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Assessment of the Nutritive and Anti-Nutritive Values of Some Selected Browse Plants in Mayo-Ine, Fufore LGA of Adamawa State, North-Eastern Nigeria

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ABSTRACT: *The study was conducted to evaluate the nutritional value of some selected semi-arid browse forages. Ten browse forages consumed by ruminants were selected for the study. They were subjected to chemical, mineral and anti-nutritional analysis as well as rumen degradation. Results revealed that the browse species had high levels of crude protein that varied among the species ranging from 8.15% in Vitellaria paradoxa to 21.07% in Acacia senegal. The mean rumen degradability of the browses showed 17.79%, 33.38%, 45.65%, 50.17%, 54.31% and 62.21% at 0, 6, 12, 24, 48 and 72 hours of incubation respectively. All the browses had degraded over 50% at 48 hours of incubation except Detarium microcarpum (49.90%) and Magnifera indica (49.70%). Therefore, all the browse plants studied can be used to support ruminant nutrition.*

KEYWORDS: nutritive, anti-nutritive, browse plants, degradation.

INTRODUCTION

Livestock are important parts of the farming system in Nigeria, particularly for subsistence and commercial farmers. Nonetheless, poor feeding and quality of feeds available have hindered increased animal productivity. Feeds could be from grasses, legumes; leaves of trees or plant in the form of browse plants (Yahaya *et al.*, 2000).

Feeding animals is aimed at meeting the nutritional requirements for maintenance and production depending on the species, size, stage of development and stage of production (Gidado *et al.*, 2013). However, due to high cost of conventional feedstuff, some workers (Ogunsoboye, 2013) both in Nigeria and abroad have conducted research on the utilization of alternative feed ingredients-

particularly browse plants which are not utilized as human foods thus not in direct competition with man (Jeremiah, 1995). The potentials of leaf meals from these tropical trees and shrubs to yield relatively higher levels of crude protein and minerals, and lower crude fibre levels than tropical grasses have been recognized (Amata, 2010). Knowledge on mineral composition of browse forages would form base-line data on mineral status of available feed resources for enhanced nutrition of grazing ruminants in semi-arid areas of north-eastern Nigeria (Njidda *et al.*, 2013). Many plants also produce chemicals which are not directly involved in the process of plant growth (secondary compounds) but act as deterrents to insects and fungal attack. These compounds also affect animals and the nutritive value of the forages (Njidda *et al.*, 2012). This study therefore, aimed at determining the nutritive and anti-nutritive values of some selected browse plants.

MATERIALS AND METHODS

Study area

The study was carried out in Mayo Ine (9° 7'N, 12° 14'E) Fufore LGA in the central part of Adamawa State, North-Eastern Nigeria. Adamawa State falls within the semi-arid zones of West Africa and is characterized by short periods of rainy season which is between June and November and a mean temperature of 37°C, the relative humidity ranges from 5 – 24% and the natural vegetation is typical of Sudan Savannah characterized by scattered trees, shrubs and herbs with short grasses. The area is generally flat but with rocky hills, numerous rivers and streams (Adebayo and Tukur, 1999).

Sample collection

Ten browse forage species commonly found in the region were selected for this experiment; the species were *Acacia senegal*, *Vitex doniana*, *Terminalia catapa*, *Vitellaria paradoxa*, *Detarium microcarpum*, *Ficus platyphylla*, *Ziziphus spinochristi*, *Annona senegalensis*, *Piliostigma thonningii* and *Magnifera indica*.

Processing of samples

The samples were shade-dried for 7 – 15 days to prevent photo oxidation, ground and passed through a 1.0mm sieve. The samples were stored in labelled polythene bags until they were needed for the study.

Chemical analysis.

The forage samples were analyzed for dry matter (DM), crude protein (CP), crude fibre (CF), ether extract (EE), ash, nitrogen free extract (NFE), neutral detergent fibre (NDF), acid detergent fibre (ADF) and acid detergent lignin (ADL) according methods described by AOAC (2005) methods. Minerals determined include calcium (Ca), phosphorus (P), zinc (Zn) and iron (Fe) according to AOAC (2005) procedures. Anti-nutrient constituents determined in the browses include tannin using the method described by Makkar and Goodchild (1996), saponin was determined by method of Hiai *et al.*, (1976) with some modifications (Makkar *et al.*, 2007), oxalate was determined

according to Karimi and Ungar (1986), while phytate and alkaloid were determined according to Wheeler and Ferrel (1971) and Prince *et al.,* (1978) respectively. Finally, hydrogen cyanide was determined according to method as described by Pearson (1976).

Management of experimental animal

A bunaji bull weighing between 230 – 300kg fitted with rumen cannula was used for the rumen incubation studies. The animal was fed a diet of maize and guinea corn bran, cowpea hay and groundnut haulms throughout the period. Water and salt lick were given adlibitum. The diet given to the animal was to allow the rumen microbial population meet their requirement for essential nutrient as well as provide optimum rumen environment for degradability.

