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PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 16 (23): 1806-1810, 2013
ISSN 1028-8880 / DOI: 10.3923/pjbs.2013.1806.1810
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Nutrients Intake, Performance and Nitrogen Balance of West African Dwarf Sheep Fed Graded Levels of Toasted *Enterolobium cyclocarpum* Seeds as Supplement to *Panicum maximum*

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Abstract: A study was conducted to assess the nutritive value of *Enterolobium cyclocarpum* seeds as supplementary feed for ruminant animals during the dry season when grasses are either not available or of low quality. Matured fruits of *E. cyclocarpum* were collected, toasted, peeled and then used for the trial. Thirty two West African Dwarf (WAD) sheep aged between 12±2 months with an average body weight of 10±2 kg were used in assessing the nutritive value of graded levels of toasted *Enterolobium cyclocarpum* seed in a concentrate diets as supplement to *Panicum maximum* basal diet. The percent compositions of the experimental diets were toasted *E. cyclocarpum* seeds at various levels of inclusion (0, 10, 20 and 30%) for diets 1, 2, 3 and 4. respectively. The diets (1-4) were consecutively fed to each animal at 50 g kg^{-1} b.wt. for 12 weeks in a completely randomized design. Parameters taken were weekly body weights, daily feed intake, nutrient utilization and nitrogen balance status for each animal. Diet 2 had the highest significant ($p<0.05$) nutrients intake being 871.88, 137.13, 147.59, 33.26 and 69.86 g day^{-1} for DM, CP, CF, EE and ASH respectively. The Dry Matter Digestibility (DMD) coefficients decreased significantly ($p<0.05$) with increased inclusion levels of toasted *E. cyclocarpum* seeds supplementation. Sheep fed diet 4 had the lowest feed conversion ratio (8.61) and the highest daily average gain of 58.93 g. However the animals fed Diet 2 had the highest nitrogen retension and converted their feed to flesh.

Key words: West African dwarf, *Enterolobium cyclocarpum,* dry matter intake, nutrient utilization, nitrogen balance

INTRODUCTION

Globally, there are problems related to ruminant animal feeding in terms of matching the available feed resources with their nutrient requirements and this has been a major concern of researchers, part of their effort to finding solution to this problem is the use of tropical browse and shrub legumes plant. Tropical trees and shrubs have great potentials to serve as feed resources for ruminant animals managed by small holder livestock farmers. They are less susceptible to climatic fluctuations (Dzowela *et al*., 1995) and they provide green foliage of high digestibility and protein contents when most forage resources are low in nitrogen (Preston and Leng, 1987), but they have been found to contain antinutritional factors which tends to affect both their intake and digestibility (Babayemi *et al*., 2006). *Enterolobium cyclocarpum* is a legume tree which belongs to the family mimosadeae (Janzen, 1981). The legume is easily established and fast growing to maturity over a short period of time than the most common legume plants in Nigeria and can be used in intensive feed garden in some parts of Nigeria (Ezenwa, 1998). Its agronomic potential has been exploited. Also as a leguminous multipurpose plant, it has the potential of fixing atmospheric nitrogen into the soil and can also be exploited for feeding of ruminant animals. Navas-Camacho *et al.* (1993) also reported feeding the leaves of *E. cyclocarpum* to sheep but in the southwest of Nigeria, *Enterolobium cyclocarpum* foliage has not been accepted by sheep, goats and cattle possibly due to the presence of antinutritional factor. Most of the leguminous browse and shrubs produces seed and fruit which have been found containing higher crude protein and other nutrients. Studies have shown that the seeds produce higher volatile fatty acids on degradation by rumen microbial organisms which tend to be beneficial to ruminant animals (Babayemi *et al*., 2004a) showing the potential of browse tree seeds in livestock production. *E. cyclocarpum* (Ear pod tree) is a medium sized to a large tree growing to 25-30 m tall and with a trunk diameter up to 3.5 m. It is high in crude protein and other nutrients (Babayemi *et al*.,

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2004a) and the seeds contain an anti-nutritional factor. It should be noted that potential of these crop seeds has not been fully exploited for ruminant feeding. The aim of the present study therefore was to investigate the effect of feeding graded levels of toasted *E. cyclocarpum* seeds as a supplement to *Panicum maximum* on intake, weight gain and nitrogen balance in West African Dwarf (WAD) sheep.

