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Effect of Varying Levels of Zizyphus (*Zizyphus mauritiana*) Leaf Meal Inclusion in Concentrate Diet on Performance of Growing Yankasa Ram Lambs Fed Maize Stover Basal Diet

Research Article

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ABSTRACT

This study investigated the effects of the dietary supplementation of *Zizyphus mauritiana* leaf meal (ZLM) on the performance of Yankasa lambs. Twenty five lambs aged between 6 and 8 months were randomly divided into five groups of five animals each in a completely randomized design to receive supplementary diets containing 0, 10, 20, 30 and 40% ZLM as replacement for cotton seed cake in concentrate supplement to a maize stover basal diet for a period of 120 days. Inclusion of ZLM in the supplement did not significantly (P>0.05) affect nutrient intake. There was a significant (P<0.05) depression on dry matter (DM), organic matter (OM), neutral detergent fiber (NDF) and acid detergent fiber (ADF) digestibility, with 30 and or 40% increases in the level of ZLM inclusion in the supplementary diet. Feeding ZLM containing diets particularly at 30 and 40% levels significantly (P<0.05) influenced nitrogen utilization. Fecal nitrogen excretion significantly (P<0.05) increased with ZLM supplementation. Control (0%) and 10% level of inclusion had similar and significantly (P<0.05) lower fecal N loss (14.30 and 14.94 g/d), followed by 20% (15.42 g/d), with T4 and T5 having significantly (P<0.05) higher fecal N loss (22.04 and 22.89 g/d). Urinary N loss was significantly higher (P<0.05) in lambs offered 0, 10 and 20% ZLM (10.88, 11.98 and 11.02, respectively) diets compared to 30% (10.06) and 40% (9.89) receiving higher levels of ZLM, which were significantly (P<0.05) lower. Nitrogen retention was highest in control (26.19), followed by 10 and 20% ZLM (24.42 and 24.14), which were similar and higher than 30 and 40% supplementations (17.15 and 15.97, respectively). Nitrogen retention as % of intake was highest (50.98%) in animals fed 0% and was least in 40% ZLM supplementation (32.75%). It was concluded that inclusion of ZLM in concentrate diet at 10-20% inclusion levels gave best result in terms of performance than when the leaf meal is included at higher levels to ram lambs.

KEY WORDS growth, intake, live weight, sheep, *Zizyphus mauritiana*.

INTRODUCTION

Small ruminants such as sheep and goats can frequently be slaughtered at village level and may supply the rural population with animal protein. Their carcass weights are suitable for consumption in small families or village communities (CTA, 1986). Their products are easily and quickly sold and thus serve as monetary reserve for rural farmers. Njoya *et al.* (2005) indicated that despite the important economic, traditional, social and religious roles of small ruminants, their productivity is seriously hampered by high mortalities due to mixed infections by ‘peste des petits ruminants’, gastro-intestinal helminthoses and also by poor feeding and management. Livestock production in many tropical environments is constrained by low feed availability and quality during the prolonged dry season (Leng, 1984).

In general, an increase in the productivity of small ruminants can be achieved by improving environmental factors like management, nutrition and health care and/or by genetically improving the animal (Jaitner *et al.* 2001). However, due to high cost, most smallholder livestock farmers cannot afford to supplement the diet of their animals with highly expensive feed ingredients (Rumirez-Orduna, 2005). Several indigenous browse species growing in fallow lands are commonly used by smallholder farmers as cut and carry fodder for confined sheep and goats (Onwuka, 1992). Quantitative information on biomass production (Larbi *et al.* 1993) and chemical composition (Mecha and Adegbola, 1980) of some species have been documented. Morton (1987) and Abdu *et al.* (2007) reported that the leaves of *Zizyphus mauritiana* are readily eaten by animals and contain 12.5-16.9% CP, 13.9-17.1% CF, 11.5-2, 7% EE, 10.2-11.7% ash and 55.3-56.7% NFE.

Identification of feeding regimes that will allow small farmers to reduce their dependence on external supplies of concentrate feedstuffs has the potential to increase the viability of livestock production enterprises, increase dry season animal products supplies and improve household income. However, little information exists on livestock performance on a range of supplementary feeds using available browse plants.

