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Nutritional factors in some fodder legume trees and shrubs

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Target Audience: Animal Scientists, Livestock Farmers, Ruminant Nutritionists, Agroforestry Practitioners

Abstract

Proximate composition, macro- and micro-minerals, polyphenols, oxalates contents and trypsin inhibitor activity of leaves of 20 forage legume trees and shrubs were determined. The dried leaves contained 11.52 - 29.26 g/100g (d.w.b) protein and 8.15- 23.37 g/100g crude fibre. High levels of Ca were observed in most of the species. Except for Acacia nilotica, Lonchocarpus sericeus and Pterocarpus osun, Albizia zygia and Parkia biglobosa, considered high in polyphenols, all the species seems to represent potential sources of ruminant feed and leaf protein concentrate. The nutritional significance of some of the antinutritional factors was briefly highlighted.

***Key words**: nutritional factors, fodder, legumes, trees, shrubs,*

Description of Problem

Tree and shrub leaves provide animal feed during the dry season when the normal grazing lands are dried up. As forest resources and grazing land shrink (1) and access to them becomes more difficult, stall feeding is becoming important. In this regard tree legumes especially hold the possibility of relatively high protein fodder and their ability to fix atmospheric N via the symbiotic relationship with soil bacteria is highly attractive given the often poor N status of tropical soils (2, 3). In tropical countries leaves may also become an important source of non-conventional proteins (4). Apart from providing fodder and fuelwood, trees are seen increasingly as a means of stabilizing soils through agroforestry systems (5). Information is therefore required on the nutritive value of forage tree and shrub species to enable agronomists and forecasters to give appropriate advice. In seeking new fodder resources therefore, leaves of 20 species growing in Nigeria were analyzed and the nutritive and some antinutritive ingredients are reported.

Materials and Methods

About 1kg of the aerial parts of matured twigs was harvested from the ICRAF-IITA

Arboretum, Ibadan, Nigeria between the months of October and November. For each species samples were taken from at least three plants and pooled. The leaves were manually separated from the stem. The leaves were dried at the ambient temperature (28^oC) in the green house for one week, ground to flour using a Wiley Mill with the 1 mm mesh sieve and stored in plastic bags at -4^o C until analysis. Residual moisture, nitrogen (N), fat, ash, micro- and macro-minerals were determined by standard methods (6). Crude proteins and total carbohydrate were calculated by N x 6.25 and difference, respectively. Trypsin inhibitor activity was determined by the method of Kakade *et al*. (7) using benzoyl-DL-arginine-p-nitroanilide (BAPNA) as substrate. Polyphenols was determined by the vanillin-HCl method (8). Total oxalate contents were determined as the acid-soluble oxalate using the method of Baker (9). Gross energy was calculated from the Atwater conversion system (10). All analysis was done in duplicates.

Results and Discussion

As shown in Table 1, crude protein contents ranged from 11.52 in *Parkia biglobosa* to 29.26g/100g d.w.b in *Albizia lebbek*. The *Albizia spps, Gliricidia sepium and Gnemia prebecus* were also high in protein and could be good sources of leave protein concentrates for food or feed. The fat contents, ranging between 1.18 and 4.12 g/100g, were typical of leaves (11). Crude fibre varied between 8.15 in *T. tetraptera* and 23.37g/100g in *Albizia gummifera*. Species with high fibre content like the *Albizia* spps, *Lonchocarpus sericeus* and *Pterocarpus osun* could be of high value in ruminant nutrition.

Table 1: Proximate Composition and Energy levels of tree leaves and browses plants (g/100gDM)*

