Research Article

The Feeding Value of Moringa (*Moringa Oleifera*) Foliage as Replacement to Conventional Concentrate Diet in Bengal Goats

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Abstract | A mixed concentrate diet was replaced by graded levels of dried moringa foliage in growing Black Bengal goats and dry matter intake, digestibility and nutrient utilization and the growth performances were determined. Thirty growing male goats were divided into five groups with six animals in each group. The five dietary treatments consisted of varying proportions of moringa foliage (MF) and concentrate (C), namely, T_1 (100MF: 0C), T_2 (75MF:25C), T_3 (50MF:50C), T_4 (25MF: 75C) and T_5 (0MF:100C). The experiment was arranged in completely randomized design. All the five diets contain similar level of crude protein (average CP 18.3±0.09%) and metabolizable energy (average ME 10.96±0.19).The intake of dry matter and CP of goats on diet T_1 (100% moringa) differed significantly ($p<0.01$) from that of T5 (100% concentrate) diet. ADF intake was increased with the increasing level of moringa foliage, similarly the digestibility of ADF was increased significantly ($p<0.01$) with increasing level of moringa foliage. The digestibility of other nutrients did not vary significantly ($p>0.05$) among the diets. Nitrogen retention was significantly higher ($P<0.01$) in goats fed withT_1, T_2orT_3 diet than those fed with T_4orT_5 diet. Highest average daily live weight gain was found in goats fed with T_2 diet while the lowest ($P<0.05$) was found in goats fed with T_5 diet. It was concluded that moringa foliage may be a replacer of conventionally mixed concentrate for feeding Bengal male goats.

Keywords | Bengal goats, Body weight, Concentrate, Moringa foliage and Nutrients intake

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INTRODUCTION

In many developing countries, ruminant production is largely limited by unavailability and high cost of feeds. Low quality feeds are considered to be the major constraints hampering productivity of farm animals. The availability of feed is particularly in the dry season when natural pastures are mature, highly fibrous and inadequate (Oni et al., 2010), with low nutritive value due to low crude protein content (Moyo et al., 2012). Generally, farmers fed their animals with crop residues and low-quality hay that are low in nitrogen, high in lignocellulose and poor in vitamin and mineral contents, which leads to low digestibility and reduced voluntary intake (Gerbregiorgis et al., 2012). Consequently, these feeds cannot supply the required level of protein and energy leading to poor growth, delayed animal sexual maturity; poor reproductive performance, poor meat quality and low milk yield (Gerbregiorgis et al., 2012).

Intake and digestibility of poor quality roughages could be enhanced by supplementing concentrate diets (Nurfeta, 2010). However, smallholder livestock production systems are limited to use of such supplements due to unavailability and high cost of cereal grain or their byproduct ingredients. In order to alleviate the problems associated with the lack of protein supplement, there is a necessity to look for alternative protein sources that farmers can generate at their farm without incurring additional costs.

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. The trees provide a good and cheaper source of protein and micronutrients (Moyo et al., 2012). In recent years, there has been increased research on alternative protein sources from forage trees and shrubs that can be fed to goats, such as *Pterrocarpus lucens*, *Acacia Senegal* (Sanon et al., 2008), *Acacia etbaica, Dichrostachys cinerea* (Yayneshet et al., 2008), *Acacia karroo* (Marume, 2010) and *Manihot esculenta* (Oni et al., 2010).

In recent years, attention has been given to the use of moringa leaf meal (MLM) as a protein source and feed components in animal production especially in goats (Sarwatt et al., 2002; Asaolu et al., 2010, 2011 and 2012; and Moyo et al., 2012) and also in other ruminant (Murro et al., 2003; Sarwatt et al., 2004; Sánchez et al., 2006a; Mendieta-Araica et al., 2011 and Gerbregiorgis et al., 2012). There are many advantages of using moringa foliage as protein source including the fact that it is a perennial plant that can be harvested several times in one growing season. The leaves can be fed fresh or dried with little effect on intake. Dried moringa leaf can be stored for longer periods without deterioration in nutritive value (Mendieta-Araica et al., 2011).

