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Evaluation of Preference and Intake of Browse Species by West African Dwarf Goats in Nigeria

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Abstract:
In the south west of Nigeria there two distinct seasons (rainy and dry). Forage availability is seasonal. Rainy period is synonymous to abundance of fodders but experience scarcity during dry season. Therefore, in order to broaden the feed base for ruminants in Nigeria, the suitability of thirty one (31) browse species as feed for ruminant animals was investigated. The nutritive components of the foliage of these browse species were determined. Chemical composition of the forages was examined. Presence of secondary metabolites viz-a-viz tannins, saponins and steroids was determined qualitatively. Also, a short term forage preference (acceptability test) for the browse species by West African Dwarf (WAD) goats was evaluated using a cafeteria method in Ten (10) adult female WAD goats. The thirty one (31) browse plants were classified into two groups of legumes and non-legumes. The non-legumes were further sub-divided into non-leguminous family related and unrelated.
Results indicate that crude protein (CP) content was significantly (P<0.05) lowest in Syzygium zamaragensis and highest in Griffonia simplicifolia while Neutral detergent fibre (NDF) differed significantly (P<0.05) and ranged from 32.08 to 69.31% in Leucaena leucephala and Kigelia africana respectively. All other components were also varied significantly.
The acceptability assessment of the browse species revealed that only twelve of the fodder species evaluated were accepted and when these twelve were further subjected to acceptability test, five of the twelve that were previously preferred were only accepted. The remaining seven were rejected. It was concluded from the study that goats select their diets when they are introduced to varieties of forages.

***Key words**: Acceptability, preference, coefficient of preference, WAD goats, browses plants*

1. Introduction

Ruminants are generally faced with the period of feed scarcity during the dry season. Period of dry season is synonymous with unavailability of quality pasture. During this period, animals are left with lignified grasses, crop residues and industrial by-products. The conventional feed that may be available during this period are expensive as a result of competition between man and monogastric animals like poultry, swine etc.

Voluntary intake of tropical grasses can be a major constrain to ruminant performance in the tropics. The solution to this problem may be through the incorporation of tree fodders as feed supplements to improve the rumen environment, which can lead to increase forage intake. A lot of studies have been carried out on few of the browse trees, and the most prominent ones are *Leucaena leucocephala* (Odeyinka, 1999; Odedire and Babayemi, 2008) and *Gliricidia sepium* (Arigbede et al., 2003; Babayemi, 2007). Nevertheless their utilization in ruminant feeding is constrained because of the presence of mimosine and coumarin in *L. leucocephala* and *G. sepium* respectively. The availability of these two browse species all through the year has made them to be used as mulching of some crops during dry season and this alternative utilization has reduced their continuous availability as livestock feed. In view of this, it is then necessary to look into the potentials of some other under-utilized fodders that could sustain the livestock during the lean period. Although, most researches have been focusing on single tree fodder evaluation and not feed preference, but ruminants select their diets from a range of plant species and plant parts that differ in their physical and chemical compositions (Dove, 1996). However, in ruminant production practices, a common practice is to offer a variety of tree fodders as supplements, either separately or with grasses (Sandoval-Castro et al., 2005). The information regarding these practices on intake of forage is not readily available.

Hence, to get sufficient and good quality feed for the ruminant, a strategy has to be developed to assess the value of these parameters as predictors of forage preference, and their values in designing feed for effective management of the available browse plants.

Preference assessment or otherwise called acceptability is a fast and cheap means of assessing fodder plants in a short period of time (Sandoval-Castro et al., 2005).
Therefore, the study was carried out to assess short term preference of WAD goats to some plant fodders in a cafeteria method.

2. Materials and Methods

2.1. Grouping of Browse Plants
The thirty one (31) fodders used for this study were divided into three groups: The legumes, Non-legume family related and non-legume family unrelated. The grouping was necessary for easy assessment.