Incubation of samples

Three (3) grams of feed samples each in triplicate were weighed and put into nylon bags. The bags were tied using a nylon twine and carefully inserted into the rumen. Ten bags containing the samples were incubated at the same time in the rumen. The bags were incubated for 6, 12, 24, 48 and 72 hours.

Washing and drying

After each incubation time, all the bags were withdrawn from the rumen at the same time and immediately placed under running tap water until the water was clean and clear. This was done to wash off ingested feed particles on the bags as well as stop further fermentation processes. The bags were sun dried for two hours before putting them in the oven for drying at 65°C for 48 hours to determine the amount of dry matter degradation rate. After drying, the bags with the contents were weighed and recorded to determine the loss in weight which occurs due to degradation by the rumen microbes.

Washing loss

The zero – hour washing losses were determined by soaking three bags of each feed sample in warm water (37°C) for 40 minutes which was followed by washing and drying of the bags as done with the incubated sample residues.

Statistical analysis

The data obtained were analyzed using Fit Curve Macro (Chen X.B 1995) for Microsoft Excel (NEEWAY Excel). Degradation constants were estimated from the exponential equation $P = a + b (1 – e^{ct})$ proposed by Orskov and McDonald (1979).

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RESULTS

Chemical composition of browse plants

The proximate composition of the browse plants determined in this study is presented in Table 1. Dry matter content ranged from 88.85% in *Acacia senegal* to 91.27% in *Detarium microcarpum*. Generally, the examined leaves had moderate to high crude protein values ranging from 8.15% in *Vitellaria paradoxa* to 21.07% in *Acacia senegal*. The crude fibre content of the browses ranged from 13.54% in *Acacia senegal* to 31.95% in *Piliostigma thonningii*. Values obtained for ether extract ranged from 1.44% in *Vitex doniana* and *Ficus platyphylla* to 6.89% in *Detarium microcarpum* while those for ash ranged from 4.81% in *Detarium microcarpum* to 8.56% in *Ficus platyphylla*. The highest nitrogen free extract content of 38.95% was recorded in *Annona senegalensis* while *Detarium microcarpum* had the lowest value of 26.79%. The highest neutral detergent fibre content of 66.99% was recorded in *Ficus platyphylla* while the lowest content of 55.16% was recorded in *Vitex doniana*. *Ficus platyphylla* had the highest acid detergent fibre content of 50.25% while *Terminalia catapa* had the lowest content of 41.26%. *Acacia senegal* had the highest acid detergent lignin content of 5.56% while *Vitex doniana* had the lowest content of 3.23%.

Table 1: Proximate composition of selected browse plants (% DM).

Browse Plants	DM	CP	CF	EE	Ash	NFE	NDF	ADF	ADL
Acacia Senegal	88.85	21.07	13.54	5.21	6.34	34.69	66.05	46.25	5.56
Vitex doniana	90.59	9.13	31.63	1.44	5.56	32.83	55.16	49.06	3.23
Terminalia catapa	89.54	13.16	27.76	3.82	7.24	27.56	64.11	41.26	4.15
Vitellaria paradoxa	91.14	8.15	31.09	3.54	8.34	30.02	60.06	43.19	4.86
Detarium microcarpum	91.27	9.15	31.24	6.89	4.81	26.79	65.86	40.92	3.95
Ficus platyphylla	88.91	9.99	29.41	1.44	8.56	33.92	66.99	50.25	4.50
Ziziphus spinochristi	89.85	15.69	23.08	2.94	7.10	36.04	63.46	40.53	5.12
Annona senegalensis	89.86	12.21	22.82	2.84	6.04	38.95	66.83	42.61	4.75
Piliostigma thonningii	89.72	11.11	31.95	3.04	7.17	30.45	60.76	42.85	4.63
Magnifera indica	91.17	10.25	23.78	5.42	7.11	33.61	63.27	45.10	4.35

DM = Dry matter, CP = Crude protein, CF = Crude fibre, EE = Ether extract, NFE = Nitrogen free extract, NDF = Neutral detergent fibre, ADF = Acid detergent fibre, ADL = Acid detergent lignin,

Anti-nutritional composition of browse plants

The result of anti-nutritional constituents in the browse plants is shown in Table 2. Saponin varied from 0.94mg/g DM in *Ficus platyphylla* to 4.11mg/g DM in *Detarium microcarpum*. Oxalates ranged from 0.29mg/g DM in *Vitellaria paradoxa* to 0.92mg/g DM in *Ficus platyphylla*. Phytates content of examined browses ranged from 1.10mg/g DM in *Vitex doniana* to 3.76mg/g DM in *Ziziphus spinochristi*. Alkaloids contents ranged from 0.66mg/g DM in *Vitex doniana* to 2.46mg/g

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DM in *Annona senegalensis*. A range of 0.30mg/g DM in *Vitex doniana* to 0.43mg/g DM in *Detarium microcarpum* and *Ziziphus spinochristi* was obtained for tannins. Hydrogen cyanide ranged from 0.01mg/g DM in *Acacia senegal* and *Annona senegalensis* to 0.03mg/g DM in *Vitex doniana*, *Terminalia catapa*, *Detarium microcarpum* and *Piliostigma thonningii*.

