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Influence of the Browse Plant *Gliricidia sepium,* supplemented with Concentrate Feed on Food Intake and Growth of West African Dwarf Goat Kids

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Key words: Goat - Basal Browse Diet - Concentrate Supplementation.

Summary

Twelve West African Dwarf goat kids, 5 to 6 months old and weighing between 6.20 to 6.63 Kg. were used in the comparison of three dietary treatments involving a basal browse plant Gliricidia sepium *or the same diet supplemented with concentrate feed at 25% and 50% ad libitum dry matter (DM) intake level.*

Kids maintained on Gliricidia sepium *alone ($G_{100}C_0$) ingested significantly (P<0.05) more DM to appetite (294.7±14.94 g/day) than kids maintained on either 75%* Gliricidia sepium *plus 25% concentrate ($G_{75}C_{25}$) or 50%* Gliricidia sepium *plus 50% concentrate $(GC)_{50}$ (236.3±14.31 and 233.8±4.74 g/day respectively).*

The digestibility of the basal browse plant diet was influenced by levels of concentrate feed supplementation. Crude fibre was best digested in diet $G_{100}C_0$, moderately digested in diet $G_{75}C_{25}$ and poorly digested in diet $(GC)_{50}$. Goat kids on diet $(GC)_{50}$ had slightly (P> 0.05) greater liveweight change (0.7 kg) than either kids on diets $G_{100}C_0$ (0.6 kg) or $(GC)_{50}$ (O.6 kg)

Results showed that the utilization of the browse plant Gliricidia sepium *by the goat kids was economically desirable when fed at 75 % browse plus 25% concentrate.*

Résumé

Douze jeunes chèvres naines ouest-africaines âgées de 5 à 6 mois et pesant entre 6,20 et 6,63 kg ont été utilisées pour comparer trois régimes alimentaires de Gliricidia sepium *et comportant une proportion croissante d'aliments concentrés (0%, 25% et 50% de la m.s.) disponibles à volonté.*

Les jeunes chèvres se nourrissant uniquement de Gliricidia sepium *ont ingéré significativement (P<0,05) plus de matière sèche (294,7 + 14,9 g/jour) que les animaux dont le régime se composait également d'aliments concentrés. Chez ces derniers, la consommation de matière sèche a été respectivement de 236,3+14,3 g/jour pour le régime contenant 25 % de concentré et de 233,8+4,7 g/jour pour le régime contenant 50 % de concentré.*

La digestibilité du fourrage de base a été influencée par l'importance de la teneur du régime en aliments concentrés. La digestion des fibres brutes a été d'autant meilleure que le régime était pauvre en aliments concentrés. Les jeunes chèvres recevant l'alimentation la plus riche en concentrés ont montré un gain de poids (0,7 kg) légèrement supérieur (P>0,05) aux autres traitements (0,6 kg pour chacun des deux autres traitements).

Ces résultats ont montré que l'utilisation de Gliricidia sepium *par des jeunes chèvres était la plus rentable quand le fourrage de base était additionné de 25% d'aliments concentrés.*

Introduction

The feeding habit of goats had been variously described in the literature. They are able to utilize browses in the ecosystem. The food habits of deer and goats are similar, but differ from sheep and cattle (16). Furthermore goats are intermediate selector feeders lying between sheep, which prefer grass but will browse and deer, which primarily browse but consume grass (14). The consumption of browse by goats increase during the dry season in areas characterized by distinct wet and dry seasons, chiefly because these plant species maintain green foliage of considerable nutritive value and protein content (12). Goats also will increasingly rely upon species of poor palatability when subjected to conditions of increasing stocking rate, but yet conditions of extreme forage scarcity would not be sufficient to force significant use of unpalatable species (22). Goats are thus extremely flexible in their feeding habits, opportunists in

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exploiting ephemeral types of food and at the same time fastidiously selective in their dietary habits.