The experiments described in this paper were undertaken to provide information on productivity of sheep fed a basal diet of maize stover, supplemented with concentrate diet containing varying levels of Zizyphus leaf meal, and identify more efficient dry-season feeding practices for small farmers. This study was aimed at determining the effect of *Z. mauritiana* leaf meal supplementation on feed intake and nutrient utilization in growing Yankasa ram lambs fed a basal diet of maize stover.

MATERIALS AND METHODS

Location of study

The experiment was conducted at the Experimental Unit of the Small Ruminants Research Programme of National Animal Production Research Institute (NAPRI), Shika-Zaria. Shika is located in the Northern Guinea Savanna on latitude 11˚ 12´N, longitude 7˚ 33´E, altitude 610 m. Annual rainfall is 1100-1200 mm while mean temperature is about 24.4 ˚C (14.5-39.3 ˚C) with the lowest temperature occurring during the early dry season (November-January) while the higher temperatures are experienced during the late dry season (February-April) (Osinowo *et al.* 1991).

Experimental feeds

Maize stover was collected from farms within the research institute in September after harvest. The stover was chopped to 2-5 cm using forage chopper and then bagged in polyethene bags (Bagco sacks®) and stored in a storeroom, before used during the feeding trail.

Zizyphus mauritiana leaves were harvested in the month of July from Chilariye town in Yobe state. The Zizyphus plants were pruned and allowed to dry before removing the stems. It was then grounded using a pestle and mortar to allow for easy mixing with the other ingredients in the concentrate feed.

Experimental animals and management

Ram lambs were obtained from NAPRI small ruminant flock, aged between 6-8 months and weighing 13±0.6 kg. The routine management practices were: lambs were dewormed against external parasites by dipping in acaricide (Amitics®) once a week during the dry season and twice a week during the raining season; against internal parasites using Albendazole® 10% suspension, once every month during the raining season and once in every 3 months during the dry season. The animals were vaccinated against Pest des Petit Ruminants and Hemorrhagic Septicemia annually. Lambs were housed in individual pens with free access to fresh water in well ventilated room with concrete floor.

Treatments and design of experimental procedures

Five iso-nitrogenous concentrate diets were formulated containing 0, 10, 20, 30, and 40% ZLM. Each level of ZLM serves as a treatment. Ram lambs were allotted to five treatment groups of five lambs and randomly allocated to one of the five dietary treatments (Table 1), in a completely randomized design.

A daily allowance of concentrate was offered in single meal at 08.00 h. Chopped maize stover was offered *ad libitum*, when all the lambs had consumed the concentrate. Left stover residues were weighed post-feeding to ascertain daily feed consumption. The growth trial was carried out for a period of 90 days. Daily feed (concentrate and basal diet) intake and fortnightly body weight of all the lambs were recorded throughout the study.

Digestibility trial

Three rams were randomly selected from each treatment group at the end of the growth study and transferred to individual metabolic cages measuring 49 × 20.5 m which allowed for separate fecal and urine collection, as described by Osuji *et al.* (1993). During the trial, animals were maintained on similar treatment diets as indicated in the feeding trial. Total fecal and urine collections lasted for seven days.

Urine was collected into plastic containers, which contained 25 mL of 10% v/v sulphuric acid. Urine collected was bulked and 10% of total daily urine collected was subsampled and kept for each individual animal at -20 ˚C until required for laboratory analysis. Daily fecal samples were also collected, weighed, bulked and sub-sampled for dry matter determination and stored awaiting chemical analysis.

Digestibility was calculated as the portion of nutrient intake not recovered in faeces. Nitrogen balance (NB) and nitrogen retention (NR) was calculated as the amount of average daily nitrogen intake (NI) not excreted in feces (FN) and urine (UN).

NB= NI (g/d) – (FN+UN) (g/d)

Laboratory analyses

The dry matter (DM) content of ZLM, maize stover, concentrate diets and fecal samples were determined by drying the samples at 60 ˚C for 48 h. Kjeldahl nitrogen analyses (AOAC, 2000) were performed in duplicate on feed and fecal samples and crude protein (CP) calculated as (N×6.25), crude fiber (CF) content-by means of Foss Tecator Analyzer, ether extract content-by Soxtec System 1040 and ash content-by combustion at 550 ˚C in Muffle furnace. Neutral detergent fiber (NDF) and acid detergent fiber (ADF) was determined by the Van Soest *et al.* (1991) method. Tannin content was analyzed by the method of Wheeler *et al.* (1994).