2.2. Experimental Location
The experiment was carried out at the Animal Genetic Resources Unit of National Centre for Genetic Resources and Biotechnology (NACGRAB), Moor Plantation, Ibadan.
Browse plants were collected from the field gene bank of the above named centre. The location is 7^{o} 27´N and 3^{o} 45´E at an altitude of between 200-300m above sea level, with mean temperature of 25-29^{o}C at an average annual rainfall of about 1250mm. All plants species were collected at much matured stage.

2.3. Chemical Composition
Fodder samples were ground in a Wiley mill to pass a 1-mm screen and analysed for crude protein (CP), crude fiber (CF), ether extract (EE) and ash (AOAC,1990), neutral detergent fibre (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were estimated as established (Van Soest et al 1991). All statistical procedures were performed using SAS, (1999).

2.4. Forage Acceptability
The study was carried out at Animal Genetic Resources Department of NACGRAB, Moor Plantation, Ibadan. Ten adult female West Africa dwarf goats were used in a cafeteria feed preference study which lasted 14 days with 7 days of adaptation. The initial weight of the animals was between 10-12kg. They were housed in a well ventilated open sided pen capable of accommodating 80-100kgBW adult goats. At the time of this study three tree fodders were not available in large quantity, so only ten of the non-leguminous family-related fodders were assessed. The forages were harvested fresh and 10kg of each was introduced to the animals in different containers. Each browse was replicated thrice in order to have access to them. The positioning of the plants was changed daily to avoid conditioning and learning effects by the animals sticking to the same feed in the particular position. The feeding of the animals was monitored for 6hours (0800-1400) daily. Average daily intake was calculated by deducting the refusal from the amount served. Coefficient of preference (COP) was determined as the ratio of individual intake of the forage and the average intake. Forage with COP less than unity is considered not accepted, while COP greater than unity is well accepted (Karbo *et al*, 1993, Babayemi, 2007, Ogunbosoye, 2011).

3. Results

3.1. Chemical Composition of Legumes
Chemical composition of the leguminous plants is shown in Table 1. Dry matter varied significantly (P<0.05) among the browse species. The least value (25.27g/ 100g DM) and the highest (41.60g/100g) were *Gliricidia sepium* and *Pentaclethra macrophylla* respectively. The CP of the browse also followed the same trend. Significant differences were observed in the CP values for all the browse species. The CP contents were generally moderate except for *Dalbergia sisso* and *Griffonia simplicifolia* which has CP of 9.8% and 29.3% respectively. The CF contents of the browse trees were significantly different, ranging from 23.1% in *Leucaena leucocephala* to 38.1% in *Tamarindus indica*. The ash content of any feed is a measure of mineral level. Significant (P<0.05) differences were observed among the browse species in respect to ash. The highest value was observed in *Peltophorum pterocarpum* and significantly least value observed in *Albizia odoratissima*. Ether extract varied significantly from 5.95 to 18.58 and is also a measure of lipid content of the legumes. *Cassia fistulosa* recorded the highest value of EE while *Tetraptera* had the lowest. The fibre fractions of the browse plants were as displayed in Table 1 and the values obtained were significantly (P<0.05) different. The values ranged from 41.8% to 65.6% for NDF, 26.7% to 49.4% ADF and 6.1% to 13.7% for ADL. The highest level of NDF, ADF and ADL were observed in *Peltophorum pterocarpum* while *Albizia odoratissima*.and *Leucaena leucocephala* had the lowest values of ADL
The chemical composition of different types of non-leguminous family related browse trees grown in southern part of Nigeria are summarized in Table 2. Significant differences were obtained among the browse species. DM contents varied significantly from 21.63g/100g DM in *Ficus thonningii* to 43.79g/100g DM in *Mangifera indica*. The CP was significantly higher (16.41g/100g DM) in *Bombax glabra*. Among the plant species only Mangifera species exhibited CP value below the critical protein requirement level for ruminant, which then means that for animal to feed with such plant, it has to be supplemented with high protein feed. CF varied significantly (P<0.05) from 26.18g/100g DM in *Terminalia superba* to 42.13g/100g DM in *Tabebuia rosea*. The least values of Ash and EE were observed in *Tabebuia rosea* (5.27 and 12.46 %) respectively. The fibre fractions were also significantly different (P<0.05). However, *Kigelia africana* had the highest contents of NDF, ADF and ADL while *Milicia exelsa* had the least value of NDF and ADF but ADL content of *Tabebuia rosea* was the lowest

