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The Feeding Value Of *Dialium Guineense* As A Supplement To West African Dwarf Sheep Fed Natural Grass Hay

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Key words: ***Dialium guineense*, Chemical composition, Rumen parameter, West African Dwarf Sheep**

Summary

The feeding value of *Dialium guineense* leaves was evaluated using eight-two-year-old West African Dwarf sheep fed natural grass hay. Four of the animals were fistulated and used for ruminal ammonia and volatile fatty acid (VFA) determination. Dried leaves of *Dialium guineense* were offered at two levels (25% and 50% of dry matter (DM) requirement) as supplements to a basal hay diet. Rumen liquor was sampled one hour before and one, three and five hours after feeding. Sheep fed the control diet had a higher ($p<0.05$) ruminal ammonia concentration than those fed the diet supplemented with 25% *Dialium guineense* (D25%). Similarly, ruminal ammonia concentration was higher ($p<0.05$) in sheep fed the control diet than those fed the diet supplemented with 50% *Dialium guineense* (D50%). However, the difference between sheep fed D25% or D50% was not significant ($p>0.05$) The differences between the sampling periods were high ($p<0.05$). The VFA concentrations of sheep fed the control diet was superior ($p<0.05$) to those fed the D25% and D50% diets. However, there was a difference ($p<0.05$) between the VFA concentrations of sheep fed D25% and D50% diets. It was concluded that *Dialium guineense,* inspite of its numerous benefits as a multi-purpose tree showed a very poor ruminal ammonia concentration. Its VFA concentrations decreased linearly ($p<0.05$) with increasing level of supplementation. This poor performance could exclude *Dialium guineense* as a promising fodder tree and is probably due to its high condensed tannin content.

1 Introduction

Livestock production in Sub-Saharan Africa is essentially a smallholder farmers' affaire attracting minimum investment in housing, feed and health-care. Herding, tethering and

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confinement of animals are the three distinct management systems. Among the numerous constraints to production under these systems, those related to shortages in quantity and quality of feed during the long dry season are of primary concern. Improved animal agroforestry has been recommended (LE HOUEROU, 1980; TORRES, 1983) as a possible solution to the low dry season feed quality problem. However, quantitative information on feeding value and animal performance on diets containing forage from several multipurpose tree and shrub species in existing animal agroforestry systems in Africa is scanty (LE HOUEROU, 1980 ; REED et al., 1990). Preliminary screening of some browse trees (RITTNER, 1988; DIAGAYETE, 1981; LARBI et al., 1992) indicated that some of these browse trees are less suitable as protein supplement for small ruminant than might be expected from their high crude protein content. This is as a result of naturally occurring polyphenols, and in particular condensed tannins. Although there is considerable diversity in forage trees, past research and development activities have concentrated on a very narrow range of the available germplasm. This narrow focus has tended to overlook many other valuable trees including *Dialium guineense*.

This research was therefore conducted to determine the feeding value of *Dialum guineense* as a supplement to West African Dwarf Sheep fed natural grass hay.

2 Materials and Methods

Collection Site

Branches from mature *Dialium guineense* trees from humid/sub-humid zone of Cotonou/ Benin were collected in the dry seasons of March and April and were sun dried on a raised wooden platform. The dried leaf samples were then packed in plastic containers and exported to the University of Hohenheim, Germany.

Composition and in vitro metabolisable energy of Dialium guineense.

Dried leaf sample was ground in a Willey Mill to pass a $1mm^2$ screen for chemical analysis. Nitrogen (N) content was determined by the Kjeldahl method and for ash by burning at 550°C (AOAC, 1990). Crude protein was calculated as 6.25*N. Neutral detergent fibre (NDF), acid detergent fibre (ADF), and acid detergent lignin (ADL) were determined as described by Goering and Van Soest (1970), applying a Fibertec system M6 (Tecator , Haganas, Sweden). The difference between NDF and ADF was designated as hemicellulose, and between ADF and ADL as cellulose. Extractable tannins were analysed as described by Makkar et al (1993).

