International Journal of Plant & Soil Science
3(9): 1130-1142, 2014; Article no. IJPSS.2014.9.008

SCIENCEDOMAIN *international*
www.sciencedomain.org

Indigenous Browse Plants Used For Goat Production in Akwalbom State, Nigeria; Their Phytochemical, Mineral, Nutrient and Anti-nutrient Contents

M. E. Bassey[1*], A. A. Peters[1], G. E. Etuk[1] and T. B. Udoh[1]

[1]Department of Botany and Ecological Studies, University of Uyo, Nigeria.

Authors' contributions

Author MEB designed the study, wrote the protocol and the first draft of the manuscript, Author AAP worked on the ethnobotanical survey, while authors GEE and TBU handled the chemical analyses

Original Research Article

Received 16th July 2013
Accepted 6th November 2013
Published 9th July 2014

ABSTRACT

Aims: Common indigenous browse plants were identified in this work and their phytochemical, nutrient, anti-nutrient and mineral constituents were investigated. Recommendations have been made based on the findings.
Study Design: A structured questionnaire was administered to goat farmers. Browse plants were collected, authenticated and stored in the herbarium of the Department of Botany and Ecological studies, University of Uyo. Chemical analyses were done on ethanolic extracts of four of the browse plants.
Place and Duration of Study: Plant collections were made from Uyo, Ikono, IbiakuItam in Itu, Oku Abak, in Abak and Anamfa in Oron Local Government Areas.
Methodology: A total of 45 goat farmers (60% males and 40% females) aged 20-46 years were given questionnaires. The chemical analyses were done using mainly the methods of Association of Official Analytical Chemists (A.O.A.C).
Results: A total of 20 plant species in 19 genera and 13 families were identified as common browse for goats in AkwaIbom State. *Palisota hirsuta* (Thunb.) K. Schum, *Rauvolfia vomitoria* Afzel., *Spondias mombin* L. and *Manniophyton fulvum* (Muell) Arg. showed the presence of bioactive constituents like tannins, flavonoids, cardiac glycosides, saponins, anthraquinones, alkaloids and cyanogenic glycosides. Terpenes though

**Corresponding author: E-mail: megenbassey@gmail.com;*

present in trace amounts in *M. fulvum*, was completely absent in *S. mombin* while anthraquinones were absent in *M. fulvum*. The ash content was highest in *P. hirsuta* (10.6%), crude protein was highest in *R. vomitoria* (25.88%), crude fibre, crude fat and moisture content were highest in *P. hirsuta* (28.57%, 12.22%, and 84% respectively). Calcium (200mg/100g), magnesium (74.4mg/100g) and iron (97.58mg/100g) were very high in *P. hirsuta* than in the other three browse plants. The toxic components such as oxalates were highest in *S. mombin* (598.4mg/100g).

Conclusion: These browse plants may form good feed resources for modern intensive native goat production. Their conservation by cultivation is recommended.

Keywords: Indigenous; browse; phytochemical nutrient; mineral; conservation.

1. INTRODUCTION

Goats are small ruminant animals which play a significant role in the economy and nutrition of landless, small and marginal farmers [1]. Among the people of Akwa Ibom State, goats are commonly used in ceremonies and are very important in traditional uses and in the preparation of local delicacies. It would be safe to state that in many homes 'afia efere' and recently pepper soup rice are meals eaten at least once every week. The crowd in goat markets all over Uyo metropolis especially at weekends is enough evidence to prove the high demand for goat meat. In order to meet the demand, goats are imported in lorry and trailer-loads into the state. However, for traditional ceremonies the demand for the native species (okopusemebot) also known as the West African dwarf goat, has not been compromised.