In table 3, the chemical composition of some non-leguminous family unrelated browse plants was reported. The dry matter (DM) content varied significantly (P<0.05) from 27.67 to 43.99g/100g DM in *Hura crepitens* and *Dacryodes edulis* respectively. The result indicated that *Hura crepitens* had the least dry matter content but highest crude protein. It was observed that Crude fibre content of *Hura crepitens* was the lowest. Significant differences were also observed in ash and ether extract (EE) values. *Napoleanaea inperialis* had the least ash while *Gmelina arborea* was observed to have the lowest. The fibre fraction content of non-legume plants also varied significantly (P<0.05). The neutral detergent fibre (NDF) which is a measure of plant cell wall contents ranged between 44.34g/100g DM in *Gmelina arborea* and 65.33g/100g DM in *S.zamaragensis.* The ADF which is also a measure of cellulose content of the feed varied from 32.02g/100g DM in *Gmelina arborea* to 49.61g/100g DM in *S. zamaragensis.* The acid detergent fibre (ADF) which is the lignin content of the tested sample was lowest in *Hura crepitens.* Therefore, from all indications, *Hura crepitens* seems to be richer in nutrients than the other browse species.

ADL	DM	CP	CF	Ash	EE	NDF	ADF	ADL
CF	39.55bc	14.81g	30.48c	8.93a	18.58d	60.8b	46.9a	7.7f
PP	33.74d	13.33b	30.17c	6.41ef	7.49g	65.6a	49.4a	13.7a
TI	31.68e	15.48ef	38.11a	6.02fg	9.69e	58.2c	41.6b	11.1cd
PS	31.48e	10.38i	28.82c	9.25a	12.76ab	60.6a	46.6a	12.9ab
DS	40.19b	9.79i	29.55c	6.88ed	11.32cd	44.4f	31.7c	8.9e
GLS	25.27f	19.60c	24.87d	7.89c	11.71c	48.7e	34.3c	7.4f
GFS	39.08c	29.53a	33.64b	8.30bc	13.36a	62.1b	41.1b	12.1bc
TT	33.03d	15.30fg	39.17a	7.02d	5.95b	52.1d	39.3b	10.2d
AO	41.25a	15.99c	23.78ed	5.14f	9.05f	41.8g	26.7d	6.3g
PM	41.60a	15.15fg	33.00b	5.64gh	10.00c	60.0bc	32.5c	8.8f
PB	39.53bc	18.38d	33.48b	7.32d	13.11a	58.2c	41.6b	11.1dc
LL	31.72c	23.85b	23.14e	8.70ab	12.36b	44.5f	32.2c	6.1g
SEM	0.26	0.22	0.54	0.08	0.21	0.11	1.08	0.35

Table 1: Chemical composition (g / 100 g DM) of leguminous browse plants

a,b,c,d,e,f,g,h,i: Means on the same column with different letters are significantly different (P < 0.05)
CF= *Cassia fistulosa*, PP= *Peltophorum pterocarpum,* TI= *Tamarindus indica,* PS= *Pterocarpus santalinoides,* DS= *Dalbergia sisso,* GLS= *Gliricidia sepium,* GFS= *Griffonia simplicifolia,* TT= *Tetrapleura tetraptera,* AO= *Albizia odoratissima,* PM= *Pentaclethra macrophylla,* PB= *Parkia biglobosa,* LL= *Leucaena leucocephala.*
DM= Dry matter, CP= crude protein, EE= Ether extract, NDF= Neutral detergent fibre, ADF= Acid detergent fibre, ADL= Acid detergent lignin
SEM=Standard Error of Mean

