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Article

Effect of tree forage supplementation on growth performance of goats

Md. Zillur Rahman[1], Md. Ali Akbar[2], Md. Abul Hossain[3] and Md.Yousuf Ali[1]*

[1]Bangladesh Livestock Research Institute, Savar, Dhaka-1341, Bangladesh
[2]Department of Animal Nutrition, Bangladesh Agricultural University, Mymensingh, Bangladesh
[3]Department of Agrofoestry, Bangladesh Agricultural University, Mymensingh, Bangladesh

*Corresponding author: Md.Yousuf Ali, Bangladesh Livestock Research Institute, Savar, Dhaka-1341, Bangladesh. E-mail: 113yousuf.bau@gmail.com

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Abstract: An experiment with 25 growing goats (in 5 groups) were fed four different tree forage based diets (B,C,D,E) and control A showed that there were significant ($p<0.05$) differences in DM , ME and DCP intakes. Although there were no significant differences in the digestibility of DM, OM, CP and ADF but intake of these nutrients were significantly ($p<0.05$) differed among the treatments. There were no significant differences in the digestibility of diets having different forages but they were significantly higher than that of grass based control diet. Feeding of tree forages had significant ($p<0.05$) effect on live weight gain of goats. Animals fed tree forage based diets significantly ($p<0.05$) increased weight gain (60.03, 59.10, 57.75 and 55.57 g/d for *Sesbania grandiflora, Leucaena leucocephala, Erythrina orientalis and Morus alba*, respectively) compared to that of control group (39.25 g/d) . However, there were no significant differences in weight gain of the animals fed different tree forage based diets. Feed conversion efficiency (kg feed/kg gain) also showed that animals fed tree forage based diets presented significantly ($p<0.01$) higher efficiency (11.74, 12.05, 12.21 and 12.02) for *L. leucocephala, E. orientalis, S. grandiflora and M. alba* compared to that (16.00) of fed control diet. Nitrogen balance trial showed that there were significant ($p<0.05$) differences among the mean values in terms of total N intake (g/d), nitrogen retention (%) and nitrogen balance (g/d). It may be concluded that supplementation of diets with tree forages resulted in better weight gain, digestibility and nitrogen balance compared to green grass. So, the diets of goats may be supplemented with tree forages of *S. grandiflora, L. leucocephala, E. orientalis and M. alba* for improved growth performance.

Keywords: digestibility; nitrogen balance; weight gain; feed conversion efficiency

1. Introduction

Among domestic ruminants, goats are classified as intermediate selective feeders with preference for browse and sheep are classified as non selective intermediate feeders with preference for grasses, buffalos and cattle as grazers (Schwartz and Schafft, 1988). The traditional management system for goat production by smallholders has consisted of day-time grazing on natural pasture and housing usually in a pen with raised floors at night-time (San, 2002). It is quite common for the farmers to offer tree foliages during periods of feed shortage, such as during the dry season and in times of flooding. Better animal performance is observed with increasing levels of tree fodder in animal ration. Many trials on the use of shrubs and leaves of trees to supplement either natural grasses or crop residues gained positive responses in the performance of goats. Statistical analyses of the data showed that each 100g of browse DM consumed per day raises the productivity index by 1.41 kg lamb weaned/dam/year (Atta-Krah and Reynolds, 1989). Nitis (1989) reported a case where sheep and goats fed on *Pennisetum purpureum* supplemented with 0.3 to 1.8 kg Gliricidia sepium per day gained 17– 27% more weight than the unsupplemented animals.

There are a lot of tree forages in different regions of Bangladesh. Such a huge variation in the nutrient contents in particular of CP content indicates that feeding of the forages will have great effect in the performance of livestock. Studies on the contribution of fodder trees and shrubs to the productivity of animals are still limited. Therefore, an experiment was conducted to know the effect of selected tree forages on the intake, digestibility and growth performance of black Bengal goats.

2. Materials and Methods

2.1. Time and place of study

The study was carried out in the Shahjalal Animal Nutrition field laboratory of Bangladesh Agricultural University, Mymensingh. The study continued for a period of 120 days from October 2008 to January 2009.

2.2. Selection and grouping of animals

A total of 25 growing goats were used in this study. Age of animals varied from 6 to 8 months. The average initial live weight of animals was 10 ± 1.4 kg. Animals were randomly distributed into five groups each having five animals. Five dietary treatments were used.