Statistical analysis

Analysis of variance was carried out on the data collected on feed intake, weight changes, nutrient digestibilities and nitrogen balance, to determine the effect of ZLM inclusion using the GLM procedure of SAS (SAS, 2001). Duncan's multiple range test was used to separate significant means.

RESULTS AND DISCUSSION

Experimental feeds

Table 1 shows the percentages of ingredients and chemical composition of the supplementary diets, maize stover and Zizyphus leaves used in the experiment.

The used maize stover had a crude protein (CP) content of 3.4%, NDF (78.1%) and ADF (53.2%). The used Zizyphus had a CP of 13.4%, 45.9% NDF, 37.310% ADF. The result shows the presence of tannin (181.13 mg/100g) in Zizyphus leaves.

The content of DM and organic matter (OM) were similar across treatments. The CP contents of the experimental diets were similar across treatments. It tends to decrease slightly as the level of ZLM inclusion increased.

NDF content increased as ZLM inclusion increased from 0 to 40% (27.6 to 37.8%) while the content of ADF also increased (12.0 to 21.54%) in the concentrate diet. The level of tannin increased from 36.15 g/100mg in concentrate diet with 10% inclusion level of ZLM to 66.67, 82.00, and 107.39 mg/100g in concentrate diets with 20, 30 and 40% levels of ZLM inclusion, respectively.

Feed intake and performance of Yankasa rams lambs

There were hardly any leftovers in the feed troughs from the supplements. Maize stover intake significantly (P<0.05) declined with the increase in level of ZLM inclusion. Animals on diet with 10% inclusion had the highest stover intake (453.10 g/d), while animals in the control and those receiving 20% ZLM inclusion had similar maize stover intake (450.0 g/d), which was higher than those on 30 and 40% inclusion levels (437.63 and 435.0 g/d), respectively. Total DM intakes were, however, similar.

Performance of Yankasa rams lambs fed experimental diets

Results of growth performance are presented in Table 2. Lambs fed control and 10% ZLM inclusion had similar and significant (P<0.05) average final body weight (18.76 and 18.68 kg, respectively) relative to their counterparts given diet with 20% ZLM, while treatment groups fed on concentrate diets with 30 and 40% ZLM inclusion had the least (15.27 and 15.18 kg, respectively) body weights.

Also, rams fed the control diet and 10% level of ZLM inclusion had significantly (P<0.05) higher ADF intake (67.38 and 63.09 g, respectively), followed by animals on 20, 30 and 40% ZLM inclusion (43.33, 22.97 and 14.28 g, respectively). Feed conversion ratio (FCR), which presented in Table 2, was lower in control group and animals fed 10% ZLM inclusion, but it increased with increase in the level of ZLM inclusion in the concentrate diets. Treatment groups fed on 30 and 40% ZLM had higher FCR (29.51 and 45.09, respectively).

Digestibility and nitrogen balance

Nutrient digestion is presented in Table 3. Inclusion levels of ZLM in the concentrate diets had significant effect (P<0.05) on apparent digestibility of DM, OM, CP, NDF and ADF. Dry matter digestibility (DMD) was significantly higher (P<0.05) in rams fed on diet with 0% (control) level of ZLM inclusion (51.7%), the least digestibility was observed in treatment groups fed 30 and 40% ZLM.

CP digestibility was significantly (P<0.05) affected by the level of ZLM inclusion. The CP digestibility decreased as the level of ZLM inclusion increased in the concentrate diet, being highest in the control (58.29%) and lowest in treatments with 40% level of ZLM inclusion (38.18%). NDF digestibility was significantly (P<0.05) affected by the

Table 1 Ingredients and chemical composition of supplements, *Zizyphus mauritiana* and Maize stover

Constituents	Inclusion levels of Zizyphus leaf meal						
	(0)	(10)	(20)	(30)	(40)	ZLM	MS
			Ingredients (%)				
Maize	37	33	28	24	19	-	-
Cotton seed cake	31	25	20	14	9	-	-
ZLM	-	10	20	30	40	-	-
Wheat bran	20	20	20	20	20	-	-
Rice bran	10	10	10	10	10	-	-
Bone meal	1.5	1.5	1.5	1.5	1.5	-	-
Common salt	0.50	0.50	0.50	0.50	0.50	-	-
Total	100	100	100	100	100		
			Chemical composition				
DM	93.4	93.4	93.4	93.5	93.8	89.7	94.0
OM	86.78	86.80	87.11	87.00	87.40	79.4	88.03
CP	14.6	14.5	14.2	14.0	14.1	13.9	3.4
EE	2.4	2.5	2.5	2.6	2.56	4.1	1.2
Total ash	6.6	6.6	6.3	6.5	6.4	10.3	6.0
NDF	27.6	31.2	32.7	33.2	37.8	45.9	78.1
ADF	12.0	15.7	16.0	18.8	21.54	37.1	53.2
Tannin (mg/100g)	NA	46.15	66.67	70.00	73.39	181.13	NA