MATERIALS AND METHODS

Experimental site: The study was carried out at the Small Ruminant Unit of the College of Animal Science and Livestock Production (COLANIM) University of Agriculture, Abeokuta (UNAAB), Abeokuta. The site lies within the derived savannah zone on latitude 7°N and longitude 3.5°E. The mean annual rainfall is 1037 mm while the annual temperature range is between 22.50-30.72°C. Relative humidity ranges from 63% in January to 96% in August with yearly average of about 82%.

Fruit collection and Seed toasting: The matured fruits of *Enterolobium cyclocarpum* were handpicked from the ground. The seeds were manually separated from the pods and then toasted using stove top toasting method. The seeds were heated in a dry, heavy skillet over medium heat for 20-40 min until they're dark brown in colour and they give off a rich, toasty fragrance. The seeds were stirred frequently for even toasting after which it was removed and allowed to cool; the toasting facilitated the peeling of the coat. The peeled seeds were then used for the trial.

Animals and their feeding: Four concentrate diets were compounded to contain toasted *E. cyclocarpum* seeds (0, 10, 20, 30% levels), soyabean meal, wheat offal, maize, brewer's dried grain and salt in the percentages as shown in Table 1. Fresh *Panicum maximum* was allowed to wilt and then chopped to between 2-4 cm lengths. The concentrate diets were offered to the animals individually based on their body weight (50 g kg^{-1} b.wt.) at 8:00 h while the chopped *P. maximum* was offered at 16:00 h.

Thirty two WAD sheep of the same sex of between 10-12 months old weighing an average of 12 kg were used for the trial which lasted for 12 weeks. The sheep were randomly divided into 4 groups of 8 animals and allocated to the treatment diets in a completely randomized design to evaluate the effects of the inclusion levels of toasted ECS in the concentrate diets on the voluntary intake, weight gain and performance of sheep using Elephant grass as the basal diet. The animals were dewormed and purged of external parasites using Ferbendazole and Pfizona, respectively and housed in individual pens and offered liberal but known quantities of the experimental diets for 14 days preliminary period to adapt the animal to the diets and pen environment, fresh water was made available *ad libitum*. After 2 weeks adaptation period to the diets, the data collection started.

Table 1: Composition of experimental diets

Ingredient (%)	Diet 1	Diet 2	Diet 3	Diet 4
ECS	0	10	20	30
SBM	30	20	10	0
Wheat offal	45	45	45	45
Maize	4.5	4.5	4.5	4.5
BDG	20	20	20	20
Salt	0.5	0.5	0.5	0.5
Total	100.00	100.00	100.00	100.00

The sheep were fed according to treatment group. Feed offered to each experimental animal ensured at least a 5% remnant in which both feed offered and refusals were weighed and recorded daily to determine the voluntary feed intake for both the concentrate and basal diets. At the twelfth week of the trial, four animals per treatment were randomly selected and housed individually for digestibility study in a metabolic pen under laid with a wire mesh to aid faecal collection using a flat wooden net. Two days acclimatization period was observed. At 8.00 am total faecal output was collected, total urine output and feed intakes were recorded over seven days period.

Chemical analysis: Feed remnants collected from the animals were dried in the oven at 65°C for 3 days to determine their Dry Matter (DM) contents. The dried samples were then ground with laboratory hammer mill to pass through 1 mm sieve and then preserved for chemical analysis. The proximate composition was determined according to AOAC (2006) while the Fibre fractions were determined according to Van Soest *et al.* (1991) procedure.

