results were reported by Babeker and Bdalbagi (2015) and Syed Ali (2017).

Table 1: Effect of inclusion of *Moringa oliefera* leaf meal on body weight (kg), ADG (g) and DMI of Deccani lambs.

Experimental diet	Initial (kg) BW	Fortnightly body weight (kg)						Overall mean (kg)	Total weight gain (kg)**	ADG (g)**	DMI (kg/day)
		1	2	3	4	5	6				
T1	14.21±1.00	15.01±0.97	16.38±1.13	17.51±1.07	18.71±0.99	20.01±0.99	21.91±1.07	17.68±1.03	7.70±0.26 [b]	85.55±2.98 [b]	0.82±0.04
T2	14.18±1.95	15.47±1.92	17.06±1.95	18.63±1.91	20.16±1.94	21.73±1.98	23.31±1.98	18.65±1.25	9.13±0.24[a]	101.50±3.01[a]	0.88±0.06
T3	14.18±1.89	15.35±1.99	16.88±2.04	18.51±2.09	20.00±2.06	21.43±2.07	22.85±2.06	18.45±1.20	8.67±0.25[ab]	96.29±2.83[a]	0.86±0.08
N	6	6	6	6	6	6	6	6	6	6	6
SEM	0.908	0.920	0.945	0.950	0.956	0.953	0.967	0.647	0.203	2.269	0.012
P-value	1.00	0.98	0.96	0.88	0.81	0.76	0.85	0.82	0.001	0.001	7.13

[ab]Means with different superscript in a column different significantly: **P<0.01P- value: Probability value; N: Number of animals; SEM: Standard error mean; T1: 0% MLM; T2: 25% MLM; T2: 50% MLM.

Average daily gain

The T2 group lambs fed with 25% MLM-based concentrate mixture had significantly (P<0.01) higher ADG than T1 group lambs. However, there was no significant difference between T2 and T3 groups. Higher digestibility of nutrients with efficient utilization of absorbed nitrogen might be the reason for increased ADG in supplemented lambs. The present findings are in concurrence with findings of Sultana *et al*. (2015) and Bebekar and Bdalbagi (2015), Damor *et al*. (2017), in goats when fed with Moringa oleifera leaves. Syed Ali (2017), Bhavana *et al*. (2018) reported a non-significant difference in average daily body weight gain among the treatment groups.

Dry matter intake

The average daily dry matter intake (kg/day) in Deccani growing lambs fed with experimental diets were numerically higher in the T2 diet (Table 2). The values recorded for average DMI per 100 kg body weight were not significantly different among three different diets. The daily average dry matter intake (DMI) per 100 kg body weight was comparatively higher in Deccani lambs fed with T2 and T3 diets.

The non-significant increase in the DMI among the experimental groups could be due to the lower fiber content of the Moringa leaves thereby enhancing the palatability and digestibility. The observations made in the present study are concurrent with Damor *et al*. (2017) and Bhavana *et al*. (2018) who reported non-significant differences in DM intake in animals supplemented with Moringa oleifera leaves. In contrast to the present findings, Sarwatt, *et al*. (2002), Sultana *et al*. (2015) and Babeker and Bdalbagi (2015) reported a significant increase in dry matter intake on Moringa leaves supplementation.

Feed conversion ratio

The FCR in the T1 diet is higher than T2 and T3 diets and there was no significant difference in FCR among the lambs fed on three experimental diets. However, the lowest FCR found in the *Moringa included* groups. The present study results are in agreement with the findings of Bhalerao (2018) who reported the lower feed conversion ratio in goats fed with different levels of Moringa leaves.

Nutrient digestibility

The average dry matter digestibility coefficient is presented in Table 2. The dry matter digestibility coefficient (%) was non-significantly higher in T2 and T3 than in T1 group lambs. Higher digestibility of Moringa supplemented diets could be due to low structural carbohydrates and good quality protein. The results obtained in the present study are corroborated with the finding of Manh *et al*. (2005) and Sultana *et al*. (2015) who observed in the concentrate mixture the DM digestibility did not significant with increased Moringa levels.

The organic matter digestibility coefficients (%) were non-significantly (P>0.05) higher in the T2 and T3 treatment groups when compared with the control (T1) group. The

obtained value is in agreement with the finding of Asaolu *et al*. (2011), Tona *et al*. (2014) and Sultana *et al*. (2015) reported the non-significant effect of Moringa leaves inclusions in dietary treatments.

Among the *Moringa* leaf meal supplemented lambs, T2 lambs showed a relatively higher CP digestibility coefficient than T3. Higher crude protein digestibility coefficient (%) in Moringa supplemented groups could be due to the presence of high-quality protein in the leaves. Similar results were reported by and Oyedem *et al*. (2016) and Syed Ali (2017) and Soby *et al*. (2015). The present results are in disagreement with the observations of Tona *et al*. (2014), Fadiyimu *et al*. (2016).

Relatively higher CF digestibility was observed in the Moringa leaf meal supplemented group (T2 and T3) compared to the control group (T1) lambs (Table 2). However, the differences were not significant. The higher CF digestibility in T2 and T3 equally suggests an increase in the activities of fibrolytic bacteria in the rumen probably as a result of the availability of essential nutrients especially protein, energy and minerals in balanced proportions. The obtained values are in line with the finding of Soby *et al*. (2015); Sultana *et al*. (2015); Oyedele *et al*. (2016) and Syed Ali (2107). While Fadiyimu *et al*. (2010); Tona *et al*. (2014) and Kholif *et al*. (2016) reported dissimilar results. No significant difference was found in the average ether extract digestibility coefficients among the three experimental diets. A similar finding was reported by Sultana *et al*. (2015) and Syed Ali (2017). The average Nitrogen free extract digestibility was significantly (P<0.05) higher in the T2 and T3 treatment groups when compared to the control (T1) group. T2 group had significant difference with T3 and T1 groups.