Gliricidia sepium is one of the browse plants goats consume with apparent relish. Its productivity and use as an animal feed had been studied in Sri-Lanka (5). Its use in the nutrition of adult West African Dwarf (WAD) goats has been reported in Nigeria (4). *Gliricidia sepium* is a perennial leguminous plant which originated from South America. It is widely established in most parts of Nigeria from the temperature range of about 22°C during the coldest months to about 40°C during the hot periods of the year and a mean annual rainfall of 750 mm to over 2000 mm. It is fast growing plant able to thrive well on low fertile soils.

Browse plants alone cannot constitute a complete food for goats and so they should be given adequate attention in the feeding management of goats

Among the domestic ruminants, goats have faster rate of passage of food materials through the digestive tract (rumino-reticular retention time) than sheep or cattle. It is recommended that goats should be given more concentrate supplementation in the diet than cattle, because their digestive tract size is smaller relative to their maintenance energy needs (14).

The objective of this study is to appraise the effect of the feeding of the browse plant, *Gliricidia sepium* plus concentrated feed supplementation at moderate (25%) and high (50%) levels on the dry matter intake, nutrient digestibility and growth of WAD goat kids.

Material and Methods

Twelve WAD goat kids between 5 to 6 months old and weighing between 6.2 kg to 6.6 kg were maintained on three dietary treatments at the University of Ibadan Teaching and Research Farm, to study their dry matter intake (DMI), nutrient digestibility and growth performance.

The experimental diets comprised a basal browse plant leaves (including the soft terminal stem, to mimic the eating behaviour of the animals) of freshly cut *Gliricidia sepium* supplemented with concentrate feed at moderate (25%) and high (50%) levels of browse DMI *ad. lib.* The centesimal and proximate chemical composition of the concentrate feed and browse plant are presented in Table 1.

Table 1: Centesimal and chemical composition of concentrate feed and browse plant, *Gliricidia sepium.*

(a) Centesimal composition

Ingredient (%)	Concentrate feed
Cassava flour	55.0
Dried brewers grain (milled)	36.0
Molases (non-dehydrated)	5.0
Urea	2.5
Salt (NaCl)	1.0
Mineral/Vitamin mixture*	0.5
Total	100.0

*Mineral/Vitamin mixture: Content in g/kg: Manganese 16.0; Zinc 12.0; Iron 6.0; Copper 4.0; Cobalt 0.30; Iodine 1.20; Magnesium 200.0; Vitamin A 0.50 IU and Vitamin D 0.25 IU.

(b) Chemical composition

Constituent on a DM basis	Concentrate	Browse leaves (plus soft-terminal stem) *Gliricidia sepium*
Fresh weight dry matter	-	27.46
Residual dry matter (DM)	95.50	93.36
Organic matter (OM)	92.00	86.19
Crude protein (CP) N X 6.25	12.60	19.34
Crude fibre (CF)	15.71	27.79
Ether extract (EE)	4.71	8.05
Nitrogen free extractives (NFE)	58.98	31.01
Ash	3.50	7.17
Phosphorus	1.84	0.17
Calcium	0.94	0.65
Magnesium	0.27	0.39
Sodium	1.05	0.13
Manganese	0.35	0.34
Gross energy (Kj/100g)	2238.44	2292.83

Four kids (two males and two females) were randomly assigned to each of three dietary treatments listed below:

i. Basal browse plant *(Gliricidia sepium)* feed alone Treatment $G_{100}C_0$

ii. 75% browse plant plus 25% concentrate feed Treatment $G_{75}C_{25}$

iii. 50% browse plant plus 50% concentrate feed Treatment $(GC)_{50}$.

Goat kids on treatment $G_{100}C_0$ were started on the diet 3 days a head of other treatments and the subsequent mean DM1 of browse plant *ad. lib.* was used to estimate concentrate feed supplementation for dietary treatments $G_{75}C_{25}$ and $(GC)_{50}$. All goat kids were housed in individual pens littered with wood shavings and were fed twice a day at 0800 and 1500 hours. They were weighed before the experiment and at weekly interval before the morning feed for three months. All goat kids had free access to daily fresh water supply and salt lick.