2.3. Formulation of diets

Five diets were prepared and considered as five dietary treatments (A, B, C, D and E) with roughage and concentrates. In the roughage part Dal grass (*Hymenachne psedointerrupta)* was common to all the treatments, however, four types of tree forages *Erythrina Orientalis (*B), *Leucaena leucocephala* (C), *Morus alba (D)* and *Sesbania grandiflora (E)* were supplied in four treatments excepting one consisted no tree forages which was considered as control (A). The proportion of Dal grass and tree forages in the ration was 67:33. The concentrate part of the ration consisted of wheat bran, rice polish, crushed maize, soyabean meal, fish meal, vitamin-mineral premix, DCP and salt. The concentrate mixture contained of 20% CP and 10.2 MJ/kg DM of ME. Fresh roughage was supplied (33%) and the concentrate was fed at 2% of the live weight.

2.4. Nutrient requirements estimation

The daily nutrient requirements such as DM, CP and ME of the animals were estimated based on the ARC (1980).

2.5. Feeding of animals

The animals were stall fed on grass-based diet. Five diets formulated (A,B,C,D and E) as described above were supplied randomly to animal groups. The animal group received the dietary treatment A containing only grass and was considered as control group. Tree forage, grasses and concentrate were supplied to the animals based on live weight. The daily required amount of feed was portioned into two for feeding to the animals in the morning at 7:00 h and afternoon at 16:00 h. Concentrate was supplied first followed by roughages with extra 20% of requirements and *ad libitum* access to fresh water. The management practices of all the animals irrespective of groups were similar. The feed supplied to the goats was adjusted every week on the basis of their body weight changes.

2.6. Feeding tree forages and grasses

Tree forages *E.orientalis, L.leucocephal, M.alba and S.grandiflora* were supplied as supplemental feed to animal groups. Usually leaves and edible soft stem parts of the foliage were collected in the afternoon for feeding the animals on the following morning. After harvesting it was chopped with scissors and chops length was 2-3 inch then fed to animals. Dal grass *(H. psedointerrupta*) was harvested at the growing stage in the morning and chopped for feeding the goats on the same day.

2.7. Management of goats

Faeces of goat were examined for parasitic infestation and the animals were dewormed with anthelmentic drug prior to starting of the experiment. The animals were neck tagged and then allowed 10 days to adapt the experimental feed and environment prior to commencement of the study. They were housed in a well ventilated shed with sufficient sunlight. Separate feeders were used for tree forages, green grass and concentrate for each goat. Feed and water troughs were cleaned every morning before supply the feeds. A good sanitary condition was maintained throughout the experimental period.

2.8. Measurement of feed intake and sample collection

The roughage (tree forages and green grass) intake of each goat was determined by subtracting the amount of left over if any from the amount of feed given on the previous day. Refusal was collected every morning before feed supply and weighed to determine daily feed intake. During the experimental period, all animals consumed all of the concentrate. Representative feed samples of tree forages, green grass and concentrate were collected and kept for chemical analysis.

2.9. Collection of feces and urine

For metabolism trial output of feces and urine, was recorded daily during the last 7 days of the feeding trial period of 120 days. Feces were collected at every 08:00 am and after 24 h, weighed and sub-sample were taken every day from animals. Samples of feces were put in plastic bags in the freezer (-20 °C). Urine sample was collected in a bucket containing 6N H_2SO_4 solution to maintain a pH of 4 or lower and taken 10% sub-sample to determine N.

2.10. Chemical analysis of samples

All the samples of feeds and feces were prepared and sub-samples were used for analysis. The samples were subjected to chemical analysis for the determination of DM, OM and CP following the methods of AOAC (1995). The ADF was determined according to Goering and Van Soest (1970). All the samples were analyzed in duplicate and the mean values were recorded.

2.11. Statistical analysis

The statistical analysis was done using 'SPSS-11.5' statistical program to compute analysis of variance (ANOVA) in completely randomized design (Steel and Torrie, 1980). Differences among the treatment means were determined by Duncan′s Multiple Range Test (DMRT, Duncan, 1955).

3. Results

3.1. Nutrient composition

Nutrient composition of the diet components used in the trial is shown in Table 1. All the tree forages used in the experiment were having high contents of CP, ranging from 20.10% to 24.76%. In contrast Dal grass contained lower level of protein (10.41%). The DM content of the forages was also higher than that of Dal grass. The CP content of concentrate mixture was 20.47%.

