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Full Length Research Paper

Seasonal availability and physical and chemical characteristics of four major browse plants used for stall-feeding of livestock in Eastern Nigeria

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Four major browse species were studied with respect to their time of availability throughout the year and some aspects of their physical and chemical characteristics. *Elaeis guineensis* and *Ficus elasticoides* were available at all times of the year for stock feeding. For the physical milling characteristics studied, the browse species compared well with those of the legume species included in the study or were intermediate between those of the legumes and grasses. The nutrient composition indicated that the browse species could be a good source of livestock feed, especially during the dry season when grass from the natural grassland is scarce.

Key words: Nutrient composition, milling characteristics, livestock, browse species.

INTRODUCTION

The prevalent system in Eastern Nigeria is that of farmers growing crops and also keeping a few livestock. Forage browse plants are used by small holder livestock farmers for the feeding of ruminant animals (Okoli et al., 2003). The use of forages from the natural grasslands is usually supplemented with fodder from certain browse species purposely grown in compound farms and periodically harvested for cut-and-carry stall-feeding of sheep and goats. Four major browse species, which usually grow into trees, are most commonly used in this way, viz., *Elaeis guineensis, Ficus elasticoides*, *Ricinodendron heudelotii* and *Hymenodictyon pachyantha*. In addition, these tree species serve other purposes in the mixed farming system. The oil palm is an economic tree mainly exploited for its palm oil and kernel. In addition to being used for fencing the compounds, it also find use in the cropping system as 'giant stakes' on which vinous climbing crops like yam, cowpeas and cucurbits in the multiple cropping systems are grown. These 'giant stake' trees are usually planted at measured distances in homestead farms to serve the purpose of supporting vinous climbing crops and at the same time supply readily harvestable forage, especially during inclement weather and also when species in the natural range lands have dried due to the dry season. Although, these species have been widely used by the local farmers, there has been no planned investigation to document the times or season of their availability and their general characteristics, and also there is limited information on their nutritive value as animal feed-stuff.

The objective of this investigation was to identify the period of availability of these major species and to study aspects of their physical and chemical characteristics, as well as their nutritive value. In this study, some well known grass and leguminous forages were used for comparison of some of the physical and chemical characteristics.

MATERIALS AND METHODS

Period of feed availability

Two locations were chosen for studying the periods of availability of foliage from the four species. The locations were Eha-Alumona near Nsukka, at latitude 06° 25`N and 07° 24`E, and Neni which is about 100 km south of Nsukka. Ten selected stands of each

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Table 1. Pattern of herbage availability of four major browse species used in Eastern Nigeria.

Browse species	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.
Ricinodendron heudelotii	+	Y	Y	-	NF	+	+	+	+	+	+	+
Ficus elasticoides	+	+	+	+	+	+	+	+	+	+	+	+
Hymenodictyon pachyantha	+	Y	-	NF	+	+	+	+	+	+	+	+
Elaeis quineensis	+	+	+	+	+	+	+	+	+	+	+	+

+ = Herbage available; - = leaves completely shed; Y = leaves overmature, with yellowing and shedding; NF = new flush of leaves.

species in each location were inspected at a specified date of every month of the year. Availability was measured by the presence of abundant harvestable foliage and non-availability by the complete absence of leaves (leaves completely shed) or by the presence of a new flush of tender leaves too immature for harvest (Table 1).

Study of the physical characteristics

Only samples from Eha-Alumona were used for the chemical and physical characteristics. About 0.5 kg of the leaves (petioles and laminae, but only laminae for *E. guineensis*) was harvested from five randomly selected stands of each species, once every month. These were immediately taken to the laboratory where subsamples were dried in the oven at 100°C for 24 h. Five grams of each dry sample was then chopped into approximately 2 to 4 cm lengths so as to allow for easy feeding into the hopper of a Wiley mill (model 5 KC 43NG 638T). The Wiley mill was connected to a wattmeter for measurement of power consumption. The milling machine was first calibrated by running it empty for 30 s to get the idling energy. This was repeated five times and the mean value was obtained. The energy expended in milling the sample was then measured by feeding the 5 g sample and allowing the mill run for 30 s. The milled portion of the sample which passed through 1 mm sieve screen was carefully collected in a glass receptacle and the weight was determined. The energy for grinding was given by the total energy consumed minus the idling energy. The time taken to grind 1 g sample was give by:

$$\frac{\text{Time the mill was run, i.e for 30 seconds}}{\text{Weight (g) of the milled sample}}$$

and the energy expended to grind 1 g sample was given by:

$$\frac{\text{Energy expended for grinding for 30 seconds}}{\text{Weight (g) of the grinding for 30 seconds}}$$

For each forage species, five determinations were made and the mean value was presented. Packing efficiency and the density of the milled forage samples were also part of the physical characteristics studies, using a manual and a centrifugal method of packing. For the manual method, 2 g milled dry sample was put in a graduated plastic measuring cylinder. The bottom of the cylinder was allowed to strike a wooden table many times until a constant volume was attained (Clifton and Pfander, 1967). Duplicate determinations were made for each sample. For the centrifugal method, the same 2 g weight of each sample was placed in a calibrated centrifuge tube and centrifuged at 2,500 rpm for 10 min, and the volume it occupied after 10 min of centrifuging was recorded. The densities were calculated from the weights and volumes obtained in each case.

