Nutrient and anti-nutritional constituents of *Penisetum purpureum* and four indigenous tree legume of South-Western Nigeria: A potential ruminant feed

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Abstract

A study was carried out to investigate the nutrient composition as well as anti-nutritional constituents of some tree plants (*Ficus sur*, *Bridelia macarrantii*, *Gmelina arborea* and *Albizia saman*) and forage grass (*Penisetum purpureum*) in south-western Nigeria. Results indicated significant ($P < 0.05$) variability in values of percentage crude protein (9.71 - 23.67%) where *Penisetum purpureum* recorded the least value and highest value observed in *Ficus sur*. Dry matter (DM), Crude fiber (CF), Organic matter (OM) and Ash contents varied significantly ($p < 0.05$) from (23.52-46.23%, 8.45 - 30.22%, 64.01 - 96.95% and 2.66 - 8.44%) respectively. *Albizia saman* recorded significantly ($p < 0.05$) higher ADF value (35.39%) with intermediate value (4.14%) of NDF. *Penisetum purpureum* had most ADL value (17.19%) while the least value was recorded in *Gmelina arborea*. Hemicellulose value ranged between (4.45 - 22.23%) with least value recorded by *Ficus sur* and highest by *Penisetum purpureum* plants. The concentrations of anti-nutritional factor was generally low, tannin content significantly ($p < 0.05$) ranged from (0.75 - 3.56%) in *Ficus sur* and *Albizia saman* respectively. *Penisetum purpureum* had the least phytate (0.94 %) while *Bridelia macarrantii* recorded the most phytate value (2.65%). Saponin, Alkaloid and Oxalate level ranged from (0.10 - 1.51%, 0.36 - 1.58% and 0.34-1.41%) respectively. The results show that the investigated plants seem to have good nutrient composition as well as low level of anti-nutritional factors and therefore can best be incorporated into ruminant feeding systems.

Key words: Nutrient composition; Anti-nutritional constituents; tree plants; forage grass

Introduction

The potentials of trees and shrubs as alternative fodder resources in ruminant nutrition (Fadiyimu *et al.*, 2011) have attracted the attention of researchers worldwide; several indigenous and exotic browse species have been investigated and evaluated for inclusion in ruminant feeding systems in Nigeria. Unfortunately, the adoption of most of these species by farmers has been faced with several challenges such as pest and disease attack and presence of anti-nutritional factors.

There is therefore the need for continuous screening of browse plants to identify those with good potentials as livestock fodder and which could serve as alternatives to those species which have already been evaluated. Beside grasses, browse plants constitute one of the cheapest sources of feed for ruminants, Ahamefule *et al.*, (2006). Their year round evergreen presentation and nutritional abundance enable them to provide for year round of fodder (Ibeawuchi *et al.*, 2002). The importance of browse plants is increasingly

acknowledged worldwide (Keay, 1989); they provide protection, vitamins and frequently mineral elements which are lacking in grassland pastures. Okoli *et al.*, (2003), Proximate analysis has been the most commonly used method of screening the tropical browse plants utilized by indigenous farmers for ruminant feeding. In few of paucity of information in literature on the nutritive quality of indigenous fodder tree leaves. The present study is an attempt to further report on the potential of indigenous browse plants as ruminant feed resource.

Materials and Methods

Location of the study: The study location lies within the savanna agro-ecological zone of southwest Nigeria (latitude: 7° N, longitude 3.5°). Abeokuta has an average annual rainfall of 1037 mm in a bimodal rainfall pattern that peaks in July and September with a break of 2–3 weeks in August. Temperatures are fairly uniform with daytime values of 28–30°C during the rainy season and 30 to 34°C during the dry season with the lowest night temperature of approximately 24°C during the harmattan period (December and February). Relative humidity of the study site is high during the rainy season with values ranging between 63 and 96% as compared to dry season values of 55 to 84% (Anele *et al.*, 2011).

Sample collection and preparation

Four tropical browse plants (*Bridelia micranthi*, *Ficus sur*, *Albizia saman*, *Gmelina arbore*) and a forage grass (*Penisetum purpureum*) were used for the study (Table 1). *Penisetum purpureum* was harvested from cultivated pastures established by Department of Pasture and Range management at Teaching and research farms directorate (TREFAD) premises while fresh samples (leaves and

tender stems) of selected tree plants were collected from mature plants within the arboretum of the Federal University of Agriculture, Abeokuta, Nigeria at the peak of dry season (December to February). Each sample was replicated three times. Laboratory analysis was carried out at Animal Nutrition laboratory, Federal university of Agriculture, Abeokuta, South-West, Nigeria. A portion of the harvested samples was weighed and oven-dried at 60° C for 48 hours, ground through a 1 mm screen and stored in a polythene bag prior to chemical analysis.