Table 2: Anti-nutritional composition of browse plants (mg/g DM)

Browse Plants	Saponin	Oxalates	Phytates	Alkaloids	Tannins	Hydrogen cyanide
Acacia Senegal	2.13	0.66	1.97	1.95	0.42	0.01
Vitex doniana	3.01	0.86	1.10	0.66	0.30	0.03
Terminalia catapa	1.54	0.43	1.22	0.67	0.37	0.03
Vitellaria paradoxa	2.62	0.29	1.32	0.72	0.35	0.02
Detarium microcarpum	4.11	0.45	1.50	0.73	0.43	0.03
Ficus platyphylla	0.94	0.92	1.51	0.82	0.37	0.02
Ziziphus spinochristi	1.36	0.67	3.76	2.16	0.43	0.02
Annona senegalensis	2.10	0.75	2.16	2.46	0.35	0.01
Piliostigma *thonningii*	2.14	0.65	2.81	0.64	0.33	0.03
Magnifera indica	3.15	0.54	2.93	0.67	0.42	0.02

Mineral composition of browse plants

The result of the mineral constituents in the browse plants is shown in Table 3. Calcium contents of the examined plants ranged from 18.21g/kg DM in *Magnifera indica* to 22.21g/kg DM in *Vitellaria paradoxa*. A range of 11.25g/kg DM in *Piliostigma thonningii* to 24.37g/kg DM in *Annona senegalensis* was obtained for phosphorus. Zinc content of the plants ranged from 1.39mg/kg DM in *Ficus platyphylla* to 2.89mg/kg DM in *Vitex doniana*. Iron content in the browses ranged from 4.16mg/kg DM in *Annona senegalensis* to 8.98mg/kg DM in *Ficus platyphylla*.

Table 3: Mineral composition of browse plants.

Browse Plants	Calcium (g/kg DM)	Phosphorus (g/kg DM)	Zinc (mg/kg DM)	Iron (mg/kg DM)
Acacia Senegal	23.34	16.45	1.76	6.26
Vitex doniana	23.89\	16.51	2.89	7.96
Terminalia catapa	19.65	20.84	2.35	6.02
Vitellaria paradoxa	26.16	23.55	2.45	5.12
Detarium microcarpum	18.78	20.68	2.45	6.44
Ficus platyphylla	21.33	22.09	1.39	8.98
Ziziphus spinochristi	20.67	21.58	2.48	9.12
Annona senegalensis	21.33	24.37	3.46	4.16
Piliostigma thonningii	28.69	11.25	2.54	6.75
Magnifera indica	18.21	29.51	2.55	7.06

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Rumen degradation characteristics of browse plants

The rumen degradation characteristics values of the browse plants are presented in Table 4. The highest actual dry matter disappearance for the browse plants recorded at 6 hours was 41.10% in *Annona senegalensis* while the lowest was 25.90% in *Acacia senegal*. At 12 hours of incubation, dry matter disappearance ranged from 41.80% in *Magnifera indica* to 49.20% in *Annona senegalensis*. *Magnifera indica* had the lowest degradation of 45.60% while *Annona senegalensis* had the highest degradation at 55.20%. At 48 hours of incubation, degradation ranged from 49.70% in *Magnifera indica* to 58.20% in *Annona senegalensis*. *Vitellaria paradoxa* had the highest degradation of 65.80% while *Detarium microcarpum* had the lowest degradation of 56.70% at 72 hours of incubation.

Table 4: Actual Dry Matter Degradation of Browse Plants Incubated in the Rumen (% DM)

Browse Plants	**0 hours**	**6 hours**	**12 hours**	**24 hours**	**48 hours**	**72 hours**
Acacia senegal	18.70	25.90	42.70	47.90	51.80	59.50
Vitex doniana	20.00	35.20	43.60	48.20	53.10	62.30
Terminalia catapa	19.10	32.80	49.10	53.40	57.80	64.70
Vitellaria paradoxa	20.10	29.70	47.60	50.10	54.30	65.80
Detarium microcarpum	16.90	36.20	41.90	46.70	49.90	56.70
Ficus platyphylla	17.30	29.70	48.00	54.20	56.90	63.80
Ziziphus spinochristi	17.60	31.40	45.30	49.30	55.20	62.40
Annona senegalensis	16.80	41.10	49.20	55.20	58.20	65.10
Piliostigma thonningii	15.90	38.20	47.30	51.10	56.20	64.20
Magnifera indica	15.50	33.60	41.80	45.60	49.70	57.60

Dry matter degradation characteristics of browse plants

The dry matter degradation characteristics of the browse plants is shown in Table 5. Washing loss "A" ranged from 15.50% in *Magnifera indica* to 20.10% in *Vitellaria paradoxa*. Rumen degradable fraction "B" ranged from 36.80% in *Acacia senegal* to 51.48% in *Piliostigma thonningii*. Degradation rate constant "C" of the browses ranged from 0.021 fraction/hour in *Vitex doniana* to 0.260 fraction/hour in *Detarium microcarpum*. A range of 55.50% in *Acacia senegal* to 69.13% in *Vitex doniana* was recorded for potential degradability "A + B". Lag time ranged from 0.40 hours in *Vitellaria paradoxa* to 3.30 hours in *Acacia senegal*.