Rearing of the native goats is largely practiced by the rural dwellers where there are still enough shrubs and trees to provide goat feed. The tender shoots of trees, twigs and leaves of shrubs and woody plants as well as fruits make up a large part of the natural diet of many ruminant animals including goats. Fodder trees and shrubs are an enormous potential source of protein for ruminants in the tropics [2]. However, such fodder has become difficult to collect with a lot of clearing of bushes for various human activities. With the availability of limited goat feeds, the number of goats a farmer can rear is usually few thus resulting in low production of goats to meet market demands. Most tree leaves and twigs contain secondary metabolites such as tannins and anti-nutritional factors and are therefore fed to the goats with caution since they may be toxic when consumed in large quantities [3]. Some browse plants are also used for herbal cures in goats as well as in man. The presence of some anti-nutrients may cause low palatability and thereby make the feed unacceptable to the farm animals [4].

The nutritive value of feeds depends on feed intake and the efficiency of absorption and assimilation of nutrients from the feed during digestion. Feeds of high nutritive value promote high level of production which is seen in live weight gain [5]. Goat meat is lean meat and is therefore low in cholesterol and healthier for consumption. It is also preferred because of its chew ability [6].

Work has been done on trees and shrubs of known fodder value in tropical humid Africa by [7] and [8]. The latter reported that efforts to screen 22 native browse plant species in Nigeria were abandoned after two years of observations because they could not match the productivity of two exotic plants; *Gliricidia* sp. and *Leucaena* sp. The use of exotic, more

productive plants as goat feed may eventually lead to loss of indigenous knowledge of browse plants among other deleterious effects of exotics on the environment.

Four commonly used browse plants among the people of AkwaIbom State have been examined in this work. They include; *Palisota hirsuta* (Thunb.)K. Schum. (Commelinaceae) a bushy, succulent shrub up to 3m high, with characteristic swollen nodes. The stem and leaves are covered in soft pilose brown hairs. The leaves are arranged in a rossete towards the apex of the stem. Leaves are lanceolate, acute, cuneate, up to 30cm long and 12 cm wide. The inflorescence is paniculate, flowers whitish and fruits glossy and black. It is called "edongebot" locally. *Rauvolfia vomitoria* Afzel (Apcynaceae) is a shrub up to 5m tall with whorled leaves which are elliptic, acuminate, entire, glabrous. The inflorecence is a many flowered, terminal cyme with small, white flowers up to 5mm long. Latex is produced when cut. This accounts for the local name "mmongebaebot". *Spondias mombin* Linn. (Anacardiaceae) is a deciduous tree up to 9-10meters tall with compound, imparipinnate leaves. Flowers in short paniculate racemes borne directly on the stem. The fruits are white or yellow-green when ripe and are relished by natives who call it "nsukara". *Manniophyton fulvum* Mull. Arg. (Euphorbiaceae) is a shrub up to 1.5meters high with deeply trilobed leaves with short sharp hairs, cordate at base and acuminate. The inflorescence is a panicle of unisexual creamy to pale yellow flowers. The fruit is a deeply 3-lobed capsule up to 3cm long and covered with short brown hairs. It is locally called "nkunikun". This work aims at conserving indigenous knowledge and drawing attention back to indigenous browse plants and why they should still be used in rearing the native goats by;

- Identifying commonly used browse plants among the people of AkwaIbom State
- Investigating the phytochemical, nutrient, anti-nutrient and mineral constituents for such browse plants.

2. MATERIALS AND METHODS

A structured questionnaire was administered to 45 respondents who of necessity were goat farmers or had knowledge of how to keep goats. The ages ranged from 20 to above 46. The plants were collected, authenticated and processed for storage in the University of Uyo herbarium of the Department of Botany and Ecological Studies. The use of the browse plants in herbal cure for the goats was documented.

Fresh leaves of *Palisota hirsuta* collected from Ikono, *Rauvolfia vomitoria* from Itu, *Spondias mombin* and *Manniophyton fulvum* from Uyo were air dried for 4 days after which they were reduced to powdered form. These plants were chosen because of their common use by the three ethnic groups sampled in this work. Collections were made in May during the rainy season. The powdered leaf samples were stored in air tight containers. The methods for phytochemical screening, proximate analyses, mineral, nutrient and anti-nutrient analyses used were those of [9] and [10].

For the phytochemical screening, 200g of each powdered sample was extracted using 70% ethanol. Each mixture was allowed to stand for 72 hours at room temperature. The extract was then filtered and the filtrate concentrated to dryness in vacuo at 40ºC. The dried extract was then used.