Statistical analysis: The data obtained were subjected to one-way analysis of variance (SAS, 2002) and the levels of significance between treatment means were determined with probability difference of SAS.

RESULTS AND DISCUSSION

Experimental diets: The proximate composition of concentrate diets offered to the sheep is presented in Table 2. The Dry Matter (DM) contents of the diets differ significantly ($p<0.05$) which increases from Diet 1-4 as percentage of toasted ECS increased in diets. The Dry Matter (DM) content of the concentrate diets were 90.20, 90.23, 90.64 and 90.76%, for Diet 1 to 4, respectively and these were comparable to 90.97% for Guiera senegalensis

Table 2: Proximate and fibre composition of experimental diets (%dm) fed to sheep

Parameter	P. maximum	Diet 1	Diet 2	Diet 3	Diet 4	SEM
Dry matter (DM)	41.48^{d}	90.20^{e}	90.23^{c}	90.64^{b}	90.76^{a}	5.24
Crude protein (CP)	10.62^{e}	16.64^{d}	17.22^{c}	18.30^{b}	18.43^{a}	0.77
Crude fibre (CF)	31.83^{a}	9.37^{e}	12.63^{d}	12.87^{c}	14.67^{b}	2.13
Ether extract (EE)	3.66^{d}	3.81^{c}	3.86^{c}	4.14^{b}	4.32^{a}	0.06
Ash	6.76^{e}	7.79^{d}	8.27^{c}	8.38^{b}	9.36^{a}	0.23

Table 3: Dry matter and nutrient intake of WAD sheep fed concentrate diets containing graded levels of *E. cyclocarpum* (g day^{-1})

	Levels of *E. cyclocarpum* seeds				
Parameters	0	10	20	30	SEM
TDMI	910.75^{a}	871.88^{b}	855.93^{c}	812.76^{d}	10.61
TCPI	139.48^{ab}	137.13^{b}	141.20^{a}	127.35^{c}	2.19
T.EEI	34.40^{a}	33.26^{c}	33.78^{b}	34.46^{a}	0.15
T.CFI	130.01^{c}	147.59^{b}	147.78^{b}	153.50^{a}	2.66
T. ASHI	67.25^{b}	67.74b	69.86^{a}	70.83^{a}	0.13

Means along the same row with different superscript are different p<0.05, TDMI: Total dry matter intake, TCPI: Total crude protein intake, T.EEI: Total ether extract intake, T.CFI: Total crude fibre intake, T.ASHI: Total ash intake

earlier reported (Muhammad and Garba, 2008). Increasing levels of ECS in the experimental diets (1-4) significantly influence (p<0.05) dietary compositions of CP and CF. The Crude Fibre (CF) values was least in the control diet (9.37%) and highest in diet 4(14.67%) and it has been reported that maximum dietary CF digestion in the rumen occurs when dietary CP is between 12 and 16% (McAllan, 1991; Sowande, 2004). The CF values across the concentrate diets are quite low which supports the report of FAO (eg. FAO 1983) that concentrates are feeds that contain a high density of nutrients, usually low in crude fibre content (less than 18% of Dry Matter (DM) and high in total digestible nutrients. The EE values of the diets increased with increasing level of toasted ECS, this may be due to the contributory effect of the toasted seeds which tends to increase the lipid contents of the seeds. The ASH values followed the same pattern of CF with the supplementation of the toasted E. cyclocarpum seeds. The Ether Extract (EE), Nitrogen Free Extract (NFE) and Gross Energy (GE) values were however similar (p>0.05) for all diets.