Plant spp	DM	CP	CF	Ash	EE	NDF	ADF	ADL
BG	28.81h	16.41a	33.15e	9.60e	11.82b	58.36e	42.46d	11.36e
AD	41.44c	13.54c	26.41j	6.24h	14.72a	57.42f	39.79e	6.96h
CP	31.64g	16.19a	30.48h	10.15b	9.31ef	58.09ef	41.65d	14.16b
KA	32.19f	9.01e	38.31b	12.46a	7.69g	69.31a	52.62a	16.83a
NL	43.07b	9.89d	41.13a	8.46f	12.25b	66.57b	48.36b	12.93c
TR	35.27e	13.32c	41.75a	5.27i	6.10h	58.12ef	39.96e	6.07j
TA	38.33d	9.19e	30.41h	10.98c	11.25c	55.75i	29.95g	6.59i
ME	38.11d	8.00f	29.25i	11.51b	9.92d	40.49j	28.39h	6.14j
MI	43.79a	6.35h	32.05f	7.05g	9.19f	58.63e	37.70f	13.06c
SM	32.22f	15.45b	31.28g	8.63f	11.07c	54.65h	39.96e	7.85g
TS	26.85i	15.45b	26.18j	9.83d	9.74ed	56.60g	38.92ef	9.88f
TC	25.85	7.22g	37.04c	9.50e	9.80d	62.47d	44.81c	12.00d
FT	21.63k	13.54c	35.49d	12.12a	10.10d	64.06c	47.65b	12.18d
SEM	0.14	0.57	0.18	0.17	0.15	0.28	0.46	0.09

Table 2: Chemical composition (g/100g DM) of some non-leguminous browse species

Means with the same letters within the column are not significantly different (P<0.05) *Bombax glabra* (BG), *Adansonia digitata* (AD), *Ceiba pentandra* (CP), *Kigelia africana* (KA), *Newbouldia leavis* (NL), *Tabebuia rosea* (TR), *Treculia africana* (TA), *Milicia excelsa* (ME), *Mangifera indica* (MI), *Spondias mombin* (SM), *Terminalia superba* (TS), *Terminalia catappa* (TC) and *Ficus thonningii* (FT)

Plant spp	DM	CP	CF	Ash	EE	NDF	ADF	ADL
Gmelina arborea	35.46c	11.66d	31.66c	7.10d	10.07e	44.34f	32.02e	9.09c
Dacryodes edulis	43.99a	6.98e	28.30d	10.65b	10.54d	46.49e	34.73d	9.37c
Blighia sapida	38.12c	13.53c	40.09a	6.02fg	12.26a	56.99c	35.54cd	11.76b
Syzygium zamaragensis	37.27d	5.43f	28.43d	9.51c	10.20ed	65.33a	49.61a	12.60a
Hura crepitens	27.67f	17.89b	27.62ed	11.52a	11.64b	52.46d	39.36b	8.22d
Napoleonaea inperialis	39.12b	11.71d	35.37b	6.12e	12.14a	58.86b	36.39c	9.33c
SEM	0.04	0.21	0.58	0.17	0.13	0.13	0.37	0.29

Table 3: Chemical composition of foliage from non-leguminous family unrelated browse species (g/100g DM)

Means within the column with the same letters are not significantly different (P<0.05)

	Acceptability parameters	
Browse species	**Ave. daily intake (kg DM) for all the animals**	**Coefficient of preference (COP)**
Cassia fistulosa	0.16	0.14
Peltophorum pterocarpum	0.96	0.82
Tamarindus indica	1.62	1.38
Pterocarpus santalinoides	0.88	0.75
Dalbergia sisso	1.80	1.53
Gliricidia sepium	2.00	1.70
Griffonia simplicifolia	0.30	0.26
Tetrapleura tetraptera	1.38	1.17
Albizia odoratissima	1.14	0.97

