The intake, digestibility and utilization for weight gain of *Gliricidia sepium* by goats were increased by supplementation with cassava peels.

INTRODUCTION

Goats are one of the few important trypanotolerant livestock species in the humid zone of Nigeria. Many households in the humid parts of Nigeria keep an average of 4 to 5 goats while larger numbers are kept in the savanna parts of the country. The estimated goat population in Nigeria is 26.0 million (FAO, 1985).

One major constraint to goat production in Nigeria is the low level of available nutrients. The extent to which feed is available is a limitation to livestock production industry in Nigeria (Adegbola, 1982; Olubajo and Oyenuga, 1974).

Gliricidia sepium is a fast-growing, perennial, leguminous browse plant whose other desirable characteristics have been documented by Thomas (1961), Chadhokar (1982), Falvey (1982) and Sumberg (1984). Its utilization as livestock feed started receiving attention in Nigeria only fairly recently, for example by the International Livestock Centre for Africa (ILCA, 1983), Ademosun et al (1985), Mba et al (1982) and Onwuka (1983). It has 17.4 - 34.5% DM on 'as fed' on fresh basis; other contents on DM basis are OM (81.9 - 92.3%), crude protein (CP) (19.4 - 26.1%), NDF (30.8%), ADF (18.5 - 44.4%), crude fibre (CF) (12.7 - 32.5%) and lignin (7.3 - 29.6%) as reported by King (1986), Ngone (1985), Mani (1984), Onwuka (1983), Chadhokar and Sivasupiramaniam (1983), Carew (1983), Gbankoto (1982) and Oakes and Skov (1962).

Cassava peels are a major by-product of the cassava tuber processing industry. In parts of Nigeria where cassava is grown and the tubers processed, the peels are largely un - or under-exploited as livestock feed. Cassava peels have been reported to have the following composition: residual DM, 86.5 to 94.5%; OM, 89.0 to 93.9%; CP, 4.2 to 6.5%; and CF 10.0 to

31.8% (Onwuka, 1983; Carew, 1982; Adegbola, 1980; and Oyenuga, 1968).

The average intake of Gliricidia by goats has been reported as 21.3 (range = 10.8 to 31.8) $g.kg^{-0.75}.d^{-1}$ DM (Ademosun et al, 1985; Onwuka, 1983; Carew, 1983). Mba et al (1982) reported intake values ranging from 31.4 to 50.2% for kids on Gliricidia while Onwuka (1983) reported gains of 20 $g.d^{-1}$ for goats on sole Gliricidia diet.

Information on intake and utilization of cassava peels and Gliricidia fed together to goats is rather scanty. The perennial and multipurpose nature of Gliricidia and underutilization of cassava peels as goat feed, formed the basis of the present study. The research was, therefore, undertaken to investigate the influence on intake, digestibility and utilization of cassava peels with Gliricidia sepium fed to WAD goats.

MATERIALS AND METHODS

Animals and their management

Twelve intact bucks, aged 6 to 9 months and weighing an average of 6.05 kg (range = 5.0 to 10.0 kg), from the University of Ibadan Teaching and Research Farm, were first rid of their internal and external parasites using appropriate drugs. They were then housed in previously disinfected individual metabolism cages. They were offered liberal but known quantities of the experimental diets daily for a 21-day preliminary period to adapt the animals to the diets and the cage environment.

Cool fresh water and salt lick were offered free choice in the cages. During this period, the daily voluntary feed intake was determined. Total faeces and urine from the experimental animals were collected during the next 7 days (day 22-28) and the last 7 days (day 84 - 90). Confinement and feeding continued to day 90. Animals on diet T-2 were removed from the experiment after day 28 in order to save the animals from that of the peels (Table 1). The least DMI from T-2 was probably due to the lowest N content of the peels. This is supported by Rajpoot et al (1981), Malechek and Provenza (1981) and Preston and Leng (1986) who had earlier reported that the low N content of feeds significantly ($P<0.05$) reduced the DMI of such feeds. The present study, however, seemed to indicate that the relationship between dietary N content of feed and the feed DMI per metabolic size was rather weak ($r=0.03$, $P>0.05$). Nonetheless, the positive though weak relationship between N (or CP) and DMI of diet was similar to the much higher $r=0.86$ ($P<0.01$) reported by Lippke (1980).

Table 1. Chemical composition of Gliricidia sepium and cassava peels diets fed to West African Dwarf goats.