Chemical analysis

Samples of the leaves (petioles and laminae) were dried to constant weight at 100°C for 24 h and ground to pass through a 1 mm sieve in a Willey mill and stored in screw cap bottles at room temperature until analysed. The dried samples were analysed for crude protein, crude fibre, ether extract, nitrogen-free extract and ash according to the AOAC (1975) procedures. Calcium and magnesium contents were determined by atomic absorption (AOAC, 1975), using the UNICAN, SP90A series 2 atomic absorption spectrophotometer. Phosphorus was determined by the method described by Cavell (1955); the samples having been initially digested in a 4:1 mixture by a volume of 70% nitric acid and 60% perchloric acid (AOAC, 1975).

Statistical analysis

The data collected were subjected to analysis of variance (Snedecor and Cochran, 1974) in order to determine if there were significant differences among the forage types (browse, grass or legume) or among species within the forage types. Separation of treatment means was by Duncan's multiple range tests (Steel and Torrie, 1966) at 5% probability level.

RESULTS

Browse availability

The survey showed that *E. guineensis* and *F. elasticoides* provided feed throughout the year even during the severe dry season period when most natural grassland species had dried up (Table 1). *R. heudelotii* leaves were not available in January, February and March, while *H. pachyantha* could not provide foliage for feeding in December, January and February.

Physical characteristics

The time taken to grind 1 g sample was lowest with *E. guineensis* and *S. gracilis* leaves but highest ($P < 0.05$) with *P. maximum* leaf and stem (Table 2). The energy expended to grind 1 g sample was not necessarily related to the grinding time. *H. pachyantha*, *C. muconoides*, *R. heudelotii* and *S. gracilis* leaves required, on average, less than one sixth of the energy required to grind a comparable quantity of *Panicum maximum* or *Brachiaria brizantha* stem or less than one quarter of the energy for

Table 2. Grinding time and energy expended per g sample.

Species	Portion	Grinding time per g sample (s)	Energy expended per g sample (J)
Elaeis guineensis	Leaf	10.2 ± 1.3	230.2 ± 23.1
Ficus elasticoides	Leaf	21.7 ± 5.0	356.0 ± 54.5
Hymenodictyon pachyantha	Leaf	15.2 ± 6.8	101.4 ± 7.0
Ricinodendron heudelotii	Leaf	25.8 ± 6.4	165.0 ± 44.3
Calopogonum mucunoides	Leaf	16.8 ± 1.1	143.0±20.7
	Stem	13.3 ± 0.2	359.8±47.1
Centrosema pubescens	Leaf	12.8 ± 2.9	218.0±47.4
	Stem	14.9 ± 2.0	445.5±120.9
Stylosanthes gracilis	Leaf	11.4 ± 3.1	182.4±15.6
	Stem	18.8±2.0	584.4±20.2
Brachiaria brizantha	Leaf	15.4±2.3	649.0±205.3
	Stem	19.9±6.3	1015.4±435.7
Cynodon nlemfuensis	Leaf	17.1±2.9	860.0±162.4
	Stem	14.8±2.2	798.8±154.0
Panicum maximum	Leaf	27.9±2.7	823.2±95.4
	Stem	41.2±3.0	1434.0±497.1

grinding their leaves. On average, leaves of the browse and legume species required rather low energy for grinding, while the grass species required higher grinding energy.

Milled leaf samples of *E. guinensis* and *R. heudelotii* had the highest bulk density while, *C. muconoides* had the least (P < 0.05) bulk density value which was similar with that from *F. elasticoides* (Table 3). Among the grasses, *Cynodon nlemfuensis* gave the highest (P < 0.05) bulk density. On the whole, estimation of the volume or density of milled samples by manual method appeared to give more consistent values as compared to the centrifuge method.