Moringa, is a non-leguminous multipurpose tree. Its leaves contain between 257.00 to 261.00 g kg^{-1} DM crude protein (Sultana et al., 2014) and negligible amounts of anti-nutritive compound (Nouala et al., 2006; Ogbe and Affiku, 2011; Aye and Adegun, 2013; Mendieta-Araica et al., 2011). Moringa foliage dried meal, on the other hand, contains 214.80 to 216.20 g CP kg^{-1}DM, 268.30 to 310.29 g ADF kg^{-1} DM and 347.1 to 381.8 g NDF kg^{-1} DM (Sultana et al., 2014). Conventionally mixed concentrates used for feeding ruminants in Bangladesh consist of crop by products, such as brans and protein meals at variable ranges depending on market prices, usually contain CP 160.00 to 200.00 g kg^{-1} DM; cereal by-products being a major part and also act as rich sources of available cell wall materials (Huque and Sultana, 2007). Recent price hike of cereal by-products also restricts its use by farmers. Moringa foliage being rich available sources of protein and cell wall materials may be one of the alternatives to conventionally mixed concentrates used for feeding goats.

Moringa foliage has been evaluated to a limited degree in terms of as a supplementary feed to enhance production performances of goat. Therefore, the present study was undertaken with the objectives of determining the feeding value of dry moringa foliage as an alternative to conventionally mixed concentrate for feeding of Bengal goats.

MATERIALS AND METHODS

Location

This study was conducted at the Goat Farm of Bangladesh Livestock Research Institute (BLRI), Savar, Dhaka, Bangladesh.

Experimental Animals and Feeding Management

A total of thirty growingBlack Bengal (BB) male goats selected from the herd at the Goat Farm of BLRI were used in this study. They were 6-8 months of age and had an average body weight of 10.12 ± 0.53 kg (mean ± standard error). All goats were treated with antihelminthes (Endex, Novartis, India limited) before the commencement of the experiment to ensure the goats were free of intestinal worm. The goats were kept in individual pens measuring 1.25m^2 (1.25 m × 1.0 m) and provided individual feeders and water buckets. The goats were allowed 10 days of adjustment period during which they were gradually introduced to the experimental diets.

Experimental Diet

Moringa oleifera foliage was harvested at 56 days (8 weeks of age) of growth during the rainy season from the moringa plots of the BLRI. The collected moringa foliage consisted of leaves, petioles, stems and soft rachis. The whole foliage was chopped and sun dried on thick plastic sheets for three days, then bagged and stored until used for feeding. The conventional concentrate ingredients (broken maize, wheat bran and soybean meal) were purchased from a local feed mill, and prepared weekly for feeding. The physical and chemical composition of experimental diets is shown in table 1 and table 2 respectively. All diets content similar protein and energy and formulated to meet the nutritional requirements of growing goats (NRC, 2007). Moringa foliage and concentrate mixture feed was provided as mash form. Dried moringa foliage (leaves, petioles and soft stems) was gradually replaced at 25, 50, 75 and 100% with conventional concentrate mixture and were mixed thoroughly and supplied to animals.

Experimental procedure and design

A total of thirty 6 to 8 months old male goats were allocated into five groups with six animals per treatment. The design of the experiment was a completely randomized design (CRD) with five treatments and each treatment consisted of six goats. The five experimental treatments were:

T_1 = 100 % moringa foliage
T_2 = 75% moringa foliage + 25% concentrate mixture
T_3 = 50 % moringa foliage + 50% concentrate mixture
T_4 = 25% moringa foliage + 75% concentrate mixture
T_5 = 100% concentrate mixture

Feed was offered twice daily at 5% BW on dry matter basis. The feed was given twice daily at 08:30 and 15:00 h. The feeders and water buckets were cleaned daily before fresh feed and water were offered. Feed intake for each day during the collection period was determined by subtracting the mass of moringa foliage and concentrate refusals from the offered moringa foliage and concentrate.