Table 3 shows the DM and nutrient intake of WAD sheep fed the experimental concentrate diets as supplement to *Panicum maximum*. The Dry Matter Intake (DMI) differs significantly (p<0.05) across the diets. Sheep on the control diet (diet 1) consumed 910.75 g day^{-1} which was the highest DM intake while the trend reduced with increasing levels of toasted *E. cyclocarpum* in the other diets. The significantly higher DMI observed for sheep fed the control diet in this study does not agree with the findings of previous studies. Findings have observed that diets low in protein depress intake (Ifut, 1988) and that diets with low energy makes animals consume more feed in order to meet up with their

Table 4: Performance and digestibility of WAD rams fed graded level of concentrate diets containing graded levels of *E. Cyclocarpum* (g day^{-1})

	Levels of *E. cyclocarpum* seeds				
Parameters	0	10	20	30	SEM
Initial weight	12.83	12.13	12.33	12.17	0.55
Final weight	16.07	15.27	15.50	14.93	0.66
Total weight	3233.33	3300.00	3166.67	2766.67	131.91
Daily weight gain	57.72	58.93	56.55	47.62	2.43
Feed efficiency ratio	0.10^{ab}	0.12^{a}	0.10^{ab}	0.08^{b}	0.01
Feed conversion ratio	10.65^{ab}	8.61^{b}	10.53^{b}	12.07^{a}	0.53
Nutrient digestibility (%)					
Dry matter	83.27^{a}	83.91^{a}	81.80^{b}	79.88^{c}	0.87
Crude fibre	74.34^{c}	78.26^{b}	76.76^{b}	75.97^{bc}	0.99
Ether extract	94.02^{a}	93.90^{b}	93.65^{b}	92.48^{b}	0.31
Crude protein	86.60^{b}	88.10^{a}	86.07^{b}	85.54^{b}	0.59
Ash	85.73^{b}	87.45^{a}	85.39^{b}	85.39^{b}	0.6

Means along the row with different superscripts are different (p<0.05)

energy requirement (Obioha, 1984). Contrary to these facts, diet 1, which had the least CP and the highest energy content of all diets was consumed most Also, this could be attributed to the decreasing palatability of the diets with increasing levels of toasted *E. cyclocarpum*. The intake of crude protein and crude fibre increased with increasing levels of toasted *E. cyclocarpum* supplementation. This could be attributed to the fact that the toasted *E. cyclocarpum* seeds is rich in protein and also the inclusion levels tend to increase the fibre content and this subsequently decrease the dry matter intake, ECS has been reported to contain high Crude Protein (CP) and Crude Fibre (CF) (Babayemi *et al*., 2006). Increasing levels of ECS in diets 2-4 increased the CP content and CF content, this may explain why the ECS diets were consumed less in relation to the control in this study. Meanwhile, among the ECS diets, diet 2 may have yielded the best-synchronized release of nitrogen and carbohydrate (Silva and Orskov, 1985) in the rumen required for microbial protein synthesis. This may have influenced the observed superior DMI for sheep on diet 2 and the observed poor but relatively higher nitrogen utilization value for animals fed same diet (2). The significantly higher EEI observed in sheep fed the diet 4 may be due to the increased level of toasted ECS which tends to decrease the digestibility of nutrients at this level of supplementation.

Performance: The data on performance characteristics of West African Dwarf (WAD) sheep offered diets containing graded levels of toasted *E. cyclocarpum* seeds as supplement for *Panicum maximum* is shown in Table 4. It was observed that the weight gain values decreased with increasing level of toasted *E .cyclocarpum* seed inclusion in the diet as the highest daily weight gain value (58.93 g) occurred at 10% level of supplementation and the least daily weight gain value (47.62 g) observed at

Table 5: Nitrogen Utilization of WAD rams fed graded level of concentrate diets containing graded levels of *E. cyclocarpum* (g day^{-1})

	Levels of *E. cyclocarpum* seeds				
Parameters	0	10	20	30	SEM
N intake (g day^{-1})	2.23^{b}	2.25^{a}	2.19^{c}	2.14^{d}	0.01
Feacal N (g day^{-1})	0.29	0.32	0.31	0.26	0.09
Urinary N (g day^{-1})	0.06^{d}	0.10^{a}	0.09^{b}	0.07^{c}	0.01
N Balance (g day^{-1})	1.93	1.93	1.92	1.82	0.02
N Balance (%)	86.37^{b}	87.76^{a}	86.00^{b}	85.37^{c}	0.03