The higher NFE digestibility in T2 and T3 could be due to the supply of essential nutrients especially protein, energy and minerals in balanced proportions through Moringa leaf meal. Similar findings are reported by Akinyemi *et al*. (2010) and Syed Ali (2017) when sheep and goats respectively fed with Moringa oleifera as supplements to Panicum maximum and Cottonseed cake, respectively. Soby *et al*. (2015) reported dissimilar results when different levels of Moringa leaves fed to fattening lambs.

The observed neutral detergent fibre digestibility was non-significantly (P>0.05) higher in T2 and T3 groups than in T1 group lambs. The higher NDF digestibility in T2 and T3 equally suggests an increase in the activities of fibrolytic bacteria in the rumen probably as a result of the supply of essential nutrients through *Moringa* leaf meal. Similar findings were reported by Akinyemi *et al*. (2010) who reported higher value for NDF digestibility when animals fed with *Moringa oleifera* leaves.

Acid detergent fibre digestibility was non-significantly higher in T2 and T3 groups compared to T1 group lambs. It could be due to the higher rumen microbial activity and availability of digestible cellulose from ADF of Moringa foliage to the lambs. The values obtained for ADF digestibility are similar to those recorded by Manh *et al*. (2005) and Akinyemi *et al*. (2010) reported higher values for ADF digestibility when increasing the inclusion level of *oleifera*. In contrast to the present findings, Mahmoud (2013) reported a significant (P<0.05) difference between the Moringa supplement groups in growing lambs.

Table 2: Effect of inclusion of *Moringa oliefera* leaf meal on nutrient digestibility of Deccani lambs.

Treatment	Dry matter	Organic matter	Crude protein	Crude fibre	Ether extract	Nitrogen free extract*	Neutral detergent fibre	Acid detergent fibre
T1	64.81±0.93	67.21±1.40	69.64± 2.35	62.90±0.61	78.89±3.33	70.10±1.36^{b}	69.78±0.52	62.62±1.60
T2	66.21±0.69	68.60±0.89	71.40±2.37	63.14±0.71	80.70±2.97	75.23±1.24^{a}	71.82±0.88	66.38±1.51
T3	65.14±0.45	67.86±0.80	70.93±2.15	62.95±0.81	79.72±3.25	72.88±1.12^{ab}	70.84±0.42	65.32±1.85
N	6	6	6	6	6	6	6	6
SEM	0.406	0.593	1.256	0.536	1.747	0.844	0.401	0.977
P	0.38	0.66	0.86	0.66	0.92	0.03	0.11	0.29

^{ab}Means with different superscript in a column different significantly: *P<0.05 P- value: Probability value.

Table 3: Effect of feeding Moringa based diets on carcass characteristics of Deccani lambs under intensive system.

Treatments	Pre-slaughter live weight (kg)	Empty live weight (kg)	Hot carcass weight (kg)	Dressing % (PSW)	Dressing % (ELW)	Edible offal (kg)	Non-edible offal (kg)
T1	21.33±7.41	17.33 ±0.49	10.30±0.52	48.75±0.69	59.34±1.38	0.57±0.02	5.90±0.63
T2	22.30±3.41	17.46±1.96	10.70±1.95	47.55±2.06	63.60±4.48	0.64±0.14	5.51±0.17
T3	26.16±7.41	22.50±1.77	14.50±1.69	48.10±2.21	61.80±3.23	0.70±0.12	8.18±0.51
N	3	3	3	3	3	3	3
SEM	1.566	0.936	0.883	1.764	0.997	0.059	0.298
P	0.47	0.32	0.47	0.66	0.53	0.73	0.28

Carcass characteristics

T3 group had statistically non-significant (P>0.05) higher pre-slaughter, empty live and hot carcass weights than T2 and T1 groups (Table 3). There was a non-significant difference (P>0.05) in dressing percentage on pre-slaughter and empty live weights basis in all three treatment groups. However, the T2 group had a numerically higher dressing percentage (63.3±4.48) on empty live weight compared to the T1 (59.34±1.38) and T3 (61.8±3.23) group. Lower gut fill due to higher digestibility and higher empty live and hot carcass weights due to better feed efficiency with *Moringa*-based rations in T2 and T3 resulted in better productivity.

A non-significant difference was observed among the treatment groups for the weight of liver, kidney, heart and testis. The weight of the head, leg, skin, blood, lung, stomach was also non-significant among the treatment groups. However, relatively higher edible and non-edible offal weights were observed with Moringa-based rations supplemented lambs (T2 and T3). This might be due to efficient digestion and absorption of nutrients leading to better growth and development of the gut (Meel *et al*., 2021).

A similar result was reported for hot carcass weight and edible organ weights by Moyo *et al*. (2013) when crossbred Xhosa lop-eared goats were fed with Moringa oleifera leaves. In the case of dressing percentage, a lower dressing percentage was reported by Moyo *et al*. (2013). A similar result was reported by Kochewad *et al*. (2018) in Decani lambs when reared in intensive farming systems.

CONCLUSION

Moringa oleifera is a very good source of protein, antioxidants, minerals and vitamins. It could be used as an alternative feed resource in the diet of Deccani lambs. From the present investigation, it is evident that *Moringa oleifera* could be included in the diet of Deccani lambs at 50% level for better performance without any adverse effects.

Conflict of interest

The authors declares that they have no conflict of interest.

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