Animal Trial

Eight West African Dwarf sheep (Djallonke), all castrates and about two years of age were used in this experiment. Four of the sheep were fistulated and used for ruminal ammonia and volatile fatty acid (VFA) determination. The animals were adapted for 10 days on the experimental diets before they were kept in individual cages for rumen liquor collection. The rumen liquor was collected on three consecutive days. Water was offered *ad.lib.*

Experimental Diet

Dried leaves of *Dialium guineense* were offered at two levels (25% and 50% of DM requirement) as supplements to a basal hay diet. The treatments were as follows:

i) Control diet.	(100% Hay);
ii) D25% diet.	(25% *Dialium guineense* supplementation + 75% Hay);
iii) D50% diet	(50% *Dialium guineense* supplementation + 50% Hay).

Rumen Parameter Determination

For the studies of volatile fatty acid (VFA), ruminal ammonia (NH_3), Carbon dioxide (CO_2) and pH concentration, rumen liquor were taken immediately prior to feeding, one hour, three, and five hours after feeding directly by means of a vacuum pump with plastic tube thrust into the rumen compartment. Immediately after collection pH measurements were made with a Schott CG 840 pH-Meter. The samples were then immediately freed of coarse particles by filtration through cheese cloth and subjected to refrigerated centrifugation at 2500g for 20 minutes.

VFA Determination

For determining VFA composition in ruminal fluid, duplicate 5-ml sample of the filtrate were used in a vacuum distillation procedure according to Zijlstra et al (1977). Gas-chromatography analysis was made using Hewlett Packard 5880A series Gas- chromatograph with hp 7671A Automatic sampler. Sample were kept in a refrigerator for determinations made the same day or frozen until the following day.

Ruminal Ammonia

For ruminal ammonia determination, 5-ml sample of the filtrate was diluted with 45-ml of de-ionised water and then 0.5-ml of 10 mol/l NaOH added. The gas released was measured immediately using the gas sensitive electrode. A standard solution was used for the calibration curve for an ammonia electrode as described by Cammann (1979).

Ruminal Carbon Dioxide

For carbon dioxide determination 5-ml sample of the filtrate was diluted with 45-ml of de-ionised water and then 5-ml of sodium citrate buffer solution added. The gas released was measured immediately using the gas sensitive electrode. A standard solution was used for the calibration curve for a CO_2-electrode as described by Cammann (1979).

Statistical Analyses

Multivariate Analysis of Variance (MANOVA) was used to analyse the data using the General Linear Modelling Procedure (SAS 1985). The sources of error that were analysed included effects of time and treatment and their interaction. A level of $P < 0.05$ was chosen as the minimum for significance.

3 Results and Discussion

Composition and energy contents of *Dialium guineense* and the hay diet are presented in Table 1.

Table 1: Composition and energy contents of *Dialium guineense* and hay

		Dialium guineense	Hay
GE (KJg^{-1} DM)		19.44 ± 0.04	17.78 ± 0.02
Crude Protein	**(% DM)**	14.28 ± 0.01	11.52 ± 0.05
Ash	**(% DM)**	7.08 ± 0.15	9.91 ± 0.26
Water content	**(% DM)**	6.89 ± 0.03	6.24 ± 0.11
NDF	**(% DM)**	61.65 ± 0.7	59.66 ± 0.04
ADF	**(% DM)**	45.14 ± 0.3	36.47 ± 0.42
Hemicellulose	**(% DM)**	16.51 ± 0.6	23.19 ± 0.54
ADL	**(% DM)**	20.48 ± 0.8	4.34 ± 0.10
Cellulose	**(% DM)**	24.66 ± 0.7	32.13 ± 0.45
Total Phenols [a]	**(% DM)**	6.1 ± 0.1	-
Condensed Tannins [b]	**(%DM)**	5.9 ± 0.17	NA
Metabolisable energy (KJg^{-1} DM) In vitro		4.97 ± 0.05	8.63 ± 0.19
App ME (% GE)		35.68 ± 6.6	51.94 ± 3.01

a As tannic acid equivalent

b As leucocyanidin equivalent

NA: Not applicable

Of particular interest are the relatively high total (6.1% of DM) and condensed (5.9 % of DM) tannin content. Crude protein of *Dialium guineense* was also reasonably high at 14.3 % of DM. The high crude protein content suggested that *Dialium guineense* leaves could effectively serve as a cheap source of dry season protein supplements for low nitrogen cereal crop residues for resource-poor farmers with stall-fed small ruminants in West Africa. However, the soluble phenolic and condensed tannin content (61g/Kg and 59g/kg respectively) of *Dialium guineense* may lower its value as supplement to cereal crop residues (WOODWARD and REED, 1989; REED et al., 1990; ONWUKA, 1992).

