

## NUTRITIVE VALUE OF TEPHROSIA CANDIDA SEED IN WEST AFRICAN DWARF GOATS

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### ABSTRACT

Groundnut-cake (GNC), Soybean-meal (SBM) and cottonseed-cake (CSC) are expensive protein sources for ruminants. This study examined the feeding value of unconventional protein source of *Tephrosia candida* seed (TCS) in WAD goats. Four diets were formulated using GNC, SBM, CSC and TCS protein sources and fed to WAD goats to monitor intake, digestibility and nitrogen utilization. Effects of feeding the diets as supplements on weight gain of grazing goats were also investigated. Results showed the dry matter intake (DMI) of the concentrate made from the conventional protein were not significantly different (mean = 101.0 g/d) but depressed in TCS diets (66.11 g/d). Crude protein intake (CPI, g/d) from TCS (16.67) was higher ( $P < 0.05$ ) than that of GNC (16.55) but was inferior to the CPI of both CSC (25.56) and SBM (19.72) diets. Intake of NDF (38.21 – 51.08 g/d) and ADF (17.84 – 28.97) varied ( $P < 0.05$ ) and followed the trend observed for CPI. Apparent digestibility of CP (%) was higher ( $P < 0.05$ ) in TCS (63.05) than values for both the SBM (58.2) and CSC (42.79) diets, but not the GNC (63.78). The best digested NDF (53.36%) and ADF (53.93%) were from GNC and TCS diets respectively. N-balance (g/d) and retention (%) compared favourably in TCS (1.42 and 53.2) with those of SBM (1.69 and 51.9) and GNC (1.41 and 53.2) but were significantly least ( $P < 0.05$ ) in CSC diet (1.34 and 32.6). Weight gain of grazing goats was highest (27.38 g/day) and lowest (7.74 g/day) in goats fed TCS and SBM respectively. *Tephrosia candida* seed can be used as a protein source ingredient as performance of goats on it was comparable to those of expensive GNC, SBM and CSC.

**Key words:** Protein ingredients, *Tephrosia candida*, performance characteristics, digestibility, nitrogen utilization, goats.

## **INTRODUCTION**

Much of the feeds and the feedstuffs that are available for ruminants during the dry season in Nigeria are low in quality and have been described to be fibrous, resulting in low digestibility and poor livestock productivity [23]. In Nigeria, the usual practice is to supplement the livestock diets with protein rich ingredients such as groundnut cake (GNC), soybean meal (SBM) and cotton seed cake (CSC). These ingredients are becoming scarce and expensive because of various competitive uses for them. A cheaper alternative of enhancing utilization of low quality grass is by supplementation with high nitrogen multipurpose trees [22]. In the light of this, research efforts [11; 12; 16] confirmed the efficacy of using browse trees for ruminant production in the tropics. Although browse plants are rich in protein and minerals, farmers are still skeptical in using them as high percentage of these legume trees contained certain antinutritional factors [15] that are repulsive (e.g. coumarin in *Gliricidia sepium* and momosine in *Leucaena leucocephala*) and also could be detrimental to the animals consuming them. Alternatively, there are pods and seeds of leguminous and non-leguminous trees and shrubs, otherwise known as unconventional feeds present in the tropics that may be beneficial to livestock. Among the numerous lesser-known plants, in which the seeds remain relatively unexplored for animal feeding is *Tephrosia candida*. Available report showed that *Tephrosia candida* is biennial and early maturing [6]. The dry matter degradability of the foliage is encouraging and a low release of crude protein was obtained when compared to other species [5]. Preliminary study [7] on the nutrient concentration of the seed showed that *T. candida* seed contained 38.2% CP, which may be capable of meeting the protein requirement of West African dwarf goats. Further study involving the in vitro fermentation of *T. candida* seeds [8], indicated the presence of phenols (condensed tannins) of moderate concentration and lower level of isovalerate in the seed, suggesting an advantage of by-pass protein for ruminants [10]. The present study was set up to investigate the utilization of *T. candida* seeds based concentrate by West African dwarf goats and the supplementary value of the concentrate to grazing goats in the dry season.