At the end of three months on the diets, the kids were transferred to individual metabolism cages (Fig 1 and plate 1) adapted after the type described for lambs (21). The metabolism cages were designed to trap faeces voided in trays of closely knit mesh which can be withdrawn for collection of faeces. These removable trays retain all faeces but permit urine to drain freely on to urine channels below.

The animals were allowed a preliminary period of ten days, followed by a seven day collection period. Total faeces voided daily were weighed and dried in a forced-draught oven at 70°C for 36 hours. These daily stored samples were then bulked for each animal at the end of the collection period and weighed, milled with Christy and Norris hammer mill and stored in airtight bottles at room temperature until required for chemical analysis. The urine excreted by each animal was collected in urine collection bottles wetted with 2 to 3 ml of 10% mercuric chloride. The volume of urine excreted by each animal was measured daily and 10% of the daily samples were stored at - 5°C in a deep freezer till the end of the collection period, when these

Key :

A : Feed trough
(Partioned : A^1, for concentrate feed
A^2, for grass/browse plant)
B : Water trough
C : Feed trough for grass/browse plant only
D : Removable tray to trap faeces (partially drawn out)
E : Urine channel
F : Urine collecting bottle
G : Cover (expanded metal 2x2 cm)

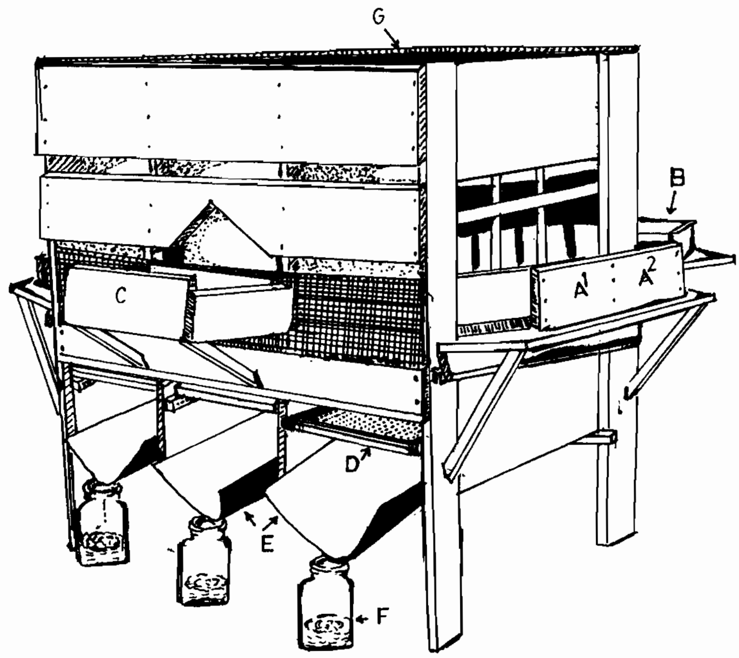

Figure 1 : 3-unit metabolism cage for young West African Dwarf goats weighing between 2 to 8 Kg.

were bulked, mixed and used for chemical analysis.

Samples of concentrate feed, browse plant and faeces were analysed for their proximate chemical composition (2). The energy contents of the food and faeces were determined using ballistic bomb calorimeter (A. GallenKamp, London). All data on feed intake, digestibility and liveweight change were analysed statistically using completely randomized design and significant difference between treatment means were determined according to Duncan's multiple range test (8, 20)

Results

The summary of DMI by the WAD goat kids is presented in Table 2. The DMI by goat kids on treatment $G_{100}C_0$ expressed either as g DMI/day or on metabolic weight (g DMI/day/W0.75kg) were significantly ($P<0.05$) higher than for those on treatments $G_{75}C_{25}$ or $(GC)_{50}$ The DMI expressed as the percentage of liveweight across all treatment groups was about 3.6±0.33%.