ZLM: Zizyphus leaf meal; MS: maize stover; NA: not analyzed; DM: dry matter; OM: organic matter; CP: crude protein; EE: ether extract; ADF: acid detergent fibre; NDF: neutral detergent fibre.

Table 2 Feed intake and performance of animals during growth trial

Parameters	Inclusion levels of Zizyphus leaf meal					SEM
	(0)	(10)	(20)	(30)	(40)	
			Intake (g/d)			
Concentrate	247.10	248.56	248.50	245.50	243.50	3.59^{ns}
Maize stover	450.0^{a}	450.10^{a}	450.00^{a}	437.63^{b}	435.00^{b}	5.58
Total DM	697.10	700.66	698.50	683.13	678.50	6.64^{ns}
			Body weight changes (kg)			
Initial	13.10	13.38	13.26	13.34	13.98	0.49^{ns}
Final	18.76^{a}	18.68^{a}	16.90^{b}	15.27^{c}	15.18^{c}	0.53
Total gain	5.66^{a}	5.30^{a}	3.64^{c}	1.92^{d}	1.27^{e}	0.38
ADG (g)	67.38^{a}	63.09^{a}	43.33^{b}	22.97^{c}	14.28^{d}	2.12
FCR	10.51	11.05	15.65	29.51	47.09	

The means within the same row with at least one common letter, do not have significant difference (P>0.05).
DM: dry matter; ADG: average daily gain; FCR: feed conversion ratio (kg DM/kg gain).

Table 3 Effect of the levels of Zizyphus Leaf Meal inclusion on nutrient digestibility by Yankasa rams fed maize stover basal diet

Parameters	Inclusion level of Zizyphus leaf meal					SEM
	(0)	(10)	(20)	(30)	(40)	
			Digestibility coefficient (%)			
DM	51.70^{a}	47.83^{b}	46.14b^{c}	45.43^{cd}	44.34^{d}	0.92
OM	55.08^{a}	45.53^{b}	42.62^{c}	40.80^{cd}	39.62^{d}	0.92
CP	58.29^{a}	50.40^{b}	48.74^{bc}	46.59^{c}	38.18^{d}	0.62
NDF	35.45^{a}	22.17^{b}	21.78^{b}	19.72^{c}	19.44^{c}	0.79
ADF	37.37^{a}	20.03^{b}	19.72^{b}	17.63^{c}	17.40^{c}	1.15

The means within the same row with at least one common letter, do not have significant difference (P>0.05).
DM: dry matter; OM: organic matter; CP: crude protein; ADF: acid detergent fibre; NDF: neutral detergent fibre.

level of ZLM inclusion. Lambs offered diet with 30 and 40% ZLM had 19.72 and 19.44% NDF digestibilities, which were lower when compared with lambs offered diets with 0, 10 and 20% ZLM inclusions. Also, ADF digestibility showed a significant (P<0.05) decrease as the inclusion level of ZLM increased. The control treatment had the highest (37.37%) digestibility, followed by 10 and 20% levels of inclusion (22.17 and 21.78%, respectively), which were similar but higher than treatments with 30 and 40% ZLM inclusions (17.63 and 17.40%, respectively). The result of nitrogen balance study is presented in Table 4. Total nitrogen (N) intake was similar among treatment groups. Lambs offered diets with 30% and 40% ZLM had significantly higher (P<0.05) daily fecal N output (22.04 and 22.89 g/d, respectively) compared to lambs offered the control and 10% ZLM. Daily urinary N output was significantly higher (P<0.05) in lambs offered the control diet compared to those receiving diets with varying levels of ZLM. Nitrogen balance was significantly different (P<0.05) among the treatment groups, but lambs offered 30 and 40% ZLM had similar and least amount of N retained (17.15 and 15.97 g/d, respectively) compared to control group (26.19 g/d). Nitrogen retention as percent of intake follows similar trend.