## **MATERIALS AND METHODS**

### **Experimental site**

The study was conducted at goat unit of the Teaching and Research Farm, University of Ibadan, Nigeria (7°20'N; 3°5'E; altitude of approximately 200 m above sea level) between January and April 2004. The time coincided with the pick of the dry season period in Nigeria. The unit is

of the conventional dwarf wall type, which permits cross ventilation. The roof is made of corrugated iron sheets, which prevents direct sun and rain from getting into the pens. The floor is made of concrete and wood shaving was used as bedding materials. In grazing, the goats were stocked on cultivated pasture established thirty years ago at a rate of 25 growing goats/ha. Coinciding with the period of the experiment was the pick of dry season, when most of the grass species had dried up. Pasture species that were predominant were *Panicum maximum* (59%), *Cynodon dactylon* (12%), *Penisetum purpureum* (7%), *Imperata cylindrica* (22%). The pasture was also comprised high percentage of forbs ranging from *Aspilia Africana* (14%), *Chromolaena odorata* (6%), *Ageratum conyzoides* (9%), *Amaranthus spinosus* (17%), *Tridax procumbens* (10%), *Combretum hispidum* and *Commelina spp* (3%). Included in the pasture were browse trees and shrubs named *Gliricidia sepium* (8%), *Azadiracta indica* (2%) and *Leucaena leucocephala* (6%).

### **Preparation of *Tephrosia candida* seeds**

*Tephrosia candida* seeds were obtained between late October and early December 2003 from the established plots of two-year-old *Tephrosia candida* plants at the Rockefeller unit of the Teaching and Research Farm, University of Ibadan. The matured pods were harvested by hand picking method into jute bags and the bags were kept in the sun for few days to achieve self-shattering of the pods. The seeds were separated from the husk by winnowing. They were thereafter milled raw and kept in an airtight container, until they were used in concentrate feed formulation.

### **Experimental animals and diets**

A total of thirty-two West African dwarf goats, all males were used for the study. The body weight of the animals ranged between 5.5 and 6.0 kg. The animals were purchased from a goat market within Ibadan metropolis, Nigeria, and were transported to the Farm. During the adaptation period, the animals were dewormed using an injectable levamisole (0.5 ml/10 kg body weight) against endoparasites and were dipped in a solution of diatol to control ectoparasites. They were also given antibiotics with vitamin B-complex at the dosage rate of 1 ml per 10 kg live weight intramuscularly and vaccinated against peste des petits ruminants (PPR). Feeding of the animals during the adaptation period was purely on dried cassava peels and Guinea grass, which were the feeds fed to them at the place of purchase. This was however, reduced gradually until the experimental diets were completely introduced. Four experimental diets were formulated based on cotton seed cake (CSC), groundnut cake (GNC),

Table 1: Ingredient composition (kg/100 kg DM) of the concentrate diets fed to the West African dwarf goats during grazing and digestibility studies

Ingredient	Type of concentrate			
	CSC	GNC	SBM	TCS
Cassava peel	30	55.2	53.2	30
Corn bran	10	12.5	12.5	10
Wheat offal	9.5	4.0	4.0	9.5
Cotton seed cake (CSC)	50	-	-	-
Groundnut cake (GNC)	-	27.8	-	-
Soybean meal (SBM)	-	-	29.8	-
<i>Tephrosia candida</i> seed (TCS)	-	-	-	50
Common salt	0.5	0.5	0.5	0.5

soyabean meal (SBM) and *Tephrosia candida* seed meal (TCS) and were made to be isonitrogenous (Table 1).

#### Digestibility and nitrogen utilization trials

The thirty-two experimental animals were divided into four groups to balance for weight and were allocated to experimental diets and metabolism cages in a completely randomized design. Daily feeds were served to meet 3% of their body weight and this was frequently adjusted to ensure that each animal received about 20% of feed above its previous day's consumption. Quantity of feed consumed was monitored as the difference between what was served and the left over in the troughs after 24 hours. The metabolic cages used were fitted with devices for collecting faeces and urine separately. Animals were allowed 7 days adaptation period before 7 days for sample collection. Total quantities of faeces and urine voided by each animal were collected and the amount determined appropriately. About 10 % aliquot of each day's collection of both the faeces and urine were taken, bulked and kept for laboratory analysis. Urine was stored in plastic bottle and 2 ml of 90% (v/v) tetra oxo sulphate six acid with distilled water was added to arrest microbial activities as well as volatilization loss of nitrogen.

#### Concentrate supplementation of grazing animals

This study lasted for 84 days, and it involved releasing all the thirty-two goats for grazing in the morning between 0830 to 1200 hrs and later served the experimental concentrate diets by 1330 hrs. Grazing was done jointly irrespective of the treatment group of the experimental animals, since the experiment was not to monitor the intake of the forage during grazing. The grassland consisted predominantly of natural pastures with some stands of shrub plants. Grazing goats were accompanied for four days in a week and forage plants consumed frequently were sampled, identified and prepared to be used in the laboratory analysis for chemical components. For feeding of concentrate supplement, the existing

animal group for each of the diet during digestibility and nitrogen utilization study was maintained, where allocation to individual pens was done randomly. Each animal was served concentrate supplement, based on 2% body weight. The left over was weighed the following morning to determine the intake of the supplements. Animals were also weighed on a weekly basis to monitor weight gain. The feed intake, digestibility and nitrogen utilization of goats were based on concentrate. The grass forage at the period of this study coincided with the peak of dry season when there was no appreciable grass that can be quantified. The grazing situation was more or less scavenged.