Before morning feeding, all animals were weighed at the commencement of the experiment and subsequently every week. The average daily live weight gainwas calculated by regression of body weight of each animal on number of days of feeding during experimental period. The feed conversion ratio (FCR) was calculated as a proportion of live weight gain to feed intake of whole experimental period. The duration of the feeding trial was 78 days.

Digestibility Trial

During the last seven days of the feeding trial, four goats were randomly selected from each treatment and subjected to a digestibility trial to determine the digestibility of nutrients and nitrogen retention. All feeds were prepared at the same time for collection period and feed samples was taken about 250g and stored for analysis. Daily fecal output of each goat was collected, weighed and mixed thoroughly, then 10% of total fecal output was taken and stored at -20°C. Refusal was also collected, weighed and kept from individual animal. Urine collected in plastic bucket with 50 ml 6N H_2SO_4 sulphuric acid to prevent nitrogen volatilization. A measuring cylinder was used to determine daily urine volume and total urine was made 1L, then 10% urine was collected from each animal and stored at -20°C. After collection period,faeces and urine samples were taken out from freeze and thawed and mixed by each animal and 10% of total sample was collected and frozen until analysis.

Chemical Analysis of Feed, Refusals, Feces and Urine

Dry matter (DM) and organic matter (OM) for feeds and faecal matter were determined as described by the Association of Official Analytical Chemists (AOAC, 2000). Total nitrogen (N) in all samples was determined by a Kjeltec Auto Analyzer (Tecator, Hoganas, Sweden) (AOAC, 2000). Acid detergent fibre (ADF) were analysed as outlined by (Van Soest et al., 1991). The apparent digestibility of DM, OM, CP and ADF was calculated from digestibility trial. The difference between N intake and N output in faeces and urine was a measure of N retention. GE (Gross energy) of the feed samples was determined using a bomb calorimeter (IKA®C200). ME intake was calculated according to AFRC, (1993) (ME=0.0157*DOMI, digestible organic matter intake). ME (Metabolizable energy) (MJ kg DM) was calculated according to the following formula (Kuperus, 2002):

ME in straw = 0.36* GE
ME in high quality pasture or concentrate= 0.66*GE

The Ca content of *Moringa oleifera* leaves and total foliage was determined using the atomic absorption spectrophotometer (Perkin Elmer, AAnalyst 400), according to methods described by AOAC (2000). Phosphorus was determined using spectrophotometry (UV-Visible Spectrophotometer, CARY 50 Probe), as described by AOAC (2000).

Table 1: The composition (%) of experimental diets

Feed ingredients	Treatments				
	100MF	75MF:25C	50MF:50C	25MF:75C	100C
Moringa foliage	100.00	75.00	50.00	25.00	-
Broken maize	-	7.50	15.00	22.50	30.00
Wheat bran	-	9.50	19.00	28.5	38.00
Soybean meal	-	7.50	15.00	22.5	30.00
Vitamin mineral premix	-	0.125	0.25	0.375	0.5
DCP (Di-calcium phosphate)	-	0.25	0.50	0.75	1.0
Salt (Nacl)	-	0.125	0.25	0.375	0.5

MF= Moringa foliage; C = concentrate

Table 2: Chemical composition of experimental diets (%DM)

Diets	DM	CP	ADF	OM	Ash	ME (MJ/kg DM)	Ca	P
T_1 (MF100 : 0C)	77.44	18.26	32.49	89.33	10.67	11.24	1.95	0.21
T_2 (MF75 : C25)	79.04	18.24	29.30	90.02	9.99	11.12	1.56	0.37
T_3 (MF50 : C50)	80.64	18.42	26.10	90.70	9.30	11.00	1.17	0.54
T_4 (MF25 : C75)	82.24	18.23	22.91	91.34	8.62	10.87	0.78	0.70
T_5 (MF 0 :100C)	83.84	18.16	19.71	92.07	7.93	10.75	0.39	0.86

MF= *Moringa* foliage; C=Concentrate; DM= Dry Matter; CP = Crude Protein; ADF= Acid Detergent Fiber; OM=Organic Matter; ME= Metabolizable Energy.