Nutrient composition

The proximate compositions of the leaves of *Hymenodictyon* and *Ricinodendron* for the different months are summarized in Table 4. The crude protein content of *Hymenodictyon* was lowest in November and December and highest in February and March, while the crude fibre was highest in November and December and lowest in February and March (Table 4). The ranges of crude protein in the dry matter were 11.65 to 14.69% for *Hymenodictyon* and 18.19 to 21.60% for *Ricinodendron*. *Ricinodendron* had higher (P < 0.05) crude protein and crude fibre content than *Hymenodictyon*. The ranges (and averages) of ether extract contents were 2.04 to 2.52 (2.36) and 2.16 to 2.93 (2.59) for *Ricinodendron* and *Hymenodictyon*, respectively. The ash contents were high in the two browse species through out the year. Similarly, the ratio of calcium to phosphorus in herbage dry matter was high in the species, with average values of 6.5:1 and 6.9:1 for *Hymenodictyon* and *Ricinodendron*, respectively. The nitrogen-free extract (NFE) content was higher (P < 0.05) for *Hymenodictyon* (average 63.11%) than for *Ricinodendron* (54.51%).

DISCUSSION

In a survey of voluntary intake of roughage by sheep (Laredo and Minson, 1973), a significant negative correlation (r = -0.81) between voluntary intake and grinding energy of feed was obtained and it was concluded that in addition to the chemical composition, the physical properties of the feed are also very important in determining voluntary intake. In this study, the low energy values expended in grinding *Hymenodictyon* and *Ricinodendron* leaves in a laboratory mill were of interest and compared well with those for the leaves of two legume species; *Calopogonium* and *Stylosanthes*. The low energy values suggest a potential for high voluntary intake for those browse species. Again, less energy was expended to grind *Elaeis* and *Ficus* leaves as compared to the leaves or stems of the grasses. In general, the grinding energy values suggest a higher voluntary dry matter intake for the four browse species as compared to the three grasses used in this study. Among the browse species, lower grinding energy appeared to be greatly influenced by the low fibre content. Low fibre content may lead to less apparent retention time in the rumen and to increased voluntary intake (Adesogan et al., 2009). The density of packing in the rumen can be important in voluntary dry matter intake considerations (Thornton and Minson, 1973).

Month of sampling and season of the year did not appear to affect proximate composition of the leaves of the browse species considerably. This is in agreement

Table 3. Packing efficiency and density of ground samples.

Forage species	Portion	Volume (m1^3 g^{-1})		Density (g m1^{-1})	
		Manual method	Centrifuge method (at 2,500 rpm)	Manual method	Centrifuge method (at 2,500 rpm)
Browse plants					
Elaeis guineensis	Leaf	2.3±0.01	2.7±0.02	0.436±0.001	0.374±0.004
Ficus elasticoides	Leaf	3.7±0.01	3.7±0.07	0.273±0.001	0.275±0.008
Hymenodictyon pachyantha	Leaf	2.7±0.02	2.9±0.04	0.374±0.004	0.345±0.006
Ricinodendron heudelotii	Leaf	2.4±0.02	2.7±0.04	0.431±0.004	0.384±0.006
Legume species					
Calopogonium mucunoides	Leaf	4.1±0.03	4.9±0.03	0.250±0.003	0.206±0.002
	Stem	3.4±0.02	4.0±0.04	0.298±0.002	0.253±0.003
Centrosema pubescens	Leaf	3.3±0.02	3.8±0.07	0.306±0.003	0.263±0.007
	Stem	2.9±0.03	3.3±0.04	0.348±0.003	0.304±0.005
Stylosanthes gracilis	Leaf	2.8±0.0	3.0±0.00	0.362±0.005	0.333±0.004
	Stem	4.2±0.01	3.3±0.07	0.241±0.003	0.191±0.004
Grass species					
Brachiaria brizantha	Leaf	2.9±0.01	3.4±0.00	0.344±0.001	0.299±0.00
	Stem	2.8±0.01	3.2±0.00	0.356±0.001	0.317±0.00
Cynodon nlemfuensis	Leaf	2.5±0.00	3.0±0.03	0.400±0.000	0.341±0.004
	Stem	2.8±0.02	3.1±0.03	0.361±0.004	0.329±0.000
Panicum maximum	Leaf	3.0±0.02	3.4±0.00	0.342±0.003	0.399±0.00
	Stem	2.5±0.03	3.2±0.05	0.351±0.006	0.313±0.005

Table 4. Nutrient composition (dry matter basis) of *H. pachyantha* and *R. heudelotii* leaves from November to July.