Pentaclethra macrophylla	1.35	1.15
Parkia biglobosa	1.44	1.22
Leuceana leucocephala	2.64	2.24

Table 4: Voluntary intake of leguminous browse fodders offered simultaneously to WAD goats

	Acceptability Parameters	
Browse species	**Average daily intake (kg DM/10 animals)**	**Coefficient of preference (COP)**
Bombax glabra	0.48	0.41
Kigelia Africana	1.0	0.85
Newbouldia laevis	0.74	0.65
Ficus thonningii	2.10	1.7
Treculia Africana	1.34	1.14
Milicia excels	0.86	0.73
Mangifera indica	2.0	1.7
Spondias mombin	1.62	1.38
Terminalia superb	1.0	0.85
Terminalia catappa	1.0	1.19

Table 5: Voluntary intake of non-legume family related fodders offered simultaneously to WAD goats

The free intake of dry matter of twelve (12) leguminous plants is presented in Table 4. It was observed that the animals were able to consume above 1kg each of eight fodders while the remaining five was below 1kg but *Gliricidia sepium* and *Leucaena leucocephala* were better consumed than the rest. Coefficient of preferences (COP) which is the ratio of individual intake and the average intake of individual forages showed that only seven of them have their COP be up to unity while the rest plants were below unity.

In table 5 voluntary intakes of non-legume family-related browse trees by WAD goats was reported. The dry matter intake varied from 0.48 kg in *Bombax glabra* to 2.10 kg in *Ficus thonningii.* Therefore, plant with the highest COP was *Spondias mombin.* The result showed that only five fodders had COP above unity.

Table 6 presents voluntary intake of the non-legume family unrelated browse plants. The average daily voluntary intake ranged between 0.38 and 1.26kg DM while coefficient of preference also varied from 0.33 to 1.07. The highest consumed plant was *Syzygium zamaragensis*. This is evidence that ruminants are able to select their diets from a range of plant parts that differ in their physical and chemical composition.

Browse specie	Acceptability parameters	
	Average daily intake (kg DM/ 10 animals)	**Coefficient of preference (COP)**
Gmelina arborea	0.46	0.39
Hura crepitens	0.38	0.33
Napoleonalia. Imperialis	0.82	0.70
Bligha sapida	0.66	0.56
Syzygium zamaragensis	1.26	1.07
Dacryodes edulis	0.70	0.06
Ivingia gabonensis	1.16	0.99

Table 6: Voluntary intake of tree fodders (non-legume family un-related) offered simultaneously to WAD goats for a period of 6 hours

Table 7 presents the re-acceptability of the accepted browse trees by WAD goats. Variations were observed among the average daily intake of the browse species by the animals. In all, twelve browse trees that were previously accepted by the animals were further subjected to preference trial. As a result of the taste, preference and behavioural pattern of goats, the animal were able to still reject some of the feeds that had been earlier on accepted when they are allowed to select again amidst the surplus. This is exactly what was observed in this study. The animals were again re-introduced into these twelve browse plants that were previously accepted and surprisingly, only five of the twelve were accepted while the rest were rejected based on the values of COP. The voluntary daily intake exhibited by the goats varied from 0.32 to 2.56kg DM in *Pentaclethra macrophylla* and *Leucaena leucocephala* respectively. The result revealed that goats still have more affinity to Leucaena than others. Hence, goats are usually seen browsing on *Leucaena leucocephala* as they pass along the roadsides or in the bush. Variations were also observed among the plant species with respect to COP values. The order of preference is *L. leucocephala* > *S. mombin* > *G. sepium* > *A. odoratissima* > *F. thonningii* respectively.