Chemical component	Diets T-1	T-2	T-3
DM			
'As fed' SD	31.04 ± 0.58	86.41 ± 0.17	47.65 ± 0.46
Residual SD	87.27 ± 0.58	87.28 ± 0.17	87.27 ± 0.46
On DM basis SD			
OM SD	91.25 ± 1.29	89.25 ± 1.84	90.66 ± 1.46
ADF SD	28.27 ± 3.65	23.85 ± 3.52	26.95 ± 2.98
NDF SD	41.45 ± 3.43	34.27 ± 4.33	39.30 ± 3.70
N SD	3.76 ± 0.05	0.96 ± 0.38	2.92 ± 0.15
Lignin SD	13.64 ± 6.55	8.39 ± 4.15	12.07 ± 5.85

When dietary N content was correlated with the absolute DMI of the animals, the relationship was highly significant and negative ($r= -0.43$, $P< 0.01$). This seems to make some (biological) sense in terms of nutrient density of the diet because it suggests that an animal offered a low-N diet would tend to consume more of the diet in order to derive more of the needed N from the feed. However, this argument was not supported in the present study because the lowest DMI (Table 2) was recorded for goats on the lowest N-containing diet (T-2). Neither was the linear relationship between N and DMI per metabolic size of goats impressive nor significant ($P>0.05$).

imminent death due to excessive loss of body weight. The animals were weighed once a week (on the same day of every week at about the same time of day) in the morning before feeding and watering so as to minimise error due to "gut fill".

Feeds

Fresh Gliricidia sepium branches (about 1.2 m long and 1.5 cm thick) with leaves and branchlets were obtained daily from ILCA, Ibadan, between April and July, 1985. Cassava peels were obtained fresh from local cassava grating plants in and around the University of Ibadan campus. The cassava peels were sun-dried for 3 to 4 days, depending on the intensity of the sun, packed into jute bags and stacked away in the store on some raised wooden planks until required for feeding.

Diets

The diets fed to the goats were 100% Gliricidia sepium (T-1), 100% sun-dried cassava peels (T-2) and 70% (w/w) fresh Gliricidia sepium plus 30% cassava peels (T-3). The amount of each diet offered to each experimental animal ensured a 5% leftover. Residues were collected after a 24 h feeding, weighed and the voluntary intake determined.

Sampling of the feeding stuff

Samples of G. sepium and cassava peels offered and rejected during the collection period were taken daily dried and stored in bottles fitted with air-tight screw caps and kept in a dark cupboard until required for analysis.

Faecal collection

Total faeces were collected in the mornings before feeding and watering during day 22-28 and the last 7 days of the experiment. The two 7-day faecal samples for each experimental animal were thoroughly mixed, milled in a laboratory hammer mill to pass a 0.6 mm sieve and put in sealed polythene bags. These were then stored in a cupboard at room temperature until required for analysis. 5 g of the milled faeces were dried in an oven at 100-105^{o}C for 48 h to determine residual moisture.

Urine collection

Total urine excreted by each experimental animal was collected daily in the morning before feeding and watering and stored in a deep freezer at -5^{o}C. At the end of the 7-day collection period the sample collections were bulked for each animal and subsamples taken for analysis.

Analytical procedure

Chemical

The milled samples of Gliricidia, cassava peels and faeces were analysed for DM, OM and N according to A.O.A.C. (1975) procedures and ADF and NDF according to the methods of Goering and Van Soest (1970) and Van Soest and Robertson (1980).

RESULTS AND DISCUSSION

The chemical composition of the experimental diets is shown in Table 1. The chemical components of Gliricidia and cassava peels of this study compared favourably with values reported in literature (Adegbola, 1980; Oyenuga, 1968, Onwuka, 1983; Carew, 1983; Chadhokar et al, 1983).

Intake

The DM and nutrients intake by WAD goats is summarised in Table 2. The highest DM and nutrient intakes were from T-3 diet probably because the combination was palatable. The lowest DM intake (DMI) from the peels (T-2) could possibly not be due to the ADF and NDF content because these were lowest for the peels. An inverse relationship has long been reported between the DMI and the fibre content of feeds (Reid and Klopfenstein, 1983; Leaver, 1974). The lignin content of the peels could also apparently not be responsible for the least DMI from T-2 because lignin content was highest in Gliricidia and 1.6 times that of the peels (Table 1). The least DMI from T-2 was probably due to the lowest N content of the peels. This is supported by Rajpoot et al (1981), Malechek and Provenza (1981) and Preston and Leng (1986) who had earlier reported that the low N content of feeds significantly ($P<0.05$) reduced the DMI of such feeds. The present study, however, seemed to indicate that the relationship between dietary N content of feed and the feed DMI per metabolic size was rather weak ($r=0.03$, $P>0.05$). Nonetheless, the positive though weak relationship between N (or CP) and DMI of diet was similar to the much higher $r=0.86$ ($P<0.01$) reported by Lippke (1980).