Chemical Analysis Procedure

Chemical composition (CP, CF, EE, Ash and DM) of the plant sample was determined according to AOAC (1995) protocol. Organic matter (OM) content was obtained by subtracting % ash content from 100 %. Neutral detergent fibre (NDF), Acid detergent lignin (ADL) and acid detergent fibre (ADF) were determined according to the procedure of Van Soest *et al.*, (1991). Cellulose and hemicellulose were derived from NDF, ADF and ADL by simple calculation as follows: Hemicellulose = NDF – ADF, Cellulose = ADF - ADL

The second portion was air-dried, ground and analyzed for the anti-nutritional factors: tannin (Makkar and Goodchild, 1996), phytate (Maga, 1982), Saponin and alkaloid were determined according to methods described by Harborne (1973), Trease and Evans (1989) while oxalate was determined by the spectrophotometric methods of Hang and Lantzsich (1983).

Statistical Analysis

Data collected were subjected to Analysis of Variance and significant differences among means were compared using Duncan multiple Range test (SAS, 1990).

Results and Discussion

The chemical composition of the tree leaves

Table 1: Forage plants evaluated

Botanical Name	Family Name	Common Name
<i>Ficus sur</i>	Moraceae	Fig tree
<i>Bridelia macarrantii</i>	Phyllanthaceae	Asasa
<i>Gmelina arborea</i>	Lamiaceae	Gmelina
<i>Albizia saman</i>	Fabaceae (alt.Mimosaceae)	Rain tree
<i>Pennisetum purpureum</i>	Poaceae (alt.Gramineae)	Elephant grass

are presented in Table 2. *Ficus sur* recorded the highest ($P < 0.05$) CP value of (23.67 %). *Gmelina arborea*, *Albizia saman* and *Bridelia macarrantii* recorded intermediate values of (16.56, 18.88 and 19.09 %) respectively. The CP value recorded by *Pennisetum purpureum* was higher than that reported by **Ukanwoko and Igwe (2012)** for *Pennisetum purpureum* (8.24%) and *Panicum maximum* (8.45%), *Amata and Lebari (2011)* reported lower CP value (14.6%) for *Gmelina arborea* compared with the value recorded in this study (16.562%), *Ahamefule et al., (2006)* reported higher CP value (18.60%) for the same plant, (16.10%) for *Alchornea cordifolia*, and (24.85%) for *Centrosema pubescens* that are categorized as moderate browse plants. *Omoniyi (2006)* reported

higher value of (29.0%) for CP in *Albizia saman* leaf; this disparity might be attributed to the growth stage, maturity of the plants as well as the soil types and constitution. The CP values recorded for all the plants were above (8%) required to satisfy the maintenance requirement for ruminants (*Norton, 2003*) and above the minimum level necessary to provide sufficient nitrogen required by rumen microorganisms to support optimum rumen activity (*Mc Donald et al., 2002*) and also for adequate intake of forages. *Getachew et al., (2004)* also stated that browse forages are higher in CP than tropical grasses and roughages such as hay, straw and stover. *Gmelina arborea* recorded the least CF value while *Pennisetum purpureum* recorded ($P < 0.05$) highest CF value.

Table 2: Chemical composition of the selected forage plants (%)

Samples	CP	CF	ASH	EE	DM	OM
<i>P. purpureum</i>	9.710 ^c	30.217 ^a	7.868 ^a	2.297 ^d	46.217 ^a	92.13 ^a
<i>F. sur</i>	23.667 ^a	16.200 ^c	8.442 ^a	6.648 ^c	23.517 ^c	91.56 ^a
<i>B. macarrantii</i>	19.090 ^b	14.848 ^c	3.047 ^b	9.051 ^b	36.094 ^b	96.95 ^a
<i>G. arborea</i>	16.562 ^b	8.445 ^d	2.658 ^b	11.517 ^a	27.737 ^c	64.01 ^b
<i>A. saman</i>	18.883 ^b	20.600 ^b	8.267 ^a	3.825 ^d	39.453 ^b	91.710 ^a
SEM	0.942	0.822	0.595	0.467	1.458	0.915