Plant species	Acceptability parameters	
	Average daily intake (kg DM/ 10 animals)	**Coefficient of preference (COP)**
Tetrapleura tetraptera	1.18	0.78
Mangifera indica	1.30	0.86
Gliricidia sepium	2.02	1.34
Syzygium gabonensis	1.10	0.73
Tamarindus indica	1.14	0.76
Parkia biglobosa	1.34	0.89
Treculia Africana	1.16	0.77
Pentaclethra macrophylla	0.32	0.21
Leucaena leucocephala	2.56	1.70
Ficus thonningii	1.60	1.06
Albizia odoratissima	1.88	1.25
Spondias mombin	2.52	1.67

Table 7: Re-acceptability of the accepted browse trees by WAD goats

3.2. Preference Study

During the 6 hours preference study of leguminous plants, there was a marked preference towards *Leucaena leucocephala*, the tree fodder with high crude protein, moderate fibre fractions, organic matter digestibility, Metabolizable energy and short chain fatty acid. It is accepted that plant morphology and structure can influence preferences and intake of forages by ruminants (Ortega and Provenza, 1993; Burns et al., 2001; Sandoval Castro, 2005). However, in this present study none of the browse leguminous plants had thorns and their leaves were equally accessible, suggesting that these factors were not the reasons for difference which favoured *L. leucocephala.* This was confirmed in the study carried out by Nieto Marin et al., (2001), who reported that intake rate of tree fodders, when offered ad libitum as single feeds, was similar at about 20g DM/min. The main cause of the difference in intake was the effective time the heifer spent eating each of each fodder. But, in contrast, Sosa Rubio et al., (2004) found, in his studies with sheep, that difference in intake of five (5) tree fodders was due to intake rate (from 4 to 34g/min). Moreover, Bamikole et al., 2004 found out in his study that when five species of Ficus were introduced to goats in cafeteria feed preference study; the animals were able to make their choice among the forages as a result of preferential taste by the goats.

The result confirms that when the animals are given opportunity to select, the intake of forage might increase. During the study period, the preference was not affected by CP, probably because N was not limiting in these animals (Van Soest, 1994) as all the tree fodders had CP above requirement level except for *M. indica* (6% CP). *Bombax glabra* was least consumed and least preferred despite the fact that it had the highest value of crude protein. Refusal of it might be due to some other factors like taste, odour, presence of anti-nutritional factors, plants morphology and structure (Ortega and Provenza, 1993, Omokanye et al., 2001., Burns et al., 2001., Babayemi and Bamikole, 2006). The reason for the preferred five tree fodders and refusal of others might be due to one of the previously mentioned factors.

3.3. Preference study on family un-related non-leguminous trees
Under this study, the animals were able to accept only one plant species (*Syzygium zamaragenesis)* despite its low protein level when compared with other fodders available. The reason for this selection might not be understood in this study, but it may be due to one of those factors mentioned in the previous preference studies. The forage most preferred here had the lowest CP and the highest fibre fraction level yet it is most relished by the goats. This result was contrary to the report of Sandoval et al (2005) who observed that when the possibility of the animals to select is reduced, it might increase intake in forage.

3.4. Re-acceptability of the accepted browse trees by WAD goats
A re-acceptability study was carried out on the twelve browse plants that had been previously accepted by these same animals. The result from this study revealed that animals may still reject the feed that was previously accepted and even vice-versa. All the fodders introduced to these goats had been previously well accepted but on re-introduction, were rejected. This result was similar to the report of Sandoval et al., (2005) who reported that when the possibility of the animals to select is reduced, it might result to increase intake of forage which was previously not accepted. Similar results have been reported by Camacho Morfin (2003) with sheep using fodders from central Mexico. The practical usefulness of constructing a scale of preference for forages is the ability to have an indication of the acceptability of new feeds to animals, relative to more commonly forages (Hadjigeorgiou et al., 2003)
In conclusion, several factors may influence preference of ruminants in selecting their diets from a range of plants species and plants parts that differ in their physical and chemical composition including the level of anti-nutrients.
This study affirms the statement that goats, due to their behavioural attitude display a characteristic different from other ruminants in their feeding habit. Feed previously rejected may be accepted in due time or vice versa depending on the forages available.

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