The proximate analyses were done using the micro kjeldahl method of [9] for crude protein. For crude fat, the samples were weighed into porous thimbles, 200ml of petroleum ether poured into a round bottom flask, a soxhlet extractor fitted into it and placed on the heating

mantle for 6 hours. The extracted oil or fat was concentrated in vacuo and weighed. For ash content, 1.0g of the dried sample was weighed into three crucibles of known weights. The crucibles with their content were covered and placed in a muffle furnace and ignited for 24hours at 500^{o}C after which they were cooled in a desiccator and the crucible weighed with contents. These procedures were repeated until a constant weight for each crucible was obtained. Crude fibre determination was done by weighing 2g of the sample into a conical flask and adding 150ml of 1.25% H_2SO_4. The mixture was boiled gently for 30 minutes while maintaining a constant volume. The content in the beaker was filtered and the residue rinsed with hot distilled water until it was acid free. The material was scraped into a flask for base digestion by adding 200ml of dilute boiling 1.25% NaOH and allowed to boil gently for 30minutes while maintaining a constant volume. The mixture was then filtered, and the filtrate was washed thoroughly with hot distilled water until it was base free. The residue was rinsed once with 10% HCL and twice with industrial methylated spirit or ethanol. It was then dried in an oven at 105ºC and weighed before it was ignited in a furnace at 550ºC for 90 minutes then weighed again. The loss in weight of crucible and content after ignition was calculated as the crude fibre content. The carbohydrate content was determined as the difference obtained after subtracting total organic nitrogen, crude fat, crude fibre, crude protein and ash content from the total dry matter. The moisture content was determined by weighing 2.0g of the powdered sample into 3 empty crucibles of known weight. After weighing the crucibles with their content, they were placed in an oven, dried at 105-110ºC for 24 hours, cooled in a desiccator containing silica gel as a drying agent and weighed. The procedure was repeated until a constant weight was obtained for each sample.

Mineral content was determined by the wet digestion method in which 0.05g of sample was weighed into a digestion flask then 10ml of perchloric acid and 20ml of concentrated nitric acid was added. The content was digested on a hot plate until the colour turned white. The digest was allowed to cool and 20ml of distilled water was added before filtering and making it up to 50ml. The solution was then used for the determination of Sodium (Na) and Potassium (K) by flame analyzer/ photometer, Calcium (Ca) and Magnesium (Mg) by EDTA titration method and Phosphorus (P) by yellow (vanadomolybdate) colorimetric method and Iron (Fe) by orthophenanthroline colorimetric method. Standard deviations were calculated for triplicate determinations.

3. RESULTS AND DISCUSSION

3.1 Results

From the survey of browse plants used for goats by the people of AkwaIbom State, it was found that both men and women rear goats as a result, 60% of the respondents were males and 40% were females. None of the respondents focused only on goat farming as the only source of income. Rather, 80% of them were business people e.g. traders etc. While 20% were farmers. A total of 20 plants species belonging to 13 families were identified (Table 1). Out of these 40% (8 species) were found to be used as herbal cures for various ailments (Table 2). The survey also showed that 91% of the respondents agreed that goat meat is very popular in AkwaIbom State and 86% preferred the native African dwarf goats to those imported into the State from the Northern part of Nigeria because of its flavour and taste. The difference in flavour and taste of the native goats was attributed to the indigenous fodder fed to them by 75% of the respondents. The fodder fed to native goats differs according to age as stated by 48% of the respondents (Table 3). Many (93%) of the respondents collect their fodder in the morning hours while 86% were unaware of formulated

feeds for goats. A total of 97% of the respondents had difficulties collecting fodder for their goats. The respondents (31%) noted that there is special fodder for pregnant goats (Table 2). According to 82% of the respondents, the massive importation of goats into the state is a threat to the survival of the native goats.