#### Chemical analysis

The dry matter content of concentrate feeds, forage and faeces was determined by drying pre-weighed samples at 100 °C until constant weight was obtained. A representative sample of the feeds and faeces collected was milled to pass through 1 mm mesh sieve and stored at room temperature pending the laboratory analysis. Two grams of milled samples in duplicates was used for chemical analysis. Nitrogen (N) in the feed, faeces and urine samples was then determined by the standard micro-Kjeldahl method [4], and the amount of crude protein was calculated as  $N \times 6.25$ . Organic matter (OM) content was obtained through the determination of the ash content using muffle furnace. Neutral detergent fibre (NDF) and acid detergent fibre (ADF) were determined as described [27] and NDF was expressed without residual ashing.

#### Statistical analysis

Data obtained were analyzed using one-way ANOVA according to the Statistical Analysis System [24]:  $Y_i = \mu + A_i + \epsilon_i$ , where  $Y_i$  is the studied parameters;  $A_i$  is the effect of protein supplements;  $\epsilon_i$  is the residual error. The significant means were separated by the use of Duncan multiple range F-tests.

**RESULTS AND DISCUSSION**

**Chemical composition of the concentrate**

The crude protein contents of the formulated concentrate diets from cotton seed cake (CSC), groundnut cake (GNC), soyabean meal (SBM) and Tephrosia candida seed (TCS) ranged between 16.09 and 17.02% (Table 2). The CP values were also higher than the 10 % recommendation for growth/maintenance in dairy goats [21]. Lactating ruminants that required 130 g/kg DM crude protein [20] are guaranteed adequate level of the nutrient from these diets.

**Digestibility of nutrients**

Apparent protein digestibility was not determined in the present study since it is not an adequate indicator to assess the protein value of diets for ruminants. The differences between diets are more likely to be a result of differences in fermentation of carbohydrates in the large intestine than the result of true protein digestibility. The only dietary protein fraction which directly contributes

the amino acids to the ruminant animals is the protein which escapes degradation in the rumen and is eventually digested in the small intestine. In Table 3 is the dry matter intake of concentrate by the goats after grazing period. Goats were supplied with CSC and SBM had considerably higher dry matter intake and more crude protein intake. Similar trend was observed for NDF and ADF. Table 3 also presents the apparent digestibility of NDF (ADNDF) and ADF (ADADF) of the concentrate diets. There were also significant ( $P < 0.05$ ) differences in ADNDF values, which ranged from 48.45 – 53.36 % and followed the pattern observed for ADCP. Impacted by the diet again was ADADF. Animals on diet containing TCS had significantly best ADADF. The ADNDF and ADADF obtained in the current study were similar to those reported elsewhere [17] for dairy weaner goats fed concentrate diets and for sheep fed maize stover supplemented with legume hay and cottonseed cake [13] but lower than those obtained for sheep fed grass silage with concentrate [1].

Table 2: Chemical composition (g/100 g DM) of the concentrate diets fed to the West African dwarf goat

Parameter	Type of concentrate			
	CSC <sup>a</sup>	GNC <sup>b</sup>	SBM <sup>c</sup>	TCS <sup>d</sup>
Dry matter	87.00	86.25	86.60	86.30
Organic matter	93.50	96.00	95.50	96.00
Crude protein	17.02	16.69	16.17	16.09
Neutral detergent fiber	29.1	38.6	41.9	42.7
Acid detergent fiber	13.5	18.0	20.5	20.5
Ash	6.5	4.0	4.5	4.0

<sup>a</sup>Cotton seed cake based concentrate, <sup>b</sup>Groundnut cake based concentrate, <sup>c</sup>Soyabean meal based concentrate, <sup>d</sup>Tephrosia candida seeds based concentrate

Table 3: Intake (g/d) and apparent digestibility (%) of some nutrients by goats fed concentrate diets containing different protein source ingredients