The summary of nutrients intake and digestibility by the WAD goat kids are presented in Table 3. The daily consumption of organic matter (OM), crude protein (CP), crude fibre (CF), ether extract (EE), and gross energy (GE) by goat kids on treatment $G_{100}C_0$ were significantly ($P<0.05$) higher than for kids on treatments $G_{75}C_{25}$ or $(GC)_{50}$. The consumption of nitrogen free extract (NFE) by kids on treatment $(GC)_{50}$ was significantly ($P<0.05$) higher than the amounts consumed by kids on treatment $G_{100}C_0$ and which was in turn significantly ($P<0.05$) higher than for kids on treatment $G_{75}C_{25}$. The mean CP consumption per day decreased with increasing levels of concentrate supplementation in the diet while CF intake increased with increasing levels of browse.

The digestibility coefficients of the three test diets were greatly modified by the nutrient composition of the diets. Diet $(GC)_{50}$ favoured relatively high dige-

Table 2: Dry matter (DM) intake by WAD goat kids maintained on three dietary treatments.

	$G_{100}C_0$	$G_{75}C_{25}$	$(GC)_{50}$
Mean initial liveweight (before metabolism studies) kg.	6.8±0.21	7.2±0.39	6.9±0.34
Mean final liveweight (after metabolism studies)	6.9±0.28	7.5±0.43	7.3±0.38
Mean liveweight	6.9±0.24	7.3±0.40	7.1±0.36
Mean liveweight (W0.75 kg)	4.1±0.11	4.3±0.18	4.2±0.16
Dry matter (DM) consumption from *Gliricidia sepium* g/day	295±14.94	179±14.31	119±4.74
Dry matter (DM) consumption from concentrate feed	—	57± 0.00	115±0.00
Total dry matter intake	295±14.94[a]	236±14.31[b]	234±4.74[b]
Total dry matter consumption as % of mean liveweight	4.3±0.23	3.2±0.27	3.3±0.17
Total dry matter consumption g/W0.75 kg	71±3.59	55±3.97	56±2.27
Dry matter consumption g/100 kg liveweight	4267.31	3229.62	3307.79
	±133.48	±151.88	±100.30

Means with same superscript in a row are not significantly different ($P>0.05$)

Table 3: Nutrient intake and digestibility coefficient by WAD goat kids maintained on three dietary treatments.

	TREATMENTS		
	$G_{100}C_0$	$G_{75}C_{25}$	$(GC)_{50}$
NUTRIENT INTAKE:			
Dry matter (DM) g/day=	294.7±14.94^{a}	236.3±14.31^{b}	233.8±4.74^{b}
Organic matter (OM)	254.0±12.88^{a}	207.1±12.42^{b}	208.2±4.09^{b}
Crude Protein (CP)	57.0±2.91	48.1±2.80	43.7±0.92
Crude Fibre (CF)	81.9±4.15^{a}	58.7±3.96^{b}	51.1±1.31^{b}
Ether extract (EE)	24.1±1.22	17.1±1.15	15.0±0.38
Nitrogen free extractive (NFE)	91.1±4.82	83.2±4.48	98.3±1.47
Gross energy (GE) KJ/day	5732.3±42.86^{a}	5382.3±91.56^{b}	5297.6±30.00^{b}
DIGESTIBILITY COEFFICIENT:			
Dry matter %	61.7±2.54	59.8±3.27	65.1±1.22
Organic matter	57.5±7.78	62.3±3.18	67.6±1.14
Crude Protein	59.6±1.98	62.1±1.72	60.9±0.61
Crude Fibre	71.0±1.77	69.3±2.68	62.2±1.13
Ether extract	50.0±8.88^{b}	49.7±5.31^{b}	69.5±1.94^{a}
Nitrogen free extractive	63.2±6.18^{b}	60.2±6.65^{b}	73.1±2.92^{a}
Gross energy	60.0±4.33	47.5±2.60	53.4±0.77

Mean values with same superscript in a row are not significantly different (P>0.05)

stibility coefficients of the DM, OM, EE, NFE and GE, the digestibility coefficient of the CP was intermediate and low for the CF. Diet $G_{75}C_{25}$ favoured relatively high CP digestibility coefficient, intermediate digestibility coefficient of the OM and CF and low digestibility coefficient of the DM, EE, NFE and GE. The digestibility coefficient of CF in the diet $G_{100}C_0$, was relatively high, intermediate for the DM, EE, NFE and GE and low for the OM and CP digestibility coefficients.