Table 1. Common browse plants used for goats in Akwalbom State

S/N	Plant family	Plant name	Local name
1	Anacardiaceae	*Mangifera indica* L.	Nsukakara
2		*Spondias mombin* L.	manko
3	Annonaceae	*Annona muricata* L.	Sawasawa
4	Apocynaceae	*Landolphia membranacea*	mba
5		*Rauvolfia vomitoria* Afzel	Mmongebaebot
6	Commelinaceae	*Palisota hirsuta* (Thumb)K. Schum.	Edongebot
7	Dennstaedtiaceae	*Pteridium aquilinum*	Nyamaasabo
8	Euphorbiaceae	*Alchornea cordifolia* (Schum. &Thinn.) Mull. Arg.	Mbom
9		*Manniophyton fulvum*	Nkunikun
10		*Microdesmis puberula (Hook. f)*	Ntabid
11		*Explanch.* *Ficus exasperata Vahl.*	Ukwok
12	Fabaceae	*Albizia lebbeck* (L.) Benth.	Ubamindia
13		*Baphia maxima* Bak.	Emum
14		*B. nitida* Lodd.	Afuo
15	Lauraceae	*Persea americana* Miller	Ebenmbakara
16	Malvaceae	*Urena lobata* L.	Ndidi
17	Passifloraceae	*Barteria nigritiana* Hook. f	Ekpaekpang
18	Poaceae	*Andropogon gayanus*	Mbokokekpo
19	Polygalaceae	*Carpolobia lutea* G. Don	Ikpafum
20	Samydaceae	*Homalium letestui* Pellegr.	Otongidim

The result of the phytochemical screening, nutrient composition, anti-nutrient composition and mineral composition of *Palisota hirsuta* (Thumb.)K. Schum., *Rauvolfia vomitoria* Afzel, *Spondias mombin* L. and *Manniophyton fulvum* are as summarised in Tables 3, 4, 5 and 6 respectively.

From Table 3, alkaloids were absent in *S. mombin* and *P. hirsuta* and strongly present in *R. vomitoria.* Saponins were completely absent in *P. hirsute* and strongly present in *R. vomitoria.* All four samples contained tannins. These were moderately present in *S. mombin* and *M. fulvum* and strongly present in *P. hirsute* and *R. vomitoria.* Flavonoids occurred in moderate amounts in three of the samples except in *P. hirsuta* where it occurred in trace amounts. Anthraquinones were absent except in *S. mombin* and *R. vomitoria* where they were found in trace amounts. In all the tests for cardiac glycosides, both *P. hirsuta* and *R. vomitoria* showed strong presence of the glycosides.

Table 2. Some fodder used in the management of ailing goats

S/n	Family	Plant name	Local name	Ailment cured
1	Anacardiaceae	*Spondias mombin* L.	Nsukakara	For dislodging retained placenta
2	Costaceae	*Costus afer* Ker Gawl	Mbritem	Constipation/ pregnant goats
3	Euphorbiaceae	*Manniophyton fulvum*	Nkunikun	Fever / for goats in labour
4	‘’	*Microdesmis puberula*	Ntabid	Insecticide against tick/mite infestation
5	Icacinaceae	*Lasianthera africana*	Editan	Internal heat/ pregnant goats
6	Malvaceae	*Urena lobata*	Ndidi	To stop purging in Goats
7	Verbanaceae	*Vitex doniana*	Nkoro	Against vitamin defficiency
8	‘’	*Rauvolfia vomitoria*	Mongebaebot	For breastfeeding goats

Table 3. Result of phytochemical screening

Test	Plant sample	Observation	Inference
Alkaloids (Dragendorffs test)	*Spondias mombin*	No precipitate observed	-
	Manniophyton fulvum	Precipitation observed	+
	Palisota hirsuta	No precipitate observed	-
	Rauvolfia vomitoria	Precipitate observed	+++
Saponins (Frothing test)	*S. mombin*	Persistent frothing for more than 30 minutes was observed	++
	M. fulvum	Persistent frothing for more than 30 minutes was observed	++
	P. hirsuta	No frothing observed	-
	R. vomitoria	Persistent frothing for more than 30 minutes	+++
Tannins Test (Ferric chloride test)	*S. mombin*	Blue-black precipitate was observed	++
	M. fulvum	Same	+
	P. hirsuta	Same	+++
	R. vomitoria	Same	+++
Flavonoids (Shinodas test)	*S. mombin*	Effervescence observed with reddish colour	++