Month	CP (%)	CF (%)	EE (%)	Ash (%)	NFE (%)	Ca (%)	P (%)	Mg (%)
Hymenodictyon pachyantha								
November	11.65	12.28	2.52	10.0	63.55	1.78	0.29	0.44
December	12.79	12.26	2.78	10.68	61.49	2.11	0.30	0.59
January+	-	-	-	-	-	-	-	-
February	14.01	8.11	2.67	8.74	66.47	1.89	0.23	0.36
March	14.69	8.50	2.75	9.58	64.48	1.94	0.25	0.34
April	13.37	10.89	2.93	9.13	63.68	2.05	0.34	0.56
May	13.25	10.93	2.63	10.14	63.05	1.73	0.30	0.67
June	13.12	10.96	2.33	11.14	62.45	1.41	0.25	0.78
July	12.85	11.21	2.16	8.61	65.17	1.54	0.30	0.56
Mean	13.22	10.64	2.60	8.75	64.79	1.81	0.28	0.54
± S. E .M.	0.31	0.55	0.09	0.32	0.63	0.08	0.01	0.05
Ricinodendron heudelotii								
November	21.60	11.97	2.43	8.80	55.20	1.96	0.38	0.46
December	20.87	8.81	2.41	9.49	58.42	2.10	0.36	0.50
January	20.19	13.05	2.52	10.36	53.88	1.68	0.32	0.52
February+	-	-	-	-	-	-	-	-
March+	-	-	-	-	-	-	-	-
April	19.63	10.68	2.37	10.67	56.65	2.40	0.31	0.57
May	19.16	15.30	2.04	9.41	54.09	2.18	0.28	0.60

Table 4. Contd.

June	18.31	13.97	2.35	11.08	54.29	2.74	0.34	0.63
July	18.19	12.97	3.01	9.42	56.41	1.96	0.31	0.53
Mean	19.71	12.39	2.45	9.89	55.56	2.15	0.33	0.54
± S. E .M.	0.48	0.81	0.11	0.31	0.79	0.13	0.01	0.02

+ = Leaves completely shed or too tender or small for harvest.

with a previous report (Otsyina and McKell, 1984; Agbo, 2008) that there were relatively little changes in the crude fibre and crude protein contents of browse over a 12-month period, especially where growing conditions favoured near continuous growth. However, the higher crude protein and lower fibre of *Hymenodictyon* in February and March relative to the values in November and December were, no doubt, due to the fact that the leaves were becoming senescent in November and December such that by January, the leaves had all been shed off. The February to March leaves were therefore young tender regrowths. Similarly, the high crude fibre content of *Ricinodendron* in January was due to the senescence of leaves; the leaves were completely shed off by February. The average proximate composition of the leaves of the two browse species appeared to be highly similar to those reported earlier (Mecha and Adegbola, 1983; Oko, 2007; Agbo, 2008) for the leaves of Nigerian trees eaten by goats, although the average crude protein and crude fibre contents were slightly higher in this study. It had been previously reported (Okoli et al., 2003) that browse plants contain lower crude fibre than dry grass and this suggested higher digestible energy value for browse.

The nutrient composition of the browse species tend to suggest that there would be no problems with palatability and therefore intake. Thus, the browse species would constitute a good supplement to grasses for ruminants, especially during the dry season when the available grasses are usually extremely deficient in crude protein. However, the high ratio of calcium to phosphorus, in these browse species, might create problems of mineral nutrient imbalance, unless supplemental phosphorus would be provided from other sources.

REFERENCES

Adesogan AT, Sollenberger LE, Newman YC, Vendramini JMB (2009). Factors affecting forage quality. University of Florida IFAS Extension Forage Handbook SS-AGR-93 http://edis.ifas.ufl.edu

Agbo CC (2008). Effect of season and location on nutritional and anti-nutritional factors of some forage browse plants in Nsukka derived savanna zone. B. Agric Project Report. Department of Crop Science University of Nigeria Nsukka. p. 54.

AOAC (1975). Official Methods of Analysis. 12th ed. Assoc. Official Analytical Chemists. Washington D.C.

Cavell AJ (1955). J. Sci. Fd. Agric., 6: 479.

Clifton AB, Pfander WH (1967). J. Dairy Sci., 50: 77.

Laredo MA, Minson DJ (1973). Austr. J. Agric. Res., 24: 875.

Mecha I, Adegbola TA (1983). In Browse in Africa: The Current State of Knowledge (Le Houeron, H.N. ed). Symp. Addis Ababa. April 8 – 12, 1980, p. 305.

Oko JI (2007). The effect of season and location on the chemical composition of common browse plant found in Nsukka derived savanna zone of Nigeria. B. Agric project report. Department of Crop Science University of Nigeria Nsukka p. 29.

Okoli IC, Maureen O, Anumobi OBE, Enomuo V (2003). Studies on selected broses of southeastern Nigeria with particular reference to their proximate and some endogenous anti-nutritional constituents. Livestock research for rural development, 15(9): 72-83.

Otsyina RM, McKell CM (1984). Wld. Anim. Rev. 53: 33.

Snedecor GW, Cochran WG (1974). Statistical Methods 6th ed. Iowa State University Press, Ames, Iowa.

Steel RGD, Torrie JM (1966). Principles and Procedures of Statistics. McGraw-Hill Book Company, New York.

Thornton RF, Minson DJ (1973). Austr. J. Agric. Res. 23: 289.