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Table 5: Dry matter degradation characteristics.

Browse Plants	A	B	C	a + b	Lag T
Acacia senegal	18.70	36.80	0.097	55.50	3.30
Vitex doniana	20.00	49.13	0.021	69.13	1.50
Terminalia catapa	19.10	41.95	0.096	61.05	1.40
Vitellaria paradoxa	20.10	41.39	0.064	61.49	0.40
Detarium microcarpum	16.90	42.75	0.260	59.65	1.20
Ficus platyphylla	17.30	42.43	0.129	59.73	3.20
Ziziphus spinochristi	17.60	42.96	0.057	60.56	2.10
Annona senegalensis	16.80	47.49	0.046	64.29	0.50
Piliostigma thonningii	15.90	51.48	0.027	67.38	1.40
Magnifera indica	15.50	45.44	0.026	60.94	1.10

A = Washing loss, B = Rumen degradable fraction, C = Degradation rate constant, A + B = Potential degradability, Lag T = Lag time

Effective dry matter degradability of browse plant

The result of the effective dry matter degradability is presented in Table 6. The effective degradability of the feed materials at degradability constants a, b, c and rumen out flow rate k = 0.02, k = 0.05 and k = 0.08. These effective degradability values are the predicted degradability of the browses if fed to the animals and are retained in the rumen for 50, 20 and 12.5 hours (k = 0.02, 0.05 and 0.08). The effective degradability of feed in the rumen depends on the length of retention of the feed in the rumen which is also a function of the quality of the feed fed to the animal (Reddy, 2001). The rumen outflow rate (k) is an inverse of the mean retention time (MRT) of feedstuff in the rumen of animal (Mbahi *et al.*, 2013). The effective degradability obtained for the browses ranged from 47.30% in *Acacia senegal* to 65.80% in *Detarium microcarpum* at fractional outflow rate (k) of 0.02 (i.e MRT = 50 hours). At outflow rate (k) of 0.05 (i.e MRT = 20 hours), it ranged from 39.30% in *Acacia senegal* to 55.60% in *Annona senegalensis*. The effective degradability at outflow rate (k) of 0.08 (i.e MRT = 12.5 hours) ranged from 34.20% in *Acacia senegal* to 46.90% in *Annona senegalensis.*

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Table 6: Effective Dry Matter Degradability of Selected Browse Plants (%)

Browse Plants	a	b	C	RSD	K = 0.02	K = 0.05	K = 0.08
Acacia senegal	13.51	47.78	0.097	4.72	47.30	39.30	34.20
Vitex doniana	16.71	51.80	0.021	3.24	53.70	50.50	42.90
Terminalia catapa	17.32	52.42	0.096	4.55	52.90	44.80	39.50
Vitellaria paradoxa	21.33	39.30	0.064	6.95	51.40	42.90	37.90
Detarium microcarpum	20.51	39.60	0.025	2.28	65.80	55.10	52.30
Ficus platyphylla	22.30	43.60	0.129	4.16	51.80	43.40	37.60
Ziziphus spinochristi	17.60	59.90	0.057	4.30	50.80	43.00	38.80
Annona senegalensis	21.90	34.90	0.046	2.84	57.80	55.60	46.90
Piliostigma thonningii	16.61	30.80	0.027	3.26	58.10	51.30	44.70
Magnifera indica	14.37	50.71	0.026	3.13	51.20	42.90	38.70

a = Fitted soluble fraction, b = Fitted insoluble but degradable fraction, c = Degradation rate constant, K = Fractional outflow rate from the rumen at 50, 20 and 12.5 hours, RSD = Residual standard deviation.

DISCUSSION

Chemical composition of browse plants

The mean dry matter content of the browses studied was 90.09% ranging from 88.85% in *Acacia senegal* to 91.27% in *Detarium microcarpum*. This result falls within reference values for tropical browse crops and agrees with Kubkomawa *et al.,* (2017) who reported a range of 84.90 – 94.24%. The result is also similar to the mean of 86.97% reported by Gidado *et al.,* (2003) for some browse species in Taraba State. The crude protein (CP) content of the browse plants was generally higher, which is above the 7% CP requirement for ruminants that should provide ammonia required by rumen microorganism to support optimum microbial growth Norton (2003). The CP contents of the browses ranged from 8.15% in *Vitellaria paradoxa* to 21.07% in *Acacia senegal*. The result is slightly higher than the range of 13.85 – 16.65% reported by Njidda, (2010) in semi-arid forages of North Eastern Nigeria. Kubkomawa *et al.,* (2017) also reported a similar range of 9.35 – 16.73% CP values. Norton (2003) justifies the use of browse forages in small quantities in order to supplement poor quality pastures and crop residues. The mean crude fibre (CF) was 26.62% with a range of 13.54% in *Acacia senegal* to 31.95% in *Piliostigma thonningii*. The result is similar to a range of 23.53 – 32.50% reported by Kubkomawa *et al.,* (2017). Njidda and Nasiru (2010) also reported similar mean value of 28.63% in the semi-arid region of North Eastern Nigeria. Most of the browses except *Acacia senegal* (13.54%) had higher than the range of 15 – 20% CF recommended for improved intake and production in finishing ruminants since it represents insoluble carbohydrate such as alkali insoluble lignin, fibre bound nitrogen and cellulose (Buxton, 1996). A range of 1.44% in *Vitex doniana* and *Ficus platyphylla* to 6.89% in *Detarium microcarpum* with a mean of 3.66% was obtained for ether extract (EE). The result agrees with