	M. fulvum	Effervescence observed with reddish colour	++
	P. hirsuta	Effervescence with orange colour was observed	+
	R. vomitoria	Effervescence with reddish colour was observed	++
Anthraquinones (Borntrager's test)	*Spondias mombin*	Violet colour was observed in the ammonia phase	+
	Manniophyton fulvum	No violet colour was Observed	-
	Palisota hirsuta	No colour change	-
	Rauvolfia vomitoria	A red colouration was observed in the ammonia phase	+
Cardiac glycosides			
• Lieberman's test	*S. mombin*	No colour change	-
	M. fulvum	No colour change	-
	P. hirsuta	A violet colour was Observed	+++
	R. vomitoria	A violet colour was Observed	+++
• Salkowski's test	*S. mombin*	No reddish – brown colour at the interphase	-
	M. fulvum	A reddish brown colour –a steridial ring was observed	+
	P. hirsuta	Same	+++
	R. vomitoria	Same	+++
• Keller-Kiliani test	*Spondias mombin*	No browning at Interphase	-
	Manniophyton fulvum	A reddish –brown ring was observed at the interphase	+
	Palisota hirsuta	A brown ring was observed at the interphase	+++
	Rauvolfia vomitoria	Same	+++

- = *Absent, + = Trace, ++= moderate, +++ = strongly present*

The nutrient analyses (Table 4), showed that *P. hirsuta* had the highest value for moisture content (84.00 %), crude fibre (28.57%), and crude fat (12.22%). *R. vomitoria* had the highest crude protein (25.88%) value and *M. fulvum*, carbohydrate (52.85%).

Table 4. Nutrient composition of the four browse plants

Nutrient	*S. mombin*	*M. fulvum*	*P. hirsuta*	*R. vomitoria*
Moisture content	50.80±0.10%	34.80±0.22%	84.00±1.00%	76.50±0.10%
Crude protein	17.06±1.00%	18.81±0.10%	14.65±0.22%	25.88±0.33%
Crude fibre	20.00±0.10%	13.00±1.00%	28.57±1.02%	21.00±1.00%
Crude fat	11.81±0.25%	10.34±0.35%	12.22±0.76%	10.54±0.50%
Ash content	8.00±1.20%	5.00±0.50%	10.66±1.52%	8.00±1.00%
Carbohydrate	43.13±0.70%	52.85±0.40%	33.88±0.38%	34.56±0.50%

The anti-nutrient analysis (Table 5), showed that oxalic acid was much higher in all the four browse plants than other anti-nutrients while tannic acid was the lowest in all four.

Table 5. Anti-nutrient composition of the four browse plants (mg/100)

Anti-nutrient	*S. mombin*	*M. fulvum*	*P. hirsuta*	*R. vomitoria*
Phytic acid	42.64±0.32	41.52±0.25	27.59±0.29	45.27±0.30
Oxalic acid	598.40±8.00	589.60±8.70	290.40±8.80	202.40±8.80
Tannic acid	10.31±0.25	8.31±0.33	6.16±0.50	3.11±0.24

The mineral analyses (Table 6) obtained from wet matter, showed high content of potassium and phosphorus in both *Palisota hirsuta* and *Rauvolfia vomitoria (*192.00mg/100g and 256.00mg/100g) and (260mg/100g and 410mg/100g) respectively. *Spondias mombin* and *Manniophyton fulvum* had the least values for magnesium which were, 0.29mg/100g and 0.24mg/100g respectively, while the least value in *P. hirsuta* was for sodium at 15mg/100g and in *R. vomitoria* in calcium at 19mg/100g.