Chemical composition of feeds

The chemical composition of maize stover offered as basal feed was within the normal range and comparable to values reported for cereal crop residues (Narayan and Sharma, 2004). The nutrient level of ZLM in this study was comparable to those reported by Le Houérou (1980) and Rubanza *et al.* (2003) for most browse plants. The small differences observed, which may be due to the stage of growth, season of collection, site of sampling and part of plant sampled (i.e., twigs, leaves or soft stem) (Ben Salem *et al.* 2005).

The amounts of secondary compound in forages are mainly a property of plant genetic factors which control physiological synthesis and accumulation of these compounds (Okuda *et al.* 1993).

Other factors associated with high rates of polyphenolic (tannin) synthesis include high environmental temperatures, drought stress, and plant defensive mechanisms against pests, pathogens and predators as reported by Mangan (1988). These conditions apply in the area were the ZLM was obtained. The concentrations of NDF and ADF were higher in treatments containing high Other factors associated with high rates of polyphenolic (tannin) synthesis include high environmental temperatures, drought stress, and plant defensive mechanisms against pests, pathogens and predators levels of ZLM than in control. This could be attributed to the high cell-wall constituents usually present in leaf meals (Anbarasu *et al.* 2004).

Voluntary feed intake

The non significant (P>0.05) difference in voluntary feed intake among the treatment groups were observed with the inclusion of ZLM has been widely reported (Silanikove *et al.* 1994; Zhu *et al.* 1992). The result of this study confirms other studies that indicated tannin-rich leaves, in combination with concentrate rations, could be fed to animals without any adverse effect on intake (Raghavan, 1990). This happens because the astringency effect of tannin on the mouth vocal mucosa of the animals consuming the supplement was masked by the presence of the other ingredients in the supplementary diets, which resulted in a concentrate diet that was palatable; hence, the animals were able to consume all the supplementary diet offered. Also, the comparable intake by lambs irrespective of dietary treatments is in agreement with the earlier observations of Komolong *et al.* (2001).

They reported that moderate levels (1- 4%) of tannins in the diet from various plant sources exerted no significant effect on feed intake. The increase in the NDF and ADF intake with increase in the level of ZLM inclusion observed in this study is in line with the report of Anbarasu *et al.* (2004), they attributed the increase in NDF and ADF to the relatively high cell-wall constituents usually present in leaf meal of most browse plant.

Table 4 Effect of the levels of Zizyphus Leaf Meal inclusion nitrogen balance by Yankasa rams fed maize stover basal diet

Parameters	Inclusion level of Zizyphus leaf meal					SEM
	(0)	(10)	(20)	(30)	(40)	
	Nitrogen balance (g/d)					
Nitrogen Intake	51.37	51.34	50.58	49.25	48.75	1.37[ns]
Nitrogen outgo in Urine	10.88[a]	11.98[a]	11.02[ab]	10.06[b]	9.89[c]	0.115
Nitrogen outgo in Feces	14.30[c]	14.94[c]	15.42[b]	22.04[a]	22.89[a]	0.09
Total N outgo	24.18	26.92	26.44	32.10	32.78	
Nitrogen retained	26.19[a]	24.42[b]	24.14[b]	17.15[c]	15.97[d]	0.23
As % of intake	50.98[a]	47.56[b]	47.72[c]	34.85[d]	32.75[e]	1.23

The means within the same row with at least one common letter, do not have significant difference (P>0.05).

Growth performance and feed conversion ratio

Lambs on treatments with 30 and 40% ZLM inclusions had lower growth rates. The lower growth rates observed in these lambs could possibly be because the tannin-protein complexes formed in the rumen had not been completely dissociated after crossing the rumen (McSweeney *et al.* 2001). This could prevent absorption of amino acids from the intestine as was reported by Dawson *et al.* (1999). Also, the negative effect on growth rate may be caused by the tannin reducing nitrogen availability in the digestive tract, as tannin has been shown to reduce the permeability of the gut wall by reacting with the outer layer so that passage of nutrients is reduced (Mitjavila *et al.* 1977). Also, Ndluvo (2000) reported that the nutritional effects of tannins are to be associated with their ability to bind with proteins (dietary and enzymes), structural carbohydrate polymers found in plant cell walls and minerals with an overall effect of lowering the bioavailability of nutrients at specific sites in the gastro-intestinal tract. This might be responsible for the retarded growth observed in the animal fed with increasing level of ZLM. Similar low growth rates were observed in animals fed fruits of *Acacia sieberiana* and *A. nilotica* (Tanner, 1988). In this study, there was no depression in feed intake. This may be attributed to the inclusion of the ZLM in combination with other ingredients in the supplementary feed offered to the animals.