Species	Dry Matter	Crude protein	Fat	Crude fibre	Ash	N-free extractives	Energy *kJ/100g*
Acacia nilotica	90.85	14.54	2.20	14.93	4.45	63.88	332.33
Acacia albida	90.16	22.79	2.16	17.65	5.18	33.50	284.24
Albizia adianthifolia	89.90	24.66	1.97	15.71	3.49	54.17	286.61
Albizia ferrugginea	92.11	21.25	1.09	15.13	5.94	40.08	285.40
Albizia lebbeck	89.88	26.30	2.25	17.46	5.72	29.06	277.10
Albizia gummifera	91.11	21.38	1.23	23.37	3.51	36.79	291.48
Albizia zygia	91.27	16.58	1.42	18.87	3.44	43.02	299.33
Albizia saman	91.47	21.79	3.25	20.35	2.66	35.53	309.85
Dalbergia latifolia	92.25	14.72	2.02	16.78	5.27	46.31	301.42
Dalbergia sassoo	91.08	17.63	2.50	12.84	6.56	43.43	290.72
Enterolobium cyclocarpum	89.98	13.69	3.30	16.95	5.88	42.14	298.31
Gnemia prebescus	91.44	18.57	2.59	14.77	8.07	39.62	285.59
Gliricidia sepium	90.23	21.73	3.31	16.43	8.13	31.82	280.37
Lonchocarpus sericeus	82.44	13.92	1.46	19.07	3.92	37.84	302.44
Millettia thonningii	91.15	16.83	1.60	15.99	2.13	46.53	304.64
Parkia biglobosa	90.62	10.44	4.09	15.75	4.53	47.31	314.30
Pterocarpus osun	90.97	17.25	2.28	19.76	5.59	37.88	293.46
Pterocarpus santalinoides	89.89	16.05	2.77	15.11	5.93	40.94	291.95
Prosopis africana	91.53	15.69	3.77	16.86	2.75	44.71	316.45
Tetraplura tetraptera	90.47	16.82	1.86	8.15	5.07	49.95	291.87
Tamarindus indica	90.12	11.75	1.48	15.32	3.43	49.23	ND

**Means of two independent analysis ; ND: Not determined*

Wide variation in mineral contents was found to occur (Table 2). Calcium contents ranged from 702.0 in *Albizia ferrugginea* to 4438.0 mg/100g d.w.b. in *Dalbergia latifolia*. Also relatively high in Ca are *Dalbergia sassoo* (3541mg/100g) and *Pterocarpus santalinoides* (2694 mg/100g d.w.b). Tree leaves are generally very rich in Ca (12). *Lycium ovalilobum*, a South American shrub, is reported to contain as high as 7320 mg/100 of Ca (13). Magnesium levels varied between 202 in *Acacia nilotica* and 548 mg/100g in *A. ferrugginea*. Zinc contents varied between 0.99 in *Enterolobium cyclocarpum* and 6.72 mg/100g d.w.b. in *D. latifolia*. Equally high Zn level (5.19 mg/100g d.w.b.) occurred in *D. sassoo*. Iron contents, varying between 10.24 in *P. africana* and 30.01mg/100g in *G. sepium,* were generally high. Copper contents in the leaves ranged between 0.65mg/100g in *P. africana* and 2.07mg/100g in *Acacia nilotica*. These fodder plant appear to be good sources of essential minerals and will easily satisfy animal needs without any need for inorganic supplementation. Zinc, Ca, Fe and Mg levels reported in this study seems to be higher than the requirement for various classes of animals (14, 15). The energy value based on protein, lipids and total carbohydrate contents ranged from 277.10 in *Albizia lebbeck* to 332.33 kJ/100g d.w.b. in *Acacia nilotica*. Results of proximate and mineral analysis in this study were generally on the same level with values reported for some tree and shrub plants leaves (11, 15).

Table 2: Mineral Composition of tree leaves and browses plants (mg/100g DM)*

Species	Ca	M	Fe	Cu	Zn
Acacia nilotica	911	202	16.09	2.07	2.77
Acacia albida	ND	ND	ND	ND	ND
Albizia adianthifolia	2389	520	23.86	1.40	1.35
Albizia ferrugginea	702	548	16.64	1.18	1.53
Albizia lebbeck	837	298	21.82	1.90	2.42
Albizia gummifera	1176	257	18.64	0.66	1.91
Albizia zygia	1268	310	14.34	1.40	1.99
Albizia saman	1086	252	14.89	1.85	1.18
Dalbergia latifolia	4438	521	16.46	1.87	6.72
Dalbergia sassoo	3541	524	17.67	1.62	5.19
Enterolobium cyclocarpum	953	504	15.75	1.44	0.99
Gnemia prebescus	2650	352	19.52	1.72	3.57
Gliricidia sepium	884	436	30.01	1.09	2.54
Lonchocarpus sericeus	2275	429	17.40	1.26	2.69
Millettia thonningii	2224	286	25.45	1.59	1.61
Parkia biglobosa	827	518	26.28	0.73	2.26
Pterocarpus osun	ND	ND	ND	ND	ND
Pterocarpus santalinoides	2694	471	14.84	1.46	2.17
Prosopis africana	407	268	10.24	0.65	2.12
Tetraplura tetraptera	2706	546	13.62	1.12	0.94
Tamarindus indica	2243	592	13.47	1.48	1.53