Ruminal Ammonia and pH

The results obtained for ruminal ammonia concentration and pH are presented in Table 2.

Table 2. Ruminal ammonia concentration and ruminal pH for hay supplemented with Dialium guineense

		Ruminal NH_3 Conc. (mg/l)		Ruminal pH	
Treatment	**Hours after feeding**	**Mean**	**SE**	**Means**	**SE**
Control diet	0	45.3^{acd}	7.56	6.64^{ac}	0.05
	1	57.3^{ac}	16.3	6.23^{ad}	0.05
	3	50.6^{acd}	14.7	6.41^{ac}	0.05
	5	19.3^{ad}	2.37	6.44^{ac}	0.04
D25% diet	0	19.5^{bcd}	0.86	6.65^{ac}	0.11
	1	26.1^{bc}	0.61	6.31^{ad}	0.08
	3	16.3^{bcd}	0.76	6.40^{ac}	0.1
	5	11.0^{bd}	0.53	6.45^{ac}	0.11
D50% diet	0	12.5^{bcd}	0.67	6.96^{bc}	0.03
	1	21.4^{bc}	0.66	6.52^{bd}	0.06
	3	14.2^{bcd}	1.22	6.60^{bc}	0.1
	5	10.1^{bd}	1.43	6.63^{bc}	0.1

n = 6; Means in a column with a common letter(s) do not differ ($p > 0.05$).

Sheep fed the control diet had a higher ($p<0.05$) ammonia concentration in the rumen than those fed the diet supplemented with 25% *Dialium guineense* (D25%). Similarly, the ammonia concentration in the rumen was higher ($p<0.05$) in sheep fed the control diet than those fed the diet supplemented with 50% *Dialium guineense* (D50%). However, the difference between sheep fed D25% or D50% diet was not significant ($p>0.05$). The differences between the sampling periods (0,1,3 & 5 hours after feeding) were high ($p < 0.05$). It can be seen that the ruminal ammonia concentration increased significantly during the feeding period, reaching its peak one hour after the feeding period was completed. It then decreased significantly to the lowest level in about five hours after feeding. Conversely, the digesta pH dropped significantly during feeding reaching its lowest value one hour after feeding was stopped and then began to increase to prefeeding value after five hours.

This study clearly showed that supplementation with *Dialium guineense* resulted in a significant ($p<0.05$) reduction of the ruminal ammonia concentration which indicates an inhibition of protein degradation. Similar observations were reported *in vitro* by a number of workers including (Reid et al, 1974; Rodrignez et al, 1975; Barry and Forss 1983; Kumar and Singh 1984a). Increasing *Dialium guineense* supplementation to 50% reduced further the ruminal ammonia concentration. This reduction was not statistically significant. The result indicated that the control diet produced ammonia concentration in the rumen required for efficient rumen function, according to the recommendation of FAO (1986).

The results obtained for volatile fatty acid composition are presented in Table 3.

Table 3: Volatile fatty acid composition (mmol/l) of ruminal fluid in West African Dwarf Sheep

Diets	Period	Fatty Acids (Means ± SEM , n =6)						
		Acetic	Propionic	Iso-butyric	Butyric	Iso-valeric	Valeric	A:P
Control	0	60.5 a	15.25 a	0.84 a	6.69 a	1.17 a	0.52 a	3.99 a
	1	65.33 a	26.73 a	0.8 a	8.32 a	0.96 a	0.77 a	2.44 a
	3	64.0 a	22.78 a	0.76 a	7.77 a	0.82 a	1.09 a	2.82 a
	5	62.17 a	19.35 a	0.69 a	7.39 a	0.75 a	0.79 a	3.23 a
	SEM	1.8	0.67	0.07	0.53	0.17	0.06	0.1
D25%	0	56.08 b	11.55 b	0.69 b	5.93 a	0.84 b	0.38 b	4.85 b
	1	57.33 b	15.48 b	0.55 b	7.83 a	0.58 b	0.45 b	3.7 b
	3	61.67 b	15.30 b	0.53 b	7.98 a	0.43 b	0.68 b	4.03 b
	5	60.33 b	14.08 b	0.5 b	7.15 a	0.43 b	0.49 b	4.28 b
	SEM	5.8	0.72	0.07	0.51	0.1	0.06	0.51
D50%	0	38.92 c	9.85 b	0.52 c	4.56 b	0.63 c	0.25 c	3.95 c
	1	51.25 c	19.05 b	0.52 c	5.78 b	0.52 c	0.43 c	2.69 c
	3	50.08 c	14.77 b	0.39 c	5.68 b	0.22 c	0.46 c	3.39 c
	5	47.83 c	13.32 b	0.35 c	5.69 b	0.2 c	0.32 c	3.59 c
	SEM	3.4	1.04	0.03	0.34	0.04	0.04	0.05