Nutrient digestibility and nitrogen balance study

Nutrient digestibility decreased with increasing level of ZLM in the diet. McBrayer *et al.* (1983) reported that CP digestibility declined with increasing level of peanut skin rich in tannin. The lowest tannin content (2.2%) was sufficient to reduce CP digestibility. Similar results were observed by Makaranga (2002), who reported that there was a significant depression in apparent CP digestibility and DMD of goats fed tannin rich browse species. The result of the present study is also in agreement with the report of Olsson and Welllin-Berger (1989), he stated that inclusion of tannin rich feeds in the diet of ruminants may reduce cell-wall digestibility by binding bacterial enzymes and/or forming indigestible complexes with cell-wall carbohydrates (Reed, 1986). The digestibility of organic matter and the fiber fractions of sheep diets comprising *A. cyanophylla* were depressed because of high contents of proanthocyanidins and soluble phenolics. Silanikove *et al.* (1997) also reported that the high tannin content of browses negatively affects the utilization of protein in supplementary feeds. However, the inclusion of a limited quantity of tree leaves in animal feed is recommended to improve rumen function and productivity (Osakwe *et al.* 2004). The complexes that are formed between tannin and protein can be either soluble or insoluble. If the tannin is present in excess, all the proteins available is precipitated. Tannins are known to reduce DM digestion in the rumen causing a reduction in the passage rate of digesta (Silanikove *et al.* 1997) or post ingestive malaise (Silanikove *et al.* 2001). Tannins may bind to cell wall and cell solubles and reduce the digestion of protein and microbial fermentation (Makkar *et al.* 1995); all these will negatively affects nutrient digestion in the rumen.

Nitrogen balance studies

Nitrogen retention is considered as the most common index of the protein nutrition status of ruminants (Owen and Zinn, 1988). The result showed increased fecal and reduced urinary N losses with increasing levels of ZLM in the diet from 30% to 40%. These results are in line with several studies on the influence of tannin on nutrient utilization by ruminants. Mbatha (2001) reported similar results in goats using Wattle tannin extract. Dawson *et al.* (1999), Komolong *et al.* (2001) all pointed out that condensed tannins from foliage or of exogenous origin undoubtedly increased fecal N and reduced urinary N excretion. Tannins from *Lotus pedunculatus* have been shown to appear to overprotect protein from ryegrass fed to sheep (Waghorn and Shelton, 1995) with subsequent increased fecal loss of protein. Increased fecal N concentrations have been suggested to arise from digesta protein bound to tannin, decreased ruminal and intestinal digestive enzyme activity due to tannin, which impaired intestinal function, and increased secretion of endogenous proteins (Butter *et al.* 1999). The lowered N retention in animals fed some tanniniferous forages suggest that bound proteins are unavailable for digestion in the gut as was reported by Waghorn and Shelton (1995). Other workers (Reed *et al.* 1990) are, however, of the opinion, that the tannin-protein complex dissociate at the lower gut (low pH), hence making protein available to the host animal for enzymatic digestion. D'Mello (1992) observed the protein-tannin complex dissociation at pH values below 4 and above 7. These pH conditions also occur in the non-ruminants. The question arises as to why such a dissociation of the complex does not occur in non-ruminants or, if it does, why adverse effects accrue in these animals, but not in ruminants. Waghorn *et al.* (1994) reported that tannin-protein complex that survives the ruminal environment might not be digested in the lower tract; hence, ruminal protein bound to tannin is no longer available for utilization by the host animal in the lower digestive tract. This may be responsible for the reduction in the performance of the animals fed high levels of ZLM in their diets.

CONCLUSION

Zizyphus leaf meal can be included in the diet of small ruminants by smallholder farmers at 20% level of inclusion. Inclusion of ZLM in concentrate diet for growing lambs fed a basal diet of chopped maize stover at this level had a positive impact as evident on nitrogen retention and growth rate of the lambs. At 30-40% levels of ZLM in the concentrate diet, a depressive effect on the performance of the lambs was observed. Inclusion of ZLM at these levels negatively affected the digestibilities of dry matter, organic matter, crude protein, ADF and NDF.

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