Table 3: Initial and final body weight, live weight gain and FCR of Bengal goats fed the experimental diets (n=6)

Variables	Treatments					SEM	P-value
	T_1	T_2	T_3	T_4	T_5		
Initial BW (kg)	10.22	10.13	10.12	10.12	10.03	0.24	0.99
Final BW (kg)	15.06^a	15.07^a	14.75^a	14.38^{ab}	12.77^b	0.28	0.04
Average live weight gain (g d^{-1})	60.32^a	63.45^a	57.27^a	51.57^a	33.02^b	2.68	0.0003
FCR	10.90	9.81	10.49	9.95	12.90	0.49	0.27

^{a,b,c} Means within column with different superscripts are significantly different. FCR = Feed conversion ratio; BW= Body weight; n= observations number.

Table 4: Effect of replacement of moringa foliage with conventional concentrate on nutrients intake of Bengal goat (n=4)

Variables	Treatments					SEM	P-value
	T_1	T_2	T_3	T_4	T_5		
DM intake (g d^{-1})	569.59^b	613.98^a	646.51^a	531.50^{bc}	515.03^c	12.39	<0.0001
DMI (%LW)	4.40^{bc}	4.74^{ab}	4.92^a	4.07^{dc}	3.94^d	0.10	<0.0001
DMI (g/$W^{0.75}$kg)	83.43^b	89.86^a	93.50^a	77.38^c	74.86^c	1.75	<0.0001
CPI (g d^{-1})	104.99^b	124.68^a	126.56^a	102.30^b	97.99^b	3.12	0.0001
ADFI (g d^{-1})	186.94^a	180.74^a	161.26^b	103.31^c	72.96^d	10.60	0.0003
OMI (g d^{-1})	498.44^{bc}	546.07^{ab}	581.01^a	485.44^c	477.37^c	11.36	0.0028
ME intake (MJ $animal^{-1}$)	6.20^b	7.02^a	7.58^a	6.09^b	5.90^b	0.18	0.002

^{a,b,c}Means within column with different superscripts are significantly different; DMI= dry matter intake, CPI= crude protein intake, ADFI= acid detergent fiber intake, OMI= organic matter intake.

Table 5: Effect of replacement moringa foliage with conventional concentrate on nutrient digestibility (%) of BB goats (n=4)

Variables	Treatments					SEM	P-value
	T_1	T_2	T_3	T_4	T_5		
DM	80.13	81.69	77.59	76.26	76.3	0.81	0.10
CP	81.74	84.36	84.84	81.18	80.20	1.25	0.78
ADF	84.92^{a}	83.16^{a}	84.09^{a}	78.71^{b}	71.77^{b}	1.39	0.002
OM	78.96	81.73	82.91	79.75	78.49	0.73	0.73

[a,b,c,] Means within rows with different superscripts are significantly different. DM= dry matter; CP= crude protein; ADF= acid detergent fiber; OM= organic matter.

Table 6: Effect of replacement of moringa foliage with conventional concentrate on nitrogen utilization (g d^{-1}) of Bengal goats (n=4)

Variables	Treatments					SEM	P- value
	T_1	T_2	T_3	T_4	T_5		
N- intake	16.80^{b}	19.95^{a}	20.25^{a}	16.37^{b}	15.68^{b}	0.50	0.0001
FN- out go	3.05	3.12	3.06	3.08	3.10	0.09	0.99
UN- out go	2.96^{b}	4.21^{a}	4.53^{a}	4.76^{a}	4.87^{a}	0.18	<0.0001
Total N- out go	6.00^{b}	7.33^{a}	7.58^{a}	7.84^{a}	7.97^{a}	0.21	0.0085
N- retention	10.80^{b}	12.62^{a}	12.67^{a}	8.53^{c}	7.71^{c}	0.52	<0.0001
N- retention, % intake	64.1^{a}	63.2^{a}	62.5^{a}	52.4^{b}	49.1^{b}	1.64	<0.0001

[a,b,c]Means within column with different superscripts are significantly different; N= nitrogen, FN= fecal nitrogen, UN= urinary nitrogen.