that of Kubkomawa *et al.,* (2017) who reported a range of 2.89 – 6.72%. Njidda (2010) also reported a range of 2.00 – 5.00% for EE of Northeastern Nigerian browse forages. EE contents of this study fell within the range of 4 – 10% EE recommendation (Campbel *et al.,* 2006). The mean ash content of the browses was 6.83% with a range of 4.81% in *Detarium microcarpum* to 8.56% in *Ficus platyphylla*. The result falls within range of 7.74 – 13.25% reported by Kubkomawa *et al.,* (2017). However, the result is slightly lower than 8.00 – 18.00% reported by Njidda (2010). Oji and Ndiomu (2002) had reported that the stage of plant growth and soil types affect plant ash values and this might explain the variation in values obtained in the present study. The mean nitrogen free extract (NFE) obtained was 33.29% with a range of 26.79% in *Detarium microcarpum* to 38.95% in *Annona senegalensis*. The result is agrees with Obua (2014) who reported similar mean value of 40.54%. However, the result is lower than a range of 47.67 – 52.45% reported by Kubkomawa *et al.,* (2017). The neutral detergent fibre (NDF) mean value obtained was 63.26% with a range of 55.16% in *Vitex doniana* to 66.99% in *Ficus platyphylla*. The result is slightly higher compared to a range of 40.20 – 64.50% reported by Kubkomawa *et al.,* (2017). Gidado *et al.,* (2013) reported lower mean value of 48.97%. Mean acid detergent fibre (ADF) obtained was 44.20% with a range of 41.26% in *Terminalia catapa* to 50.25% in *Ficus Platyphylla*. This is higher than a range of 19.60 – 39.40% reported by Kubkomawa *et al.,* (2017). Gidado *et al.,* (2013) also reported lower mean value of 23.30%. In general, the ADF values are within range (17 – 61%) documented for forages used in ruminant feeding (Topps, 1992). A range of 3.23% in *Vitex doniana* to 5.56% in *Acacia senegal* with a mean of 4.51% was obtained for acid detergent lignin (ADL). The result corroborates that of Njidda (2010), who reported 4.9 – 12.7% for browse forages in northeastern Nigeria, and Kubkomawa *et al.,* (2017) who reported a range of 5.44 – 13.45% for some browses.

Anti-nutritional composition of browse plants

Saponin had a mean of 2.31mg/g with a range of 0.94mg/g in *Ficus platyphylla* to 4.11mg/g in *Detarium microcarpum*. This result agrees with Njidda *et al.,* (2013) who reported a range of 1.08 – 2.89mg/g. The saponin level recorded were within the tolerable level (1 – 2%) for ruminants (Onwuka, 1983). Mean oxalate level obtained was 0.62mg/g with a range of 0.29mg/g in *Vitellaria paradoxa* to 0.92mg/g in *Ficus platyphylla*. The result is lower than 4.59 – 8.14mg/g reported by Njidda *et al.,* (2013). Ruminants however, unlike monogastric animals can consume considerable amount of oxalate in plants without adverse effect due to microbial degradation in rumen (Ologhobo, 1992). A range of 1.10mg/g in *Vitex doniana* to 3.76mg/g in *Ziziphus spinochristi* with a mean of 2.03mg/g was obtained for phytates. The result agrees with Njidda *et al.,* (2013) who reported a range of 2.02 – 5.81mg/g in semi-arid forages. The levels of phytate recorded in this study were below the tolerable levels of 200 – 265mg/g (McDonald *et al.,* 1995). Mean alkaloid level obtained was 1.15mg/g with a range of 0.66mg/g in *Vitex doniana* to 2.46mg/g in *Annona senegalensis*. The alkaloid level recorded in this study were within the threshold level of 220 – 260mg100g recommended as safe for sheep (McDonald *et al.,* 1995). Tannins ranged from 0.30mg/g in *Vitex doniana* to 0.43mg/g in *Detarium microcarpum* and *Ziziphus spinochristi* with a mean of 0.38mg/g. The result is similar to 0.08 – 0.41mg/g reported by Njidda *et al.,* (2013) in

semi-arid forages. The tannin contents were lower than the threshold level of 800 – 900mg/100g reported by Nastis and Malachek (1981). Mean hydrogen cyanide (HCN) content obtained was 0.02mg/g with a range of 0.01mg/g in *Acacia senegal* and *Annona senegalensis* to 0.03mg/g in *Vitex doniana, Terminalia catapa, Detarium microcarpum* and *Piliostigma thonningii*. The HCN contents of the browse species examined were equally low. The lethal dose of HCN for cattle and sheep is 2.0 – 4.0mg/kg body weight.