^{abcd} Means in the same column without superscript in common are different at $P < 0.05$

SEM: Standard Error Mean,

CP: Crude protein, CF: Crude fiber, EE: Ether extract, DM: Dried matter, OM: Organic matter

Table 3: Fiber constituents of the selected plants (%)

Sample	ADF	NDF	ADL	Cellulose	Hemicel
<i>P. purpureum</i>	34.943 ^a	57.177 ^a	17.192 ^a	17.752 ^b	22.234 ^a
<i>F. sur</i>	33.617 ^a	38.070 ^c	8.712 ^b	24.906 ^a	4.453 ^b
<i>B. macarrantii</i>	19.023 ^b	38.528 ^c	6.861 ^b	12.163 ^c	19.505 ^a
<i>G. arborea</i>	34.723 ^a	41.051 ^{bc}	6.577 ^b	28.147 ^a	6.327 ^b
<i>A. saman</i>	35.392 ^a	46.142 ^b	6.647 ^b	28.745 ^a	10.750 ^b
SEM	0.146	1.789	0.714	1.646	2.356

^{abc} Means in the same column without superscript in common are different at $P < 0.05$

SEM: Standard Error Mean,

ADF: Acid Detergent Fiber, NDF: Neutral Detergent fiber, ADL: Acid Detergent Lignin, Hemicel: Hemicellulose

Babayemi *et al.*, (2009) reported (9.9 g/100 g DM) for Ether extract in *Albizia saman* seed which was higher than the value reported (3.825%) in the present study. Ash content ranged ($P < 0.05$) from (2.66% - 8.44 %) with the least value from *Gmelina arborea* and the highest from *Ficus sur*. This result compared favourably with the report of Omoniyi (2006) who reported ash contents of (5.5%) for *Albizia saman*, (7.5%) for *Spondia mombin* and (15.5%) for *Ficus thonningii*. Igwe (2010) reported (0.09%) for *Spondia mombin* leaf, these values indicating rich source of minerals. Dry matter content was lowest ($P < 0.05$) in *Ficus sur* (23.52%) and highest in *Pennisetum purpureum* (46.22%). Isah *et al.*, (2012) reported DM value of (19.39%) for *Ficus exasperata* and (32.04%) for *Azadiracta indica*. Ambient temperature, seasonal or climatic factors might be responsible for the variation in these values obtained as corroborated by Agriculture (2011). The values for organic matter content ranged ($P < 0.05$) from (64.01%) in *Gmelina arborea* to (96.95%) in *Bridelia macarrantii*. Fadiyimu *et al.*, (2011)

reported organic matter content of (83.3%) for *Ficus exasperata*, (83.6%) for *Ficus thonningii* and (94.0 %) for *Spondia mombin*, this discrepancy could be attributed to anatomical differences between plant species which according to Phuc (2006) depend on effect of plant development and on leaf: stem ratio.

The values for fiber constituents (Table 3) revealed that ADF was ($P < 0.05$) lowest (19.023%) in *Bridelia macarrantii* and had the best value (34.94%) in *Penisetum purpureum*, Ebiegber and Uche (2009) reported (200 and 330 gkg⁻¹) for *Manniophyton fulvum* and *Microdesmis puberula*, Uzman *et al.*, (2011) reported ADF contents of (16.00, 16.00, 17.00 and 23.00 %) in *Morus alba*, *Acacia nilotica*, *Ziziphus jujuba* and *Syzygium cumuni* leaves respectively while Matlebyane *et al.*, (2009) reported (17.7, 23.3, 26.7 and 33.2 gkg⁻¹) for *Vangueria cyanescens*, *Acacia karoo*, *Cynodon dactylon* and *Acacia rehmanniaana* respectively. NDF was most ($P < 0.05$) for *Penisetum purpureum* (57.18%) and least for *Ficus sur* (38.07%), these values were lower in