The summary of the 2 - weekly liveweight of the WAD goat kids is presented in Table 4. There was no significant (P>0.05) difference between the liveweight change of the animals at the 13th week at which time goat kids on treatment $(GC)_{50}$ had slightly greater (P>0.05) liveweight change (0.7kg) than those on treatments $G_{100}C_0$ (0.6kg) and $G_{75}C_{25}$ (0.6kg)

Discussion

The DM of goats is a primary consideration since it indicates their capacity, in terms of voluntary intake, to utilize food. Goat kids maintained wholly on basal browse plant alone ($G_{100}C_0$) consumed significantly (P<0.05) more DM than those supplemented with concentrate feed either at 25% or 50% levels, because a relatively higher DMI aids the goat in maintaining itself under conditions of poor feed. The DMI by the goat kids on treatment $G_{100}C_0$ was however lower than the intake of 446.0±101.8 g/day by adult WAD goats fed with *Gliricidia sepium ad. lib.* (4). This might be due to age difference because highly significant correlation (r = 0.94; P <0.01) exist between liveweight and DMI (7). The DMI per day expressed as the percentage of liveweight across the experimental group of animals was about 3.6±0.33%.

It has been observed that the gastro-intestinal tract size is proportional to body size and that equivalent intake should be calculated on the basis of body weight rather than on metabolic size (14), hence the mean DMI in g per 100kg liveweight of goat kids in this study ranged from 3296 g/day to 4275 g/day. The lower range was similar to 3057 g/day/100 kg liveweight (approximately 3%) for Jamunapari goats (11), but higher than 2750g/day/100 kg liveweight (approximately 2.7%) for Kambing Katjang goats (6). A wide range of variation on the DMI of goats had been reported and these are attributed largely to age of the animals and composition of the feed fed, while breed differences appeared to be a less important factor (17). Regional differences (temperate Vs tropical areas) on the DMI of goats exist but small (17). DMI of 5 to 7% of liveweight had been advocated for the temperate breed of goats (10). However, as high or higher intakes had been reported for tropical breed of goats. For example, Barmer goats of India consumed 8.2% of body weight when fed with *Cenchrus ciliaris* hay (9) and Red Sokoto goats of Nigeria averaged 7.3% on a mixture of *Cynodon nlemfuensis* hay and groundnut cake (13). The quality of the DMI is the most important factor determining feed nutrients ingested in order to achieve maintenance requirements.

The ability of the young ruminants to digest nutrients in the three test diets is indicated in their relative digestibility coefficients. The browse plant diet, *Gliricidia sepium* fed alone ($G_{100}C_0$), had relatively high digestibility of CF, intermediate digestibility of DM, EE, NFE and GE and low digestibility of OM and CP. The breakdown of cellulose and other resistant polysaccharides by rumen micro-organisms is undoubtedly the most important process taking place in the rumen.

It represents a gain to the animal, contributing to the energy supply of the animal and ensures that other nutrients which might escape digestion are released

Table 4 : Mean 2-weekly liveweight of WAD goat kids maintained on three dietary treatments.

	LIVEWEIGHT (Kg)						
TREATMENTS	Beginning	Week 3	Week 5	Week 7	Week 9	Week 11	Week 13
$G_{100}C_0$	6.2±0.23	5.7±0.08	5.5±0.78	5.3±0.05	5.5±0.12	6.0±0.21	6.8±0.21
Liveweight change		-0.05	-0.7	-0.9	-0.7	-0.2	+0.6
$G_{75}C_{25}$	6.6±0.40	6.0±0.18	6.0±0.38	6.4±0.41	6.7±0.46	6.9±0.39	7.2±0.39
Liveweight change		-0.6	-0.6	-0.2	+0.1	+0.3	+0.6
$(GC)_{50}$	6.2±0.14	5.7±0.22	5.8±0.39	6.0±0.44	6.3±0.35	6.5±0.35	6.9±0.32
Liveweight change		-0.5	-0.4	-0.2	+0.1	+0.3	+0.7

from the plant cells and exposed to enzyme action since cellulose cannot be utilized further along the tract. The CF digestibility of the diets (62.2±1.1% to 71.0±1.8%) were higher than 48.2% to 58.6% for WAD forest sheep fed with different concentrate and grass ratios (1), but lower than 79 % for WAD sheep fed with *Panicum maximum* (18).