Mineral composition of browse plants

The mean calcium level obtained was 22.21g/kg with a range of 18.21g/kg in *Magnifera indica* to 26.16g/kg in *Vitellaria paradoxa*. The result in this study is higher compared to 7.80 – 12 50g/kg reported by Njidda *et al.,* (2013). The Ca contents of the browses were adequate, all the browse forages had higher Ca than the recommended requirements (g/kg DM diet) for growing cattle (2.6 – 10.8), pregnant cows (2.1 – 3.5) and lactating cows (2.9 – 5.3) (Shamat *et al.,* 2009). A range of 11.25g/kg in *Piliostigma thonningii* to 24.37g/kg in *Annona senegalensis* with a mean of 20.68g/kg was obtained for phosphorus. The result is higher compared to a range of 2.80 – 6.70g/kg reported by Okunade *et al.,* (2014). The browse plants had higher concentrations of phosphorus than the normal requirements (g/kg DM) of growing cattle (1.1 – 4.8), pregnant heifers and cows (0.9 – 2.0) and lactating cows (2.0 - 30), suggesting nutritional adequacy for livestock (Njidda *et al.,* 2013). Mean zinc content obtained was 2.43mg/kg with a range of 1.39mg/kg in *Ficus platyphylla* to 2.89mg/kg in *Vitex doniana*. The result is less than 24.20 – 26.07mg/kg reported by Barde *et al.,* (2014). It has been recommended that concentrations of 12 – 20mg/kg are adequate for growing ruminants (Anon, 1980). Mean iron content obtained for the browses was 6.79mg/kg with a range of 4.16mg/kg in *Annona senegalensis* to 8.98mg/kg in *Ficus platyphylla*. The result falls within range of 0.57 – 97.58mg/kg reported by Barde *et al.,* (2014). The plant species had lower concentrations of Fe comparable to high levels of Fe (100 – 700mg/kg DM) for tropical grasses and legumes (McDowell, 1992).

Rumen degradation characteristics of browse plants

Annona senegalensis had degraded over 40% at 6 hours of incubation while all the browses had degraded above 40% at 12 hours of incubation. At 24 hours of incubation, *Terminalia catapa, Vitellaria paradoxa, Ficus platyphylla, Annona senegalensis* and *Piliostigma thonningii* had all degraded over 50% while *Acacia senegal, Vitex doniana, Detarium microcarpum, Ziziphus spinochristi* and *Magnifera indica* had degraded above 40%. At 48 hours of incubation, the browses had degraded above 50% except *Detarium microcarpum* and *Magnifera indica*. The browses had degraded above 60% except *Acacia senegal, Detarium microcarpum* and *Magnifera indica* at 72 hours of incubation.

Highly degraded browses among them were *Terminalia catapa, Ficus platyphylla, Ziziphus spinochristi, Annona senegalensis* and *Piliostigma thonningii*.

Moderately degraded browses were *Acacia senegal, Vitex doniana* and *Vitellaria paradoxa*.

Lowly degraded browses were *Detarium microcarpum* and *Magnifera indica*.

Dry matter degradation characteristics of browse plants

Readily soluble fraction (A) of organic matter in the browse plants was observed to be highest 20.10% in *Vitellaria paradoxa*. This may be due to the presence of degradable carbohydrates, particularly the non-structural ones and NDF proteins and fat, components that may make organic matter readily degradable *in situ* in the rumen (Arieli *et al.*, 1998). In this regard, feeding diets with at least 12% protein may be necessary to maximize organic matter fermentation in the rumen (NRC, 2001). Nevertheless, the organic matter solubility range reported in the plants of this study (15.50 – 20.10%) were slightly above the range reported in some roughage (Arieli *et al.*, 1998). The insoluble but degradable organic matter fraction (B) was high in the plants. This may be the result of the organic matter solubility in the plants indicating the possibility of a high amount of nutrients by-passing the rumen microbes.

Potentially degradable (A + B) crude protein portion was generally high in all the plants tested. This could have been due to the low insoluble but degradable fraction, which suggests high effective degradability of these plants. Potential degradability values in the plants reported in this study were comparable to those reported for tropical grass and legume forages (Mgheni *et al.*, 1996). Newman *et al*. (2002), believe long lag times influence the degree to which the slowly degraded fraction 'B' is broken down in the rumen as well as the extent of nitrogen deficiency or sufficiency.

Effective dry matter degradability of browse plants

The effective degradation (rate of degradation in the rumen) depends on how long the feed remains in the rumen and this is also a function of the quantity and quality of the feed fed to the animal (Turki and Atcham, 2011). The effective degradability obtained in this study were predicted degradability of forages if fed to the animals and are retained in the rumen for 50, 20 and 12.5 hours respectively (K = 0.02, 0.05, 0.08 MRT).

The effective degradability for the forages at the degradability constants a, b, c and the rumen outflow rate K = 0.02, 0.05 and 0.08 indicates that the rumen outflow rate (K) is an inverse of the mean retention time (MRT). The results of the rumen outflow rate are slightly higher than the range of 43.40 – 58.10%, 32.70 – 48.70%, 28.20 – 43.90% reported by Mbahi *et al.*, (2013) for K = 0.02, K = 0.05 and K = 0.08 respectively.