Statistical Analysis

Analysis of Variance on the data of feed intake, nutrients utilization, FCR and growth rate were conducted based on a completely randomized design (CRD) using the general linear model procedure of SAS (SAS 9.2).The differences in the means were compared by Least Significant Differences (LSD) at 5% level (P<0.05).

RESULTS

Chemical Composition of the Experimental Feeds

The nutrient composition of moringa foliage and concentrate used in the study is shown in table 1. DM of experimental diets was increased with increasing concentrate level in the diet. CP and ME content of five experimental diets were similar. There were differences in the contents of ADF and ash which were higher in T_1 compared to the other diets. Calcium content of diet T_1 was higher, then gradually decreased with increasing concentrate feed; conversely P content of diets was decreased with increasing moringa foliage.

Body Weight Change

The effect of the dietary treatment on growth performance and FCR is shown in table 3. No significance (P>0.05) differences in the initial live weight (ILW) existed among the five experimental groups. The final live weight of goats fed T_5 was significantly lower (P<0.05) than goats on T_1, T_2, T_3 and T_4. Consequently, daily live weight gain was significantly (P<0.05) higher in goats on diets T_1, T_2, T_3 and T_4 than those on diet T_5. The average live weight gain in goats fed on T_1, T_2, T_3 and T_4 diet was significantly (P<0.01) higher than in goats fed on T_5 diet. FCR (DMI kg kg^{-1} gain) was not affected (P>0.05) by the diets.

Nutrient Intake

The effect of replacement of conventional concentrate with moringa foliage on intake in Black Bengal Goats is presented in table 4. The dry matter intake (DMI) of the goats in T_2 and T_3 was significantly (P<0.01) higher than that of T_1, T_4 and T_5 diets. DMI as percent live weight was significantly (P<0.01) higher in goats fed on T_2 and T_3 diets than that of T_1, T_4 and T_5 diets. The range of DMI as percent live weight varied from 3.94 for the animals of T_5 to 4.92% for those of T_3. Total DMI per unit metabolic body weight was significantly (P<0.01) higher in goats of T_2 and T_3 than in those of T_1, T_4 and T_5 diets. The average daily crude protein intake (CP g $d^{-1}animal^{-1}$), ME intake (MJ d^{-1}) and OM intake (OM g $d^{-1}animal^{-1}$) followed a trend similar to that of the average daily DMI. The ADF intake of goats in T_1 and T_2 was significantly (P<0.01) higher than that of the T_3, T_4 and T_5 animals.

Nutrients Digestibility

Apparent DM, CP, ADF and OM digestibility of the five experimental diets are shown in table 5. Values recorded for DM, CP and OM digestibility among different treatments were not significantly (P>0.05) different whereas ADF digestibility was significantly higher in T_1, T_2 and T_3 treatments in comparison with T_4 and T_5.

Nitrogen Balance

Results of nitrogen balance in goats among different treatments are presented in table 6. Nitrogen intake of goats in T_2 and T_3 was significantly (P<0.01) higher than that of T_1, T_4 and T_5. Non-significant (P>0.05) diet effects were observed for faecal nitrogen losses among treatments. However significant (P<0.01) diet effects were observed with urinary nitrogen losses with the highest value being obtained in the goats of $T_5$and the lowest in T_1 goats. Total nitrogen losses were significantly (P<0.05) lower in T_1 animals compared to those in T_2, T_3, T_4 and T_5. Total nitrogen losses increased progressively with increase in the amount of concentrate in the diet. Nitrogen retention was positive and significantly (P<0.01) higher in T_2 and T_3 than T_1, T_4 and T_5 diet, respectively though no significant (P>0.05) difference was observed between T_4 and T_5treatments. On the other hand, nitrogen retention as percent of total nitrogen intake was significantly (P<0.01) higher in T_1, T_2 and T_3treatments than in T_4 and T_5 while the highest percent (64.15%) of nitrogen retention as percent of total intake was recorded in T_1.