3.2. Feed intake and growth of goats

Daily intake of feed and nutrients during the experimental period are presented in Table 2. Table showed that there were significant ($p<0.05$) differences among the treatment groups in terms of total DM intake. The highest DM intake was with the diet containing *S. grandiflora* (E) and the lowest with those containing non-leaf groups (A). Total DM intake per kg metabolic live weight showed the similar results. In terms of DM intake of tree forage by the animals, it was observed that there were no significant differences among the values of different dietary treatment groups of animals. However, green grass intake was significantly ($p<0.05$) higher in animals containing non-leaf diet compared to containing tree forages. DM intake of concentrate by animals of different treatments was also not significant. In case of estimated ME and DCP intake were significant ($p<0.05$) differences between tree forage and non tree forage groups.

Changes in live weight of the animals during 120 d feeding trial are also shown in Table 2. Data in the table showed that there were significant ($p<0.05$) differences among the dietary treatments in terms of live weight gain. There were no significant differences among the groups receiving different tree forages. However, the animals of control group receiving the diet A having only Dal grass gained (39.25 g/d) significantly ($p<0.05$) lower live weight than all other groups (B, C, D and E) receiving tree forages. Among the tree forages live weight gain (g/d) of animals receiving *S. grandiflora* (60.03) was the highest followed by *L. leucocephala* (59.10), *E. orientalis* (57.75) and *M. alba* (55.57). Feed conversion efficiency was significantly ($p<0.01$) higher in tree forage groups than non tree forage group (A).

3.3. Digestibility

Apparent digestibility values in the table (Table 3) showed that these were no significant variation among the dietary groups in case of DM, OM, CP and ADF, Although CP digestibility of control group was slightly lower than those of other groups. There were significant ($P<0.05$) differences among the dietary groups of animals in case of digestible DM (g/d), digestible CP (g/d), digestible OM (g/d) and digestible ADF (g/d).

3.4. Nitrogen (N) balance

Table 4 shows nitrogen balance of the animals fed different diets containing tree forages and grass. There were significant ($p<0.05$) differences among the mean values in terms of total N intake, nitrogen retention and nitrogen balance. However, no significant differences were observed in case of total nitrogen out go. In all the parameters that had significant differences among the mean values, the animals fed control (A) diet showed significantly lower values than those of animals fed tree roughages (B,C , D and E treated diets).

Table 1. Nutrient composition (%) of feed.

Feed (ingredients)	DM basis (%)					
	DM	**OM**	**CP**	**ADF**	**Ash**	NDF
E. orientalis	24.27	88.81	20.1	34.6	11.19	48.19
L. leucocephala	26.40	89.93	23.45	29.4	10.07	45.34
M.alba	21.83	84.20	22.75	19.4	15.80	29.43
S. grandiflora	21.60	88.32	24.76	27.10	11.68	38.24
H. psedointerrupta	16.78	88.25	10.41	27.00	11.75	39.20
Concentrate	87.24	88.25	20..47	11.30	11.75	29.75

Table 2. Feed intake and live weight gain of growing goats fed different diets.

Items	Dietary treatments					SED	Level of significance
	A	**B**	**C**	**D**	**E**		
Tree forages DM intake (g/d)	-	168.00	165.00	155.00	175.00	1.60	NS
Grass DM intake (g/d)	361.00^{b}	238.00^{a}	236.00^{a}	234.00^{a}	248.00^{a}	6.35	*
Concentrate DM intake (g/d)	287.00	289.00	292.00	288.00	300.00	13.27	NS
Total DM intake (g/d)	648.00^{c}	696.00^{a}	694.00^{a}	678.00^{a}	723.00^{b}	16.35	*
DM intake (g/kgw$^{0.75}$/d)	94.00^{c}	99.00^{ab}	96.00^{ac}	97.00^{ab}	101.00^{b}	3.34	*
Estimated ME intake (MJ/d)	6.68^{b}	7.74^{a}	7.39^{a}	7.51^{a}	7.88^{a}	0.50	*
Estimated DCP intake (g/d)	67.90^{b}	92.96^{a}	92.31^{a}	93.41^{a}	99.66^{a}	3.97	*
Initial live weight (kg)	9.96	9.96	9.97	9.97	9.97	0.55	NS
Final live weight (kg)	14.83^{b}	16.42^{a}	16.60^{a}	16.20^{a}	16.70^{a}	0.76	*
Live weight gain (g/d)	40.58^{b}	53.83^{a}	55.25^{a}	51.91^{a}	56.08^{a}	2.81	*
FCR	16.50^{b}	12.05^{a}	11.74^{a}	12.20^{a}	12.043^{a}	0.49	**