Means along the row with different superscripts are different ($p<0.05$)

30% level of supplementation. The reduced feed consumption, weights and feed/BWgain as the level of ECS in the diets increased, demonstrate the negative effect of the toasted seeds of *E. cyclocarpum* on the sheeps' performance. Similar results have been reported by Iyayi *et al.* (2006) when they fed diets containing *E. cyclocarpum* and *M. pruriens* seed flour in place of soybean meals to broiler. The daily weight gain was not significantly ($p>0.05$) affected by the inclusion of toasted *E. cyclocarpum* seed in the diets, may be as a result of increased ether extract produced from the increasing level of supplementation of toasted *E. cyclocarpum* seeds.

The reduced digestibility of CP in the diets was implicated in the poor performance of animals on these diets. The higher digestibility of CP in the diet 2 is probably an indication that at low levels of replacement of toasted ECS by the sheep, ingested amounts of the major antinutrients in *E. cyclocarpum* e.g. Saponin, Phenols and steroids which tends to deter the activities of bacteria in the rumen and the extent to which the toasted seed will be fermented in the rumen are not enough to affect CP digestibility (Babayemi *et al.*, 2004b).

Nitrogen utilization: The nitrogen utilization of sheep offered diets containing graded levels of toasted *E. cyclocarpum* seeds as supplement for *Panicum maximum* is indicated in Table 5. Nitrogen intake (g day^{-1}) from diet (2) compared fairly well with the value derived for the control diet but differed significantly ($p<0.05$) from those of diets 3 and 4. The implication of this is that addition of toasted ECS in sheep diets at levels below 10% will not improve nitrogen intake. At higher levels however, nitrogen intake will improve but would be optimal at 20% ECS inclusion. ECS is a good source of nitrogen, which can be used to improve low protein-high energy feedstuffs.

Faecal nitrogen did not differ significantly ($p>0.05$) among the diets. The values obtained for sheep fed toasted ECS diets (2, 3, 4) were similar ($p<0.05$) and did not differ significantly ($p>0.05$) from those of sheep fed the control diet. This observation runs contrary to the findings of Black *et al.* (1973), who reported that faecal nitrogen was not affected by nitrogen intake.

Urinary nitrogen (g day^{-1}) values were higher for sheep fed toasted ECS in which diet 2 had the highest value, the differences were however, significantly different ($p<0.05$), when compared with the control. The higher value recorded for diet 2 may be due to the fact it is at this level that the best-synchronized release of nitrogen and carbohydrate (Silva and Orskov, 1985) in the rumen required for microbial protein synthesis can be accomplished since Urinary nitrogen is a function of nitrogen ingested, the more the N intake, the more the quantity excreted in the urine (Ibeawuchi *et al.*, 1993).

The sheep fed the graded levels of toasted ECS possessed a positive nitrogen balance required for body growth and maintenance with animals on diet 2 having the highest value (87.76%), followed by those on the control diet(86.37%) and diet 4 having the least value (85.37%). The positive nitrogen balance observed in all the animals suggested that nitrogen absorbed was well tolerated and utilized by the animals.

CONCLUSION

The results obtained from this study showed that toasted *E. cyclocarpum* seed at 10% level of supplementation is of good nutritional profile as a source of dry matter, crude protein, crude fibre, as well as nitrogen retention and feed/gain ratio when fed to WAD sheep without any deleterious effect on nutrient intake and digestion. It is therefore concluded that inclusion of toasted *E. cyclocarpum* seeds in small ruminant diets especially during feed scarcity will help to augment their nutrient intake and reduce the feed stress of the dry season therefore enhancing their performance and productivity.

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