DISCUSSION

This crude protein content of moringa foliage used in the study (Table 1) was comparable with the values (19.5 and 19.3% in DM) reported by Kakengi et al. (2005) and Aregheore (2002) respectively, but lower than the values (29.7, 25.95 and 22.6%) obtained by Fadiyimu et al. (2010), Manh et al. (2005) and Sánchez et al. (2006b) respectively. The ADF content of moringa foliage in this study is in agreement with the values reported by Sarwatt et al. (2004) but was higher than those obtained by Murro et al. (2003), Asaolu et al. (2010) and Sánchez et al. (2006b). The variations in nutritive value of moringa foliage could be due to the age of harvest, soil type and fertility, proportion of leaf and stem and agro-ecological zone where trees are growing. The calcium and phosphorus levels in moringa foliage were adequate to that meet the amount required for ruminant livestock. Mc Dowell (2003) reported that 2300, 2700 and 2800 mg kg^{-1} of P and 4600, 5100 and 3000 mg kg^{-1} of Ca are sufficient for beef cattle, sheep and goats, respectively. On the other hand, calcium content in concentrate was sufficient for goats while phosphorus was higher amount than recommended levels.

Goats on diet T_2 had the highest (63.45 g d^{-1}) growth rate which was almost comparable to growth rate of goats of T_1, T_3, T_4 treatments. Higher growth rate obtained from goats inT_1, T_2, T_3 and T4 was due to a positive effect of moringa foliage on intake, digestibility and nitrogen utilization. Lu et al., (2008) recommended about 23% ADF for growing goats. ADF content of T_5 diet was lower than recommended level while ADF content of T_1, T_2, T_3 and T_4 diet was comparable or higher to recommended level. Dietary fibre contributes significantly in goat production through its influence in and interaction with intake and digestion of nutrients. Lu et al. (2008) also reported that optimum dietary fibre in the diet increases cellulolytic activity in the rumen and increases salivation through eating and ruminating. Salivation led to increase ruminal pH that favours the growth of cellulolytic bacteria. It has been reported that ruminal pH increased linearly from 6.28 to 6.55 as ADF intake increased from 14 to 26% (Lu et al., 2008). Growth rates of goats of T_1 and T_2 almost doubled those of the sole concentrate diet (T_5). The lowest growth rate of goat inT_5 group may be due to low fiber in the diet. This result is contradict with those results of Mushi et al. (2009) and Mahgoub et al. (2005) who observed that increasing concentrate in the diet increased growth rate of goats while there was low quality and rhode grass hay as basal diet respectively. The lowest growth rate obtained from the sole concentrate diet in this study might have been due to low fibre and high non-structural carbohydrate in the diet. Feeding a large amount of grain promote the growth of lactic acid bacteria, which reduced pH in the rumen and could lead to acidosis (Owens et al., 1998).Growth of cellulolytic bacteria and protozoa are inhibited by a pH below 6.0 which decreases the fibre digestibility in the rumen that leads to reduce feed intake resulted decrease body weight (Russell and Wilson, 1996). In general, it is shown that increasing moringa foliage with conventional concentrate increased live weight gain of goats. There were no health implications when conventional concentrate was replaced with dry moringa foliage over the experimental period.

Total CP, ADF and OM intakes was positively correlated(r=0.96; r=0.76 and r=0.98, respectively) to total DM intake. The increased CP, ADF and OM intake with total DMI was probably due to the increased total DMI of the diet. In the present study, the DM intake of T_1 was higher (569.6 g d^{-1}animal^{-1}) than that of reported by Asaolu et al. (2009) (241gd^{-1}animal^{-1}) and Asaolu et al. (2011) (288 g d^{-1}animal^{-1}) in West African Dwarf goats fed moringa foliage without supplementation. It may be due to low concentration of CP content in the foliage. The DM intake in percent live weight ranged from 3.94 to 4.92 (Table 4) and was within the range of DM intake recommended value of NRC (2007). The highest DM, CP and OM intakes were found from T_3 probably because of the optimum level of fibre and a favourable combination of forage to concentrate ratio that improved palatability.