Parameter	Type of concentrate <sup>1</sup>				SEM
	CSC	GNC	SBM	TCS	
<b>Intake</b>					
Dry matter intake (g/day)	103.11 <sup>a</sup>	95.90 <sup>a</sup>	104.02 <sup>a</sup>	66.11 <sup>b</sup>	8.290
Crude protein	25.56 <sup>a</sup>	16.55 <sup>d</sup>	19.72 <sup>b</sup>	16.67 <sup>c</sup>	0.03
Neutral detergent fibre	45.57 <sup>b</sup>	38.21 <sup>d</sup>	51.08 <sup>a</sup>	44.22 <sup>c</sup>	1.29
Acid detergent fibre	28.97 <sup>a</sup>	17.84 <sup>d</sup>	24.99 <sup>b</sup>	21.23 <sup>c</sup>	0.47
<b>Digestibility</b>					
Neutral detergent fibre	48.45 <sup>d</sup>	53.36 <sup>a</sup>	50.27 <sup>c</sup>	52.96 <sup>b</sup>	1.37
Acid detergent fibre	41.72 <sup>d</sup>	52.35 <sup>c</sup>	53.62 <sup>b</sup>	53.93 <sup>a</sup>	0.16

*abcd* = Means on the same row with different letters are significantly different ( $p < 0.05$ ).

<sup>1</sup>Concentrate diets are as described in Table 2

### Nitrogen utilization

Dietary effect was noticed on the nitrogen utilization by the experimental goats (Table 4). Goats on CSC had significantly ( $P < 0.05$ ) higher N intake than those consuming SBM, and TCS, which in turn exhibited higher value than goats on GNC. Faecal and urinary nitrogen output of the animals showed significant variations based on the treatment. More N was excreted in the faeces of animals that consumed CSC but low in those goats fed TCS. A similar trend was observed for values of nitrogen output in the urine. Total N output ranked as CSC > SBM > GNC or TCS, the last two concentrate diets, being similar ( $P > 0.05$ ). All animals had positive N balance and was significantly varied among the diets, following the trend SBM > TCS > GNC > CSC. The nitrogen balance recorded (1.34 – 1.69 g/day) for goats in the present study were lower than 2.23 – 3.50 g/day reported by [18] for goats fed soy bean based diets. However, this is similar to 0.9 – 2.0 g/day reported by [3] for goats fed sole diet of Guinea grass or in mixture with *Ficus religiosa* [9]. The N-retention obtained ranged between 32.6 – 53.2% and was similar to 37.11 – 58.33% reported for dairy goats fed concentrate diets [17]. Nitrogen balance is a good indicator of protein value of the diet only when the amino acid supply is balanced with the energy supply. If there is a surplus of metabolizable protein amino acids are oxidized and N is excreted irrespective of the real protein value of the diet.

### Chemical composition of the forages grazed

Table 5 presents the list and chemical composition of forages frequently consumed during the grazing period. The crude protein content of Panicum maximum and Cynodon dactylon was 7.35 and 9.2% respectively. These values were within the range of 5.64 - 8.32% and 5.39 – 10.16% reported for Panicum maximum and Cynodon dactylon respectively by Rechar et al [23] during the

dry season. The CP of Panicum and other grasses, which were below the requirements of goats, suggested a need for supplementation with protein concentrate diets. These grasses also contained high level of fibre (43 - 52 % NDF and 27.6 – 28.2 % ADF). High fiber content is a known characteristic of tropical forages in the dry season [19]. *Leuceana leucocephala*, *Combretum hispidum* and *Azadiracta indica* were found to contain 19.91%, 15.4% and 17.4% CP respectively. The CP values were of reasonable level but experimental animals may not consume enough from them, probably due to their contents of some secondary metabolites. Ademosun [2] and [27] reported lower levels of 19.53% and 18.88% CP for *Leucaena* and *Azadiracta* foliages. The NDF and ADF contents of the browse ranged from 38 – 45 % and 38 – 29.1 % respectively.

### Feed intake and live weight gain

Presented in Table 6 is the feed intake and weight gain of goats fed concentrate diets containing different protein source ingredients. The animals fed CSC, GNC and SBM based diets had similar ( $P > 0.05$ ) feed intake and were all significantly ( $P < 0.05$ ) higher than values obtained from those fed on TCS diet. The weight gain of the goats, which ranged between 7.74 and 27.38 g/day varied significantly ( $P < 0.05$ ). Weight gains was highest in animals fed diets containing CSC and lowest in for goats on SBM. The impressive weight gain recorded for goats fed on TCS diet, despite the low intake, indicates a better utilization of the test diet. *T. candida* seed had been reported to contain condensed tannins [7]. Although high level of tannin generally depresses voluntary feed intake [26; 14; 10] but a low content is beneficial to ruminants as it produces a by-pass protein effect [8]. It has been reported in previous study that feeding protein sources with low ruminal digestibility to rapidly growing cattle increased daily gain per unit of test protein consumed