CONCLUSION

The results obtained in this study shows that all the browses are of high feeding value and rich in CP contents. They have acceptable quantities of macro nutrients, though micro nutrient constituents were low which can be supplemented. All the browses studied have attained at least

40% degradation at 48 hours incubation period. Therefore, the browse species are promising fodders that can be used for sustainable ruminant production in the tropics.

Conflict of Interest

The authors declare no conflict of interest that may affect the outcome of the study in any way.

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REFERENCES

A.O.A.C. (2005). Association of Official Analytical Chemist. Official method of analysis.18th ed. AOAC Washington DC USA.

Adebayo A. A. and Tukur A. L. (1999). Adamawa in Maps; Paraclete Publishers, Yola Pp. 20, 23 – 26.

Amata I.A. (2010). Nutrtive value of the leaves of *Myrianthus arboreus*: A browse plant. *International Journal of Agricultural Research*. 5: 576-581.

Anonymous, (1980). The Nutrient Requirements of Ruminant Livestock. 4th edition CAB International, Wallingford.

Arieli, A., Mabjeesh, S.J., Shabi, Z., Bruckental, L, Aharoni, Y., Zamwel, S. and Tagari, H. (1998). *In situ* assessment of degradability of organic matter in the rumen of dairy cows. *Journal Dairy Science* 81: 1985-1990.

Barde R.E., Abimiku H.K., Hassan D.I. and Maiangwa A.O. (2014). Potential of some Browse Plants for Ruminants in Hot Humid Environment of Lafia. PAT Journal, 10(1): 144-150. ISSN 0794 – 5213.

Buxton D.R. (1996). Quality related characteristics of forages as influenced by plant environment and agronomic factors. Anim. Feed Sci. Technol. 59:37-49.

Campbell, K. L. I., Garforth, C., Heffernan, C., Morton, J., Paterson, R., Rymer, C. and Upton, M. (2006). Small Stock in Development". Natural Resources International Ltd.: Aylesford, Kent, UK.

Gidado, O. G, Kibon, A., Gwargwor, Z. A., Mbaya, P. and Baba, M. J. (2013). Assessment of antinutritive factors and nutrient composition of some selected browse plants use as livestock feeds in Taraba State. *International Journal of Applied Science and Engineering*, 1(1): 5 - 9.

Gomez K. A. and Gomez A. A. (1984). Statistical Procedures for Agricultural Research. (2nd ed.). John Wiley and Sons, New York, USA. 680pp.

Hiai S., Oura H. and Nakajima T. (1976). Colour reaction of some sapogenins and saponins with vanillin and sulfuric acid. Planta Medica 29, 116 – 122.

Jeremiah L.E. (1995). Retail acceptability of lamb as influenced by gender and slaughter weight. *Foods Research International Journal*; 11:64-70.

Karimi S.H. and Ungar I.A. (1986). Oxalate and inorganic ion concentrations in Atriplex triangularis wild. Organs in response to salinity, light level and aeration. Vol. 147, No. 1, Pp 65 – 70.

Kubkomawa H.I., Ogundu M.A., Okoli I.C.,and Udedibie A.B.I. (2017). "Biochemical Profiling of the Values of Dry Season Feed Resources in Pastoralcattle Environment in Nigeria". *International Journal of Research In Agriculture and Forestry*, vol 4, no. 4,pp. 23-36

Makkar, H. P. S., Francis, G., and Becker, K. (2007). Bioactivity of phytochemicals in some lesser known plants and their effects and potential applications in livestock and aquaculture production systems. *Animal*, 1(9): 1371–1391

Makkar, H.P.S. & Goodchild, A.V. (1996). Quantification of tannins: A Laboratory Manual. International centre for agricultural research in the dry areas, Aleppo, Syria.

Mbahi T. F., Galadima D. A., Gworgwor Z. A. and Mbaya Y. P. (2013). In Sacco Dry Matter Degradation Characteristics of some Forages and Agro-industrial by-products in Guinea Savannah Zone of Nigeria. *Journal of Science, Technology and Education. Vol. 2, No 1.*

McDonald, P., Edwards R.A. and Greeenhalgh J.F.D. (1995). Animal nutrition. 5th ed.Longman Publishers, London. U. K

McDowell, L.R. (1992). Minerals in Animal and Human Nutrition. Academic Press, San Diego, California.

Mgheni D.M., Hvelplund T. and Weisbjerg M.R. (1996). Rumen degradability of dry matter and protein in tropical grass and legume forages and their protein values expressed in the AAT PBV protein evaluation system. In: Ndikumana, J and de Leeuw, P (eds). Sustainable Feed Productions and Utilization for smallholder enterprises in sub-Sahara Africa. Proceedings of the second Africa feed resources network (AFNET). Harare, Zimbabwe, 6-10 December, 1993. pp: 77-84.