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NDF SD	41.45 ± 3.43	34.27 ± 4.33	39.30 ± 3.70
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When dietary N content was correlated with the absolute DMI of the animals, the relationship was highly significant and negative ($r= -0.43$, $P< 0.01$). This seems to make some (biological) sense in terms of nutrient density of the diet because it suggests that an animal offered a low-N diet would tend to consume more of the diet in order to derive more of the needed N from the feed. However, this argument was not supported in the present study because the lowest DMI (Table 2) was recorded for goats on the lowest N-containing diet (T-2). Neither was the linear relationship between N and DMI per metabolic size of goats impressive nor significant ($P>0.05$).

Table 2. Dry-matter and nutrients intake ($g.kg^{-0.75}.d^{-1}$)* by West African-Dwarf goats fed *Gliricidia sepium* and cassava peels.

Intake of nutrient	Treatment 1	2	3
Dry-matter intake	46.30b	41.45b	76.01a
Organic-matter intake	42.95b	37.69b	67.50a
Nitrogen intake	1.80a	0.43b	1.48a
Acid detergent fibre intake	18.69a	8.30b	20.45a
Neutral detergent fibre intake	27.69b	10.94c	36.89a

* Means with the same letter in each row are not significantly different (P>0.05).

The significance of the relationship between dietary N and DMI might be through the indirect involvement of dietary N with DM digestibility (DMD). Low N in feeds affects nutrient balance which itself affects digestibility and, therefore, intake. Thus, the less the N content of a feed, the lower the level of its consumption, the poorer the balance of nutrients, the slower the rate of its digestion, and the longer it remains in the gastro-intestinal tract. Preston and Leng (1986) suggested a probable complication of N in rumen ammonia production level and microbial growth and activity.

The present result, therefore, suggests that it is unreasonable to feed sun-dried cassava peels as sole diet to domestic animals, especially goats.

Digestibilities

The apparent digestibility coefficient (ADC) for DM and other nutrients are presented in Table 3. The DMD of T-2 and T-3 was similar (P>0.05) but significantly different (P<0.05) from that of T-1. The rather low (54.2%) DMD and OMD (56.8%) recorded for goats on T-1 was close to 57.1% DMD reported by Onwuka (1983) who fed only dried leaves of Gliricidia to WAD goats. This could have been due to its highest lignin content (Table 1). This is supported by McDonald et al (1973) and Nastis and Malechek (1981) who concluded that lignin generally lowered feed DMD. The highest DM and OM digestibilities of T-2 were probably due to its lowest intake since digestibility and intake are inversely related (Van Soest, 1982; Wagner and Loosli, 1967).

Diets had significant influence (P<0.05) on N-digestibility. The N in T-3 was digested most. This suggested that the fermentable OM in the peels apparently encouraged higher N digestibility (McDonald et al, 1973).

Nitrogen digestibility of T-2 was negative due, probably, to the low N content (Table 1) of the peels. This is because ADC of dietary N is, to a large extent, dependent upon the proportion of N in the feed. Consequently, T-2 actually reduced the digestible N supply of the goats (McDonald et al, 1973). Also the level of N ADC could have been due to the level of feed intake (Owens and Berger, 1983).

The ADF of T-1 and T-3 was digested by goats to about the same extent (Table 3). The NDF digestibility by goats on T-1, T-2 and T-3 was, however, significantly different (P<0.05). The high NDF ADC by animals on T-3 tended to suggest that NDF was digested better when both Gliricidia and cassava peels were fed simultaneously in the ratio of 7:3.

Table 3. Dry-matter and nutrients digestibility coefficients (%)* by West African Dwarf goats fed *Gliricidia sepium* and cassava peels.

Nutrient	Digestibilty coefficient (%)		
	T-1	T-2	T-3
Dry-matter digestibility	54.21b	71.95a	74.34a
Organic matter digestibility	56.78b	77.35a	76.57a
Nitrogen digestibility	56.50a	-6.40b	57.30a
Acid-detergent fibre digestibility	42.89a	33.38b	46.15a
Neutral-detergent fibre digestibility	48.22b	36.61c	67.67a

* Means with the same letter in each row are not significantly different (P>0.05).

The digestible DM intake (DDMI) and intake of other digestible nutrients by goats is summarised in Table 4. The DDMI was significantly different (P<0.05) for all dietary treatments. The highest DDMI value of 56.4g. $kg^{-0.75}.d^{-1}$ was recorded for goats on T-3. The superiority of T-3 over T-1 and T-2 was observed in the amount of DOM and DM consumed from the diets. This suggested that supplementation of *Gliricidia* with cassava peels was beneficial to goats. It is, therefore, suggested that *Gliricidia* and cassava peels, when they must be fed to goats, be offered in suitable proportions to ensure maximum utilization of the feeding stuffs.

Table 4. Digestible dry-matter and nutrient intake ($g.kg^{-075}.d^{-1}$)* by West African Dwarf goats fed *Gliricidia sepium* and cassava peels.