**Means of two independent analysis*

The trypsin inhibitor, total polyphenols and oxalates in plant leaves are presented in Table 3. Digestibility of nutrients and availability of minerals are usually affected by the presence of high levels of antiphysiological and toxic factors. Antinutritional factors, which also includes, phytate, tannins, cyanogenic glycosides, saponins, lectins, and alkaloids may contribute to a decrease in the overall nutritional quality of crop plants and negatively affect animal productivity (16). However the presence of tannins as antinutritional substance in feed and fodder has drawn the most attention. Polyphenol contents varied between 9.45 in *Albizia adianthifolia* and 108.36mg/g dwb. Species particularly high in polyphenols includes *Acacia nilotica, L. sericeus* and *Albizia zygia* (105.21, 97.49 and 61.95 mg/g respectively). With reference to report of Ubani *et al.* (17), these species could be classified as high-tannin browse and may not be suitable for small ruminant feeding. Polyphenols (or tannins) are able to interact with dietary protein to form indigestible protein-tannin complexes and also inactivate the enzymes (18), thus lowering protein digestibility. Tannins also have weak interactions with trypsin and thus also inhibit trypsin activity. Therefore the digestion of fibre and proteins is depressed in the ruminants as indicated by Van Soest and McDowell (19). A direct relationship between the low *in vivo* DM digestibility of leaves and their tannin contents has also been observed (20, 21). Tannins may decrease the DM digestibility by causing bacteriostatic and bactericidal effects on rumen microbes (22). Van Hoven (23) established an inverse relationship between the concentration of total tannins in the leaves and the level of feed intake or the browsing preference by animals. A tannin level of about 50mg/g in browse is required for feed rejection to occur in grazing animals (18). It is worthy to note, however, that the vanillin-HCl assay is not specific for only polyphenols that are tannins. Thus tannin levels may actually be lower than the observed values (24).

Trypsin inhibitory activities were detected in all the leaf samples, ranging from 3.4 in *A. saman* to 26.35 TIU/mg in *T. tetraptera*. Total oxalate levels ranged between 1.33 in *Albizia adiathifolia* and 15.13 mg/g in *Acacia nilotica*. These levels of oxalates are substantially lower than the minimum toxic level of 3g/100g (25) indicating that the levels of oxalate in the leave samples are within acceptable limits. Oxalic acid exists as the highly insoluble Ca salt and as the soluble form, which is the toxic fraction. Oxalates occur in relatively high levels in certain forage species and have been responsible for fatalities (26). Seawright *et al.* (27) reported death of cows that grazed for 24 hours on pastures consisting of *Stearia sphacelata* which contained 6.9% oxalate.

Table 3: Trypsin inhibitor, Total polyphenols and Oxalates in plant leaves*

Species	Trypsin Inhibitor *TIU/mg*	Polyphenols *mg/g*	Total oxalates *mg/g*
Acacia nilotica	18.53	105.21	15.13
Acacia albida	5.10	18.59	2.93
Albizia adianthifolia	9.35	9.45	1.33
Albizia ferruginea	8.76	12.50	5.09
Albizia lebbeck	4.76	12.29	1.58
Albizia gummifera	4.25	13.76	1.87
Albizia zygia	8.16	61.95	2.14
Albizia saman	3.40	19.32	1.50
Dalbergia latifolia	14.54	40.64	2.75
Dalbergia sassoo	14.54	16.70	2.54
Enterolobium cyclocarpum	4.00	15.44	2.99
Gnemia prebescus	11.14	3.99	1.95
Gliricidia sepium	4.76	12.50	2.31
Lonchocarpus sericeus	7.74	97.49	3.30
Millettia thonningii	6.80	10.61	2.32
Parkia biglobosa	14.45	55.97	1.92
Pterocarpus osun	18.96	108.36	4.17
Pterocarpus santalinoides	9.78	39.17	4.58
Prosopis africana	17.85	31.29	5.03
Tetraplura tetraptera	26.35	24.26	3.24

*Means of two independent analysis

Conclusion and Applications

1. It appears that these tree and shrub species, excluding the high tannin ones, could be utilized successfully as browse in livestock feeding.
2. The high crude proteins and low levels of antinutritional factors occurring, especially in *Acacia albida, Albizia adianthifolia, Albizia lebbeck, Albizia ferrugginea, Albizia saman, Albizia gummifera and Gliricidia sepium* may allow them to be used in monogastric feeds

including fish and for protein extraction.

3. Their feed value in practical type diets and potential as fodder for livestock, therefore need to be more carefully studied. They may also become useful in local farming systems as means of stabilizing soils in agroforestry systems if promoted.

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