"A" No tree forage, "B" *Erythrina orientalis,* "C" *Leucaena leucocephala,* "D" *Morus alba*, and "E" *Sesbania grandiflora* "Feed conversion rate(FCR): total feed intake/body weight gain.", ^{abc} Mean value in a row with different superscripts differ significantly

NS: Not significant, *P<0.05 and **P<0.01

Table 3. Nutrient digestibility (%) of different diet.

Items	Dietary treatments					SED	Level of significance
	A	**B**	**C**	**D**	**E**		
Co-efficient of digestibility (%)							
DM	72.64	75.55	72.48	76.70	74.90	1.40	NS
OM	75.29	78.80	74.17	79.50	77.20	1.72	NS
CP	72.69	78.16	74.33	77.91	74.98	1.52	NS
ADF	76.89	77.80	78.90	78.77	79.00	1.68	NS
Digestible nutrient (g/d)							
DM	458.44^{b}	522.00^{a}	499.68^{a}	515.28^{a}	545.25^{a}	32.00	*
OM	428.08^{b}	493.39^{a}	468.05^{a}	480.95^{a}	507.77^{a}	37.68	*
CP	67.90^{b}	92.96^{a}	92.31^{a}	93.71^{a}	99.66^{a}	9.53	*
ADF	97.52^{b}	122.49^{a}	117.47^{a}	98.84^{b}	118.75^{a}	13.68	*

"A" No tree forage, "B" *Erythrina orientalis,* "C" *Leucaena leucocephala,* "D" *Morus alba*, and "E" *Sesbania grandiflora*

^{ab} Mean values in a row with different superscripts differ significantly;*P>0.05 NS: Not significant; *P<0.05

Table 4. Nitrogen (N) balance of animals fed different diets.

Items	Dietary treatments					SED	Level of significance
	A	B	C	D	E		
Nitrogen intake (g/d)	15.14[b]	19.09[a]	19.95[a]	19.23[a]	21.16[a]	1.49	*
Nitrogen out go (g/d)	9.50	9.61	10.36	10.79	10.67	1.31	NS
N retention (%)	37.25[b]	49.66[a]	48.07[a]	43.89[a]	49.57[a]	3.10	**
N balance (g/d)	5.53[c]	9.47[ab]	9.59[ab]	8.44[a]	10.49[b]	1.08	**

"A" No tree forage, "B" *Erythrina orientalis,* "C" *Leucaena leucocephala,* "D" *Morus alba*, and "E" *Sesbania grandiflora*
[abc]Mean values in a row with different superscripts differ significantly *P>0.05 and **P>0.01 and NS: Not significant, *P<0.05 and **P<0.01

4. Discussion

There were variations in the DM contents of the tree forages and grasses. Usually tree forages contain higher DM than most of the grasses at normal stage of cutting. In the present study, the DM of Dal grass was lower than that of tree forages. On the other hand, there were also variations in DM contents among the tree forages. *L. leucocephala* and *E. orientalis* contained higher DM than that of *M. alba* and *S. grandiflora.* In case of CP content, where *S. grandiflora* and *L. leucocephala* had higher values than others, which also contained CP above 20%. The use of forage from trees and shrubs in animal nutrition has focused the attention of many researchers, due to the fact that these feed resources are locally available, perennial sources of feeds (Singh, 1995 and Leng, 1997), rich in protein and particularly appropriate for small ruminants (Van Eys *et al.*, 1986; Robertson, 1988; Chen *et al.*, 1992; Norton, 1994 and Kaitho, 1997). In the present experiment, it was observed that the tree forages contained more than twice the CP content of Dal grass. Similar findings were also observed by Wilson (1969) and Nitis (1989) who reported that tree forages contained more than two times CP of grasses. Although it is fact that naturally not all the tree forages contain twice the CP content of all types of grasses because it depends on the type of leaves and grasses and their chemical composition.