Higher ADF intake was found with the increasing level of moringa foliage. This was expected as moringa foliage had a higher ADF content when compared to concentrate. Similar energy concentrations of different diets resulted in ME intake of all treatments close to that recommendation by NRC (2007) for growing goats (Table 4). Intake pattern could be a reflection of the relative acceptability and palatability of supplemented feed to animal. Masafu (2006) illustrated that feed intake is an appraisement of diet appreciation, selection and consumption by an animal. It is a key process which determines the quantity of feed stuff which is ingested over a period of time, usually per day (McDonald et al., 1993).

The digestibility values of DM (80.1%) and OM (79.0%) of sole moringa foliage (T_1) obtained in this study were comparable to findings of (Asoulu et al., 2011) who observed 77.19 and 79.35% DM and OM in West African Dwarf (WAD) goat fed fresh moringa whereas CP digestibility was higher (89.35%) than the result of the present study (Table 5). Similarly, Fadiyimu et al. (2010) obtained higher CP (84.96%) digestibility at 100% fresh moringa foliage in WAD goats. Sánchez et al. (2006a) reported that increasing level of moringa leaves supplementation in dairy cows fed low quality grass improved digestibility of all nutrients. ADF digestibility was increased with increasing level of moringa foliage in the diet, may be due to availability of digestible cellulose from ADF of moringa foliage to the animals. The present finding is in agreement with Murro et al. (2003) who found that digestibility of cell wall constituents was increased with increase in moringa leaf meal in the diet. On the other hand, Gebregiorgis et al. (2012) found that supplementation of moringa (*Moringa stenopetala*) leaves 150 and 300 g d^{-1} failed to improve DM, OM, NDF and ADF digestibility whereas supplementing 450 g d^{-1}improved digestibility of all nutrients in sheep.

Significantly ($P<0.01$) higher nitrogen intakes for $T_2$and T_3diets compared to T_1, T_4 and T_5 diets were observed due to the higher level of dry matter and CP intake and nitrogen concentration in experimental diets. It has been reported that dietary nitrogen intake influenced nitrogen losses through urine and feaces (Badamana and Sutton, 1992).There was no significant ($P>0.05$) differences in faecal nitrogen losses in the present study, similar to the findings of (Asaolu et al., 2010 and 2011) and (Fadiyimu et al., 2010) that faecal nitrogen was not affected by nitrogen intake. On the other hand, urinary nitrogen increased progressively from T_1 to T_5 with increasing concentrate level. Brooker et al. (1995) observed that feed is high in soluble protein which mainly digested in rumen resulting produced higher amount of ammonia that cannot be utilized by rumen microorganism. They also observed that excess amount of nitrogenis converted to urea in rumen and excreted in urine. The present result indicates that more rumen ammonia would be produced with the concentrate supplemented diets. The positive nitrogen retention values (Table 6) for all treatments showed that the protein in the diets was adequate to meet the requirement for maintenance and growth of experimental goats (Fadiyimu et al., 2010).

CONCLUSION

Intake, nutrients utilization and growth rate of goats fed on different ratio of dried moringa foliage and concentrate diets was higher than the sole conventional concentrate diet in the current study. Moringa foliage evaluated with goat performances fed with the known conventional concentrate mixture where protein source was soybean meal. Moringa foliage can be used as an alternate for conventional concentrate in the diet of growing goats due to its high crude protein content and high digestibility of nutrients. It is recommended that replacing moringa foliage at 75% with conventional concentrate could be used as a cheap protein supplement for goats. Moringa can be used effectively as substitute for conventional concentrate in the diet of growing goats at small holder farmer's level where it can be grown in abundance.

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