Component intake	Treatment 1	2	3
Digestible dry-matter intake	25.38b	31.08b	56.44a
Digestible organic matter intake	24.84b	29.17b	51.66a
Digestible nitrogen intake	1.03a	-0.03b	0.85a
Digestible acid-detergent fibre intake	8.15a	2.68b	9.44a
Digestible neutral detergent fibre intake	13.80a	4.22b	24.93a

* Means with the same letter in each row are not significantly different (P>0.05).

Nitrogen utilization and body weight changes as well as efficiency of feed utilization and estimated meat yield by goats on the experimental diets are shown in (Tables 5 and 6) respectively. N-balance among goats on T-1 and T-3 was similar (P>0.05); that of T-2 was negative ($-0.04\ g.kg^{-0.75}.d^{-1}$) probably due to the low N content (Table 1) of T-2 and the negative DNI (Table 4) from T-2. Consequently, the goats on T-2 were losing an average of 54.8 g daily and the trial had to be suspended after the initial collection period. It is, therefore, unreasonable and uneconomical to feed sole cassava peels diets to goats. Goats on T-3 were superior to those on T-1 (54.2 versus 50.0 $g.d^{-1}$) in average daily weight gain. This could probably have been due to a better balance of nutrients resulting from the feeding of Gliricidia and cassava peels simultaneously in the ratio of 7:3.

Table 5. Nitrogen utilization ($g.kg^{-0.75}.d^{-1}$)* and body weight changes ($g.d^{-1}$) in West African Dwarf goats fed <u>Gliricidia</u> <u>sepium</u> and cassava peels.

	Treatment		
	Gliricidia	100%	70/30
Nitrogen intake	1.80a	0.43b	1.48a
Faecal N Loss	0.77a	0.45b	0.63a
Absorbed nitrogen	1.03a	-0.03b	0.85a
Urinary N loss	0.26a	0.02b	0.07b
Nitrogen balance	0.77a	-0.04b	0.78a
Body weight change	50.0b	-54.77c	54.16a

* Means with the same letter in each row are not significantly different (P>0.05).

In Nigeria the average annual yield of cassava tubers is 21.1 $t.ha^{-1}$ (Hahn and Chukwuma, 1986). Since the peels constitute 20.0% of the tuber (Hahn et al, 1986), this means that about 4.22 tonnes of cassava peels per hectare are available annually for feeding ruminants, especially goats. The inclusion of 30% or less (depending on availability) of such peels would support weight gains as shown in Table 6 among goats. For example, a 6-month-old goat weighing 6.1 kg initially, when fed a T-3 diet containing 70% <u>Gliricidia</u> and 30% cassava peels and gaining an average of 54.2 $g.d^{-1}$ for one-year would weigh 25.9 kg at the end of the period, thus gaining 19.8 kg. This 25.9 kg goat, one and half years old, would have, at 51% dressing percentage (Akinsoyinu, 1974), a carcass weight of 13.2 kg which is equivalent to the edible goat meat for the one-year growth period.

Table 6. Efficiency of feed utilization* and estimated goat meat yield ($kg.yr^{-1}$)* among West African Dwarf goats fed Gliricidia sepium and cassava peels.

Treatment	1	2	3
Dry-matter intake ($g.kg^{-0.75}.d^{-1}$)	46.30	41.45	76.01
Body weight change ($g.d^{-1}$)	50.99	-54.77	54.16
Feed efficiency	0.91b	-0.76c	1.40a
Weight gain ($kg.yr^{-1}$)	18.6	-20.0	19.8
Estimated meat yield ($kg.yr^{-1}$)	9.5a	-10.2b	10.1a

* Means with the same letter in any row are not significantly different (P>0.05).

Earlier workers have indicated inclusion of cassava peels to varying degrees in livestock feeds. Adegbola (1980) concluded that 10% cassava peels meal inclusion in pig ration induced fastest rate of gain and highest feed conversion efficiency. Onwuka (1983), on the other hand, concluded that 25% cassava peels:75% browse was the best proportion for goats in terms of intake, digestibility and other performance parameters. In the present study, a 30% level of cassava peels has been shown to be beneficial to goats. These studies suggest that the actual amount of cassava peels suitable for inclusion in goat feeds is a subject for further research. Ensiling of cassava peels as a means of preservation and the nutritional value of the product should be given research attention.

Further research work is needed to relate annual yields of Gliricidia and cassava peels fed as sole or combined diets to the production of goat meat from such diets in Nigeria.

CONCLUSION

Gliricidia was richer in and, therefore, a better source of dietary N than cassava peels when the two feedingstuffs were fed either as sole or combined diets to goats.

Sun-dried cassava peels were easier to pack and kept longer in storage.

Feeding *Gliricidia* and cassava peels in a 7:3 ratio encouraged maximum intake, digestibility, utilization and highest body weight gain.

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