Tree forage had a significant positive effect on DMI of goats. The data on feed intake showed that goats consumed more DM when offered tree forages with grasses than when only grasses offered separately. Intake of all the tree forages was similar which indicated that all of them were palatable to goats. However, green grass intake of control group, as has been expected, was significantly ($p \leq 0.05$) higher than that of other groups indicating that goat preferred tree forages over green grass. Similar findings were reported by Benavides (1991). Effect of feeding tree forages supplemented diets on growth response of goats has also been recorded in this experiment. In general, the goats responded well to all the feeds. Tree forage supplemented diets resulted in much better growth response ($p<0.05$) than that of control group receiving only grass as roughage. *S. grandeiflora* and *L. leucocephala* proved their high palatability and higher effect on growth of animals. The highest growth rate was observed in animals fed on *S. grandiflora* followed by *L. leucocephala, E. orientalis, M. alba* and non tree forage group. Nhan (1998) reported that the best live weight gain was with the supplement of *S. grandiflora* followed by *L. leucocephala*. Significantly higher growth rate of goats fed with tree forage supplemented diets than that (growth rate) of control diet might be due to more palatable and nutritious quality of tree forages than green grass. This has been evident from the high nutrient composition and intake values reported earlier. High values for growth rate of goats fed on *S. grandiflora* were reported by Thuy (1996). Many trials on the use of shrubs and leaves of trees to supplement either natural grasses or crop residues gained positive responses in livestock performance. Larbi and Hanson (1993) found that *Erythrina* species had high forage potential and could effectively serve as cheap source of protein supplement for low quality diets during dry season for resource poor farmers with stall fed sheep and goat. Goats fed with this supplement gained more of those receiving only the grass.

The non-significant variation among the digestibility values of different dietary treatments (Table 3) in the present experiment indicated that supplementation of tree forages did not significantly alter the digestibility of the whole diets supplied to the animals, although control diet had slightly lower values for DM and OM digestibility's. In fact DMD, which is related to nutrient composition, varied widely among tree and shrub species. Skarpe and Borgstrom (1986), working in Botswana with Kalahari woody species reported a range in digestibility from 38 to 78%. Similar results were also evident in case of CP digestibility which has been expected to be higher in the supplemented dietary groups compared to that of the control group. The reason for not significant effect of more nutritious (high protein) tree forages on the digestibility of diets is unknown. The digestibility of CP does not always match the high CP content which characterizes fodder trees and shrubs.

Wilson (1977) found an apparent digestibility as low as 14% for *Heterodendrum oleifolium* containing 12.5% of CP while *Atriplex vesicaria*, also with 12.5% CP, had a nitrogen digestibility of 71.4%. Also there was not always a correlation between intake and digestibility; highly digestible stuff may be poorly consumed and vice versa (Wilson, 1977). The high value for DM digestibility of the *M. alba* foliage (79.2%) is similar to the findings of Jegou *et al.* (1994) cited by Sánchez, (2000). Digestibility and intake values for *L. leucocephala* range from 50 to 71% and from 58 to 85 g/kgw$^{0.75}$/d live weight, respectively (Jones, 1979). This value is closer to the present findings. Panday and Tiwari (2003) reported that tree forages including *L. leucocephala* which have over 60% digestibility. No significant treatment effect ($P<0.05$) was observed on DM, OM or CP digestibilities among different groups. Nitrogen retention for goats fed non tree forage group was lower ($P<0.05$) than the values of tree forage supplemented groups.

The results of nitrogen balance study on the animals clearly showed that the tree forage supplementation had significantly positive effect on the nitrogen retention in the body of the animals. Although all the diets used in the experiment including grass containing non tree forage diet, showed positive nitrogen balance due to feeding, the tree forage supplemented diets gave significantly higher values compared to that of control diet containing only grass. These results indicated that the higher nitrogen content of the tree forages contributed positively in the retention of nitrogen in the animal body. This has been reflected in the significantly higher growth rate of animals of tree forage supplemented groups than control group as mentioned earlier. Evans (2001) stated that supplementation of diet with *S. grandiflora* of goats fed Ginea grass hay increased intake by 25% and supported a positive N balance.

5. Conclusions

Supplementation with tree forages in the feeding system of goat resulted in better weight gain, digestibility and nitrogen balance compared to green grass. So, the diets of goats may be supplemented with tree forages (33%) of *S. grandiflora, L. leucocephala, E. orientalis and M. alba* for the improvement of growth performance.

Conflict of interest

None to declare.

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