Nastis A.A. and Malacheck J.C. (1981). Digestion and utilization of nutrients in Oak browse by goats, *Journal of Animal Science* 52:283-288.

Neway Excel Computer Programme Version 6 – A utility for processing data of feed degradability and *in vitro* gas production. International Feed Resources Unit, The Rowett Research Institute, Aberdeen, UK.

Newman Y.C., Sollenberger L.E., Kunle W.E. and Bates D.B. (2002). Crude protein fractionation and degradation parameters of Limprograss herbages. *Agronomy J*, 94: 1381-1382.

Njidda A.A. (2010). Chemical Composition, Fibre Fraction and Anti-Nutritional Substances of Semi-arid Browse Forages of North-Eastern Nigeria. Nigerian *J. Basic Appl. Sci*. 18:2:181-188.

Njidda A.A., Olatunji E.A. and Raji A.Y. (2012). Semi-Arid Browse Forages: Their anti-nutritive substances and *in sacco* neutral detergent fibre and organic matter degradability. *IOSR Journal of Agriculture and Veterinary Science*, Vol.1 (6). Pp 21 – 30.

Njidda AA, I Ikhimioya and CE Isidahomen, (2013). *In situ* crude protein degradation and mineral composition of browse forages of semi-arid Nigeria. *Inter J Agri Biosci*, 2(5): 286 296. www.ijagbio.com

Njidda, A. A. and Nasiru, A. (2010). *In vitro* gas production and dry matter digestibility of tannin containing forages of semi-arid region of North-eastern Nigeria. *Pakistan Journal of Nitrition* 9 (1): 60-66.

Norton, B. W. (2003). The Nutritive value of tree legumes. In: Gutteridge, R.C., Shelton, H.M. (Eds.), Forage trees legumes inTropical Agriculture. Tropical Grassland Society of Australia Inc., St Lucia Queensland, Pp.1-10.

NRC (2001). Minerals. In: *Nutrient Requirements of Domestic Animals*. Nutrient Requirements of Dairy Cattle. (7th edn.). Natl. Acad. Press, Washington, DC. pp. 105-161.

Obua B.E. (2014). Survey of the Diversity and Proximate Compositon of selected most preferred Browse Plants utilized for Goat Feeding in Imo and Enugu States of Southeastern Nigeria. *International Journal of Agric. and Rural Dev. Vol. 17(3): 1947 – 1958.*

Ogunbosoye D.O. (2013) Correlation between milk composition and kid's growth of West African dwarf goat fed forage based diet in southwest Nigeria. Global Veterinaria. 11(2):155-159.

Oji U. I. and Ndiomu F. O. (2002). Chemical Composition of Edible portion of selected browse species of the humid forest zone. Proceedings of the 7th Annual Conference of Animal Science Association of Nigeria, Sept. 16 – 19th 2002. University of Agriculture, Abeokuta Nigeria.

Okunade S.A., Isah O.A., Aderinboye R.Y. and Olafadehan O.A. (2014). Assessment of Chemical Composition and *in vitro* Degradation Profile of Some Guinea Savannah Browse Plants of Nigeria. Tropical and Subtropical Agroecosystems, 17: 529 – 538.

Ologhobo, A.D. (1992). Nutritive value of some tropical (West African) legumes for poultry. *Journal of Applied Animal Research*, 2: 93-104.

Ørskov E.R. and McDonald, I. (1979). The evaluation of protein degradability from incubation measurement weighted according to rates of passage. *Journal of Agricultural Science*, 92:499-503.

Ouwuka F.C. (1983). Nutritional evaluation of some Nigerian Browse Plants in the humid tropics,Unpublished Ph.D. Thesis, University of Ibadan, Ibadan, Nigeria

Pearson D. (1976). The chemical analysis of foods. Churchill Livingston, Edinburgh. Pp. 352 354.

Prince M. L., Van Scoyoc S. and Butler L.G. (1978). A critical evaluation of the vanillin reaction as an essay for tannin in sorghum grain. Journal of Agric. Food Chem, 26: 1214 – 1218.

Shamat A.M., Babiker I.A., Mukhtar A.M.S. and Ahmed F.A. (2009). Seasonal and regional variations in mineral content of some important plants species selected by camels (*Camelus dromedaries*) in arid and semi-arid lands (ASAL) of Sudan. J Appl Sci Res, 5: 1676- 1684.

Topps, J. H. (1992). Potential, composition and use of legume shrubs and trees for livestock in the tropics. *Journal of Agricultural Sciences* (Camb) 188: 1 – 8

Turki I. Y. and Atcham A. A. (2011). Study on chemical composition, degradation and protein characterization of oil seed cakes available in Sudan. Research Opinion in Animal and Veterinary Science. 1:9: 587 – 592. www.roavs.com

Wheeler, E. I. and Ferrel, R. E. (1971). Methods for phytic acid determination in wheat and wheat fractions. Cereal Chem. 48: 312-320.

Yahaya M. S., Takahash J., Matsuoka S., Kibon A. and Dibal D. B. (2000). Evaluation of arid regions browse species from North Eastern Nigeria, Using Pen Fed goats, Small ruminant research 79: 137 – 143.