comparison to the report of Abegunde *et al.*, (2011) who reported (67.0%) NDF value for *Ficus polita* in the dry season and (88.0%) was recorded for the same plant in the wet season. Ahamefule *et al.*, (2006) reported similar NDF values for *urena lobata* (57.50%) and *Landolphia owariensis* (52.00%) plants. (49.1% and 44.2%) NDF was reported for *Leuceana leucocephala* and *Canavalia ensiformis* respectively (Babayemi *et al.*, 2009), Ebiegberi and Uche (2009) reported (310.00 and 600.00g kg⁻¹DM) for *Manniophyton fulvum* and *Microdesmis puberula* as well as (36.00%) for *Ficus exasperata* and (30.00%) for *Synedrella nodiflora* (Isah *et al.*, 2012). ADL of the samples ($P < 0.05$) varied from (6.58%) in *Gmelina arborea* to (17.19%) in *Penisetum purpureum*, these values compared favourably with the report of Isah *et al.*, (2012) who reported similar ADL values (6.20%) for *Azadiracta indica* and (7.80%) for *Ficus exasperata*, Ogunbosoye and Babayemi (2010) reported (6.96%) for *Adansonia digitata*, (12.93%) for *Newbouldia laevis* as well as (12.00%) for *Taminalia catappa* while Omoniyi (2006) reported (24.32%) for *Ficus thonningii*, (27.59%) for *Spondia mombin* and (45.10%) for *Newbouldia laevis*. Cellulose content was ($P < 0.05$) lower in *Bridelia macarrantii* (12.16%) while highest value (28.75%) was observed in *Albizia saman*. Hemicellulose ranged ($P < 0.05$) between (4.45- 22.23%) where *Ficus sur* had the least and *Penisetum purpureum* recorded the best, Uzman *et al.*, (2011) reported (10.2 and 15.0%) hemicellulose for *Morus alba* and *Ziziphus jujuba* leaves which was higher than the values recorded for *Ficus sur* and *Gmelina arborea* (4.45 and 6.33%) in this study.

Figure I depict tannin, saponin, phytate, alkaloid and oxalate compositions of the

browse plants investigated, values recorded in all the plants were below (2.5%) recommendation by NRC (1985) except for *Bridelia macarrantii* and *Albizia saman*. The highest ($P < 0.05$) tannin content recorded by *Albizia saman* (3.56%) was lower than (1.02%) for *Moringa oleifera*, (1.17%) for *Ficus exasperata*, (7.71%) for *Spondia mombin* (Fadiyimu *et al.*, 2011) and (4.3 %) for *Daniellia oliveri* (Osakwe *et al.*, (2004). Diagayette and Huss (1981) were of the opinion that the level of tannin which adversely affect digestibility in sheep and cattle is between (2 – 5 %) whereas goats have a threshold capacity of about (9 %) dietary tannin (Nastis and Malachek 1981). All the plants investigated in this study contain tannin at levels tolerable to ruminants. The Saponin level is between (0.10 – 1.51%) in *Gmelina arborea* and *Penisetum purpureum* respectively which was lower ($P < 0.05$) to (4.8%) reported (Igwe *et al.*, 2010). Saponin is noted to reduce bacteria population in the rumen (Teferedegne 2000), thereby reducing the amount of methane production (Babayemi *et al.*, 2004b).

The phytate level was between (0.940 – 2.652%), *Pennisetum purpureum* recorded the lowest ($P < 0.05$) value while the highest was observed in *Bridelia macarrantii*, Aye and Adegun (2010) reported (22.24, 14.00 and 9.06mg/100g) for Gliricidia-poultry multinutrient block, Gliricidia-urea-poultry multinutrient block and Gliricidia-urea multinutrient block respectively.

Alkaloid and Oxalate varied between (0.36 – 1.59% and 0.34 – 1.41 %) in *Pennisetum purpureum* and *Albizia saman* as well as *Ficus sur* and *Albizia saman* respectively. These values compared favourably with the report of Agbabiaka (2012) who reported (0.11- 0.14 %, 0.41- 0.77) mg/g) for

Figure 1: Anti-nutritional profile of the selected plants (%)

PP: *Penisetum purpureum*, FS: *Ficus sur*, BM: *Bridelia macarrantii*, GM: *Gmelina arborea*, AS: *Albizia saman*

Alkaloid and Oxalate in rumen digesta from cattle, goat and sheep. High content of oxalate can affect Ca and Mg metabolism (Onwuka, 1983) but ruminants, unlike monogastric.

Conclusion

All the plants investigated have appreciable nutrients above recommended minimum levels to support growth and maintenance of ruminants as well as tolerable levels of anti-nutritional constituents there by making them safe for ruminant intake. These plants have potential to boost inadequate feed supply and low level of nutrients encountered by ruminants especially in the dry season. Attention should be given to efficient integration of multipurpose fodder shrubs and trees as fodder bank in feeding calendars of ruminants. These plants could be efficiently integrated with existing, well known

species and planted as intensive feed game.

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