The addition of 25% concentrate feed to the basal browse plant (diet $G_{75}C_{25}$), favoured relatively high digestibility of CP, probably due to enhanced utilization of nitrogen in the form of ammonia in the rumen, because availability of soluble carbohydrate, particularly starch from cassava in the diet, supply the rumen bacteria with energy needed for protein synthesis, which in ruminant digestion produces a net gain to the host animal. The digestibilities of OM and CF were intermediate and low for DM, EE, NFE and GE.

At 50% supplementation of the browse plant with concentrate feed, diet $(GC)_{50}$ favoured relatively high digestibility of DM, OM, EE, NFE and GE, the digestibility of CP was intermediate while the digestibility of CF was low. The low digestibility of CF could be due to increasing amounts of soluble carbohydrate in the diet which is more readily available to the rumen microorganisms resulting in depressed fermentation of cellulose as source of energy. Thus, fermentation rate may not be the entire source of energy for these small ruminants and diets that pass rapidly through the rumen provide soluble energy sources to the lower tract (17). The results of nutrient digestibility coefficients of diet $(GC)_{50}$ seem to emphasize the obvious point that when the diet contains a large portion of soluble nutrients, fermentation extracts less energy than direct digestion. Only when an appreciable amount of energy is present in the cell wall fraction does fermentation in the foregut becomes advantageous.

The rate of liveweight gain by the WAD goat kids was very slow. All goat kids generally lost weight soon after they were placed on the experimental diets, because they were obtained from a flock fed well by the University farm. They later on recovered to gain on the average about 26 g/day by the 13th week. Supplementation of browse plant with concentrate feed led to faster rate of recovery. Reported average daily gains for goats show an extreme range from about 18 g/ day for native breeds to more than 200 g/day post weaning for improved breeds on high plane of nutrition (13). Differences among breeds in size at maturity, as well as other factors affect growth rate. The WAD goat compared to other breeds of goat is small in size reaching only about 20 kg liveweight at maturity in the tropical forest belt (7). Goat kids maintained on diet $(GC)_{50}$ had slightly greater (P>0.05) liveweight change (0.7kg) than those on diets $G_{100}C_{0}$ (0.6kg) or $G_{75}C_{25}$ (0.6kg). These results indicate that supplementation of the browse plant with concentrate feed was necessary for better liveweight performance by the goat kids. However the level of concentrate feed supplementation in this study was found to be economically desirable at 25%, because diet $G_{75}C_{25}$ not only favoured moderate digestibility of CF in the diet but also produced similar liveweight change to diet $(GC)_{50}$.

Conclusion

This study undertaken to evaluate the supplementation of the browse plant, *Gliricidia sepium* with concentrate feeds at moderate and high levels revealed differential effects on DMI, nutrients digestibility and liveweight change of the WAD goat kids. The DMI by goat kids maintained on the browse plant alone was significantly higher than those supplemented with concentrate feeds, but this did not reflect to better liveweight change. The digestibility coefficients of the experimental diets were not only influenced by the basal browse plant feed but also by the level of supplementation with concentrate feeds. The pattern of liveweight change by the WAD goat kids clearly indicated that supplementation of *Gliricidia sepium* with concentrate feed was necessary for better liveweight performance.

Concerning the feeding of browse plants to goats, their importance in the tropics as a feed source arises from their stable protein and soluble carbohydrate content throughout the year compared with tropical grasses which form highly lignified cell walls and protein levels decline rapidly with maturity. The WAD goat farmer can thus utilize the advantages of relatively high nutrient stability of browse plants (*Gliricidia sepium* inclusive) over grasses especially in the dry season to feed their animals, plus moderate supplementation with concentrate feed, at no more than 25%, for better liveweight performance.

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