Means in a column with a common letter(s) do not differ ($p>0.05$). SEM = Standard error of means

The volatile fatty acid concentrations of sheep fed the control diet was superior ($p<0.05$)

to those fed the D25% and D50% diets. There was a difference ($p<0.05$) between the acetate concentrations of sheep fed D25% and D50% diets. Increasing the level of supplementation from 25% to 50% further decreased the acetate concentration significantly ($p<0.05$). However, the difference in the propionate concentrations of sheep fed D25% and D50% diets was not significant ($p>0.05$). Concentrations of isobutyrate, isovalerate, valerate and acetate to propionate ratio of sheep fed the control diet were superior ($p<0.05$) to those fed D25% and D50% diets. However, sheep fed the D25% diet showed a higher ($p<0.05$) concentration of these acids than those fed the D50% diet. The inhibition of volatile fatty acids by tannin has been reported by Chiquette et al, (1988). The result of this study is in agreement with the findings of Reid et al., (1975); Barry and Forss (1983); Kumar and Singh (1984a); Chiquette et al, (1988); Reed et al, (1990) and Onwuka (1992).

It was concluded that *Dialium guineense*, inspite of its numerous benefit as a multipurpose tree showed a very poor ruminal ammonia concentration. Its VFA concentrations decreased linearly ($p<0.05$) with increasing level of supplementation. This poor performance could exclude *Dialium guineense* as a promising fodder probably due to its high condensed tannin content.

Remarks: A further study on nitrogen balance and nutrient digestibility would elucidate the nitrogen and nutrient economy of *Dialium guineense* supplementation.

Zusammenfassung

Der Futterwert von Blättern von *Dialium guineense* wurde an acht zweijährigen Kamerunschafen, denen Heu gefüttert wurde, ermittelt. Die ruminale Ammoniak- und FFS (Flüchtige Fettsäuren)-Konzentration wurde an vier fistulierten Tieren bestimmt. Die getrockneten Blätter von *Dialium guineense* wurden im Umfang von 25 bzw. 50 % der Trockenmasseaufnahme gegen Heu ausgetauscht. Pansensaftproben wurden eine Stunde vor, eine, drei und fünf Stunden nach Fütterung genommen. Schafe, die die Kontrolldiät bekamen, zeigten eine höhere ($p<0.05$) Ammoniak-Konzentration als die, die 25% (D25%) bzw. 50% (D50%) *Dialium guineense* aufgenommen hatten. Der Unterschied zwischen Schafen die D25% und D50% verzehrten war nicht signifikant ($p>0.05$). Zwischen den Probenahmezeitpunkten traten ebenfalls Unterschiede ($p<0.05$) auf. Die FFS-Konzentration von Schafen, die die Kontrolldiät aufnahmen war höher ($p<0.05$) als bei denen, die die D25% und D50% Diät verzehrten. Nach Verzehr der D25% Diät zeigte sich gegenüber D50% eine signifikant höhere ($p<0.05$) ruminale FFS-Konzentration. Es wurde daraus geschlossen, daß nach Verzehr von *Dialium guineense*, trotz der zahlreichen Vorteile dieser vielseitig nutzbaren Pflanze, die Ammoniak-Konzentration im Pansen gering war. Mit zunehmendem Dialiumanteil nahm die Konzentration an FFS linear ($p<0.05$) ab. Die bei hohen Anteilen *Dialium guineense* stark reduzierte Konzentration an FFS und Ammoniak im Pansen schließt eine umfangreiche Nutzung der Pflanze zu Futterzwecken aus. Ursache hierfür ist

wahrscheinlich der hohe Gehalt an kondensierten Tanninen.

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