Table 4: Nitrogen utilization by goats fed concentrate diets containing different protein source ingredients

Parameter	Type of concentrate <sup>1</sup>				SEM
	CSC	GNC	SBM	TCS	
Nitrogen intake (g/day)	4.09a	2.65d	3.16b	2.67c	0.005
Nitrogen output (g/day)					
Faecal	2.34a	0.96d	1.32b	0.98c	0.001
Urinary	0.41a	0.28b	0.20d	0.27c	0.001
Total	2.75a	1.24c	1.52b	1.25c	0.063
Nitrogen balance (g/d)	1.34c	1.41b	1.69a	1.42b	0.015
Nitrogen retention (%)	32.6b	53.2a	51.9a	53.2a	1.07

abcd = Means on the same row with different letters are significantly different ( $P < 0.05$ )

<sup>1</sup>Concentrate diets are as described in Table 2

Table 5: Chemical composition (g/100 g DM) of the forages of *Panicum maximum* (PM), *Cynodon dactylon* (CD), *Azadiracta indica* (AI), *Leucaena leucocephala* (LL) and *Combretum hispidum* (CH) grazed by West African dwarf goats

Nutrient	Type of forage				
	PM	CD	AI	LL	CH
Dry matter	30.71	27.60	34.43	25.88	43.37
Organic matter	92.88	91.04	94.94	89.00	93.12
Crude protein	7.35	9.20	17.40	19.91	15.40
Ash	7.12	8.96	5.06	11.00	5.88
Neutral detergent fibre	52.00	43.00	41.00	38.00	45.00
Acid detergent fibre	28.2	27.6	29.10	28.9	28.00

Table 6: Performance characteristics of goats fed different concentrate diets as supplement after daily grazing on natural grassland

Parameter	Type of concentrate <sup>1</sup>				
	CSC	GNC	SBM	TCS	SEM
Initial weight (kg)	6.0	5.5	6.3	6.0	
Final weight (kg)	7.5	6.5	6.9	8.3	0.640
Weight gain (kg)	1.5 <sup>b</sup>	1.0 <sup>c</sup>	0.6 <sup>d</sup>	2.3 <sup>a</sup>	0.280
Weight gain (g/day)	17.86 <sup>b</sup>	11.91 <sup>c</sup>	7.74 <sup>d</sup>	27.38 <sup>a</sup>	3.070
Dry matter intake (g/day)	103.11 <sup>a</sup>	95.90 <sup>a</sup>	104.02 <sup>a</sup>	66.11 <sup>b</sup>	8.290

abc= Means on the same row with the same superscripts are not significantly different ( $P > 0.05$ ).  
<sup>1</sup>Concentrate diets are as described in Table 2

and feed efficiency [29]. The weight gains of the animals in the present study were generally low compared to the reported values of 36.44 – 41.14 g/d [17] and 20 – 23.8 g/d [3] for goats raised on concentrate diets. West African dwarf goats are noted for slow growth as they are naturally smallish when compared to those of other breeds in the temperate. However, the weight gains were similar to 11.16 – 17.86 g/day reported by Ogunmoye [18] for WAD goat fed soyabean-based diets. *Tephrosia candida* is suspected to have tannin content that could be below the threshold level for small ruminant, which

could be beneficial to animals consuming them through the production of by-pass protein effects. By-pass protein has been noted to improve the nitrogen availability in the gut [10] with consequent improvement in weight gain. Limitation to the present study was the rumen degradation of crude protein in the *Tephrosia candida* seed, which would have provided information on the true nature of the protein as relates to the gastro-intestinal system of the goats. Further studies should be carried out to elucidate the rumen and abomasal degradation of crude protein content in the seed.

**CONCLUSION**

Tephrosia candida seed based concentrate may not be as much consumed by goats as those formulated with soyabean meal, groundnut cake and cotton seed cake, it guaranteed adequate consumption and digestibility of crude protein, neutral detergent fibre and acid detergent fibre comparable or even better than those of conventional protein source ingredients. The nitrogen content of Tephrosia seed concentrate was well utilized with minimal losses in both urine and faeces leading to better nitrogen balance and retention values. Supplementary feeding of grazing goats with Tephrosia candida seed based concentrate can produce a better weight gain of goats in the dry season. More studies should be done to examine the amino acid content of the seed and its release in the rumen and abomasums.

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