Table 6. Mineral Composition of the four browse plants (mg/100g)

Minerals	*S. mombin*	*M. fulvum*	*P. hirsuta*	*R. vomitoria*
Calcium	1.20±0.40	0.06±0.00	200.00±0.40	14.00±0.40
Magnesium	0.29±0.10	0.24±0.25	74.40±0.00	28.80±0.00
Potassium	16.00±0.10	12.80±0.10	192.00±8.00	256.00±8.00
Sodium	9.60±0.20	6.40±0.20	15.00±0.10	19.00±0.10
Phosphorus	4.05±0.00	2.90±0.00	260.00±0.00	410.00±0.00
Iron	0.68±0.10	0.57±0.00	97.58±0.00	71.31±0.00

3.2 Discussion

Indigenous goat farming is largely dependent on experience and indigenous knowledge of the farmers. Such Knowledge is usually passed down from generation to generation with little or no documentation. It is increasingly becoming obvious that indigenous knowledge of biodiversity is very important [11]. More (60%) men than women (40%) were found to be goat farmers. This could be due to the work involved in collection of fodder for the goats which would mean more stress for the women who already have a lot to do in order to keep the family. In many cases, widows take up goat farming to augment income for the family. [12] also observed that there were 60% males to 40% females among the respondents who collect and use mistletoes in herbal cures. With urbanisation, the common browse plants have become scarce around the towns and necessitate travelling farther distances before they can be collected. A total of 97% of respondents stated that they had difficulties in

collection of browse plants and this may account for many farmers allowing their goats to roam. Indigenous browse species were screened by [8] out of which seven of the species were also documented in this work. Some of these could be brought into cultivation in large scale for the sole purpose of providing nutritious food for goat farmers to feed their goats and thus encourage more goat production.

Goat farming was observed to be largely a secondary source of income since 80% of the respondents were business people involved in different kinds of trade in addition to goat farming. In spite of the high demand of goat meat in the state, it is easier to buy imported goats and sell them than to be involved in goat farming. In their work, [13], observed that 54% of the TBAs they interviewed had other sources of income.

A total of 40% of the browse plants as listed in Table 2, were found to be used as herbal cures for various ailments and conditions in the goats. According to the respondents such browse plants alone are provided for the goats when they are ill, in order to ensure that the goat will consume them. In many cases plants used in herbal cures are also eaten as food. Athough formulated feeds exist for goats, 86% of the respondents said they were unaware of them.

The phytochemical screening (Table 3) revealed that the browse plants had secondary metabolites in different quantities and some were completely lacking. Saponin was present in three of the browse plants and absent in *P. hirsuta.* In goats, large doses of plant leaves containing saponins can cause distension of the rumen according to [14]. All four browse plants were found to contain tannins. According to [15], plant tannins are complex phenolic polymers varying in chemical structure and biological activity. They inhibit the utilisation of nutrients through astringency, enzymes inhibition and reduced forage digestibility. It is also associated with high lignin content, low crude protein, reduced bloating and increased protein absorption in grazing ruminants [16]. According to [15], dry matter intake, nitrogen intake and nitrogen balance were significantly influenced by the saponins and tannins in the leaves of *Gliricidia sepium, Manihot esculenta* and *Spondias mombin.*

Proximate analyses are used extensively for quick estimation of nutrient potentials of feed stuffs including tropical browse plants used by indigenous farmers for ruminant feeding [17]. The crude protein value (Table 4), for *Spondias mombin* (17.06%) and *Manniophyton fulvum* (18.81%) was found to be comparable to values obtained for *Aspillia africana* (17-17%) by [18] and for *Amaranthus spinosus* (18.55%) by [19]. The highest crude protein value (25.88%) in all four browse plants was obtained in *Rauvolfia vomitoria.* This value is comparable with the value obtained for *Microdesmis puberula* (25.9%) and *Dialium guineense* (24.96%) as reported by [20] and [21] and exceeds the minimum protein requirements of 10-12% for ruminants as estimated by [22]. The introduced species of *Gliricidia* and *Leucaena* were reported to have protein values of 22.2% and 22.5% respectively by [23]. These are often preferred above indigenous browse plants as documented by [8]. However, *R. vomitoria* has a higher protein value than they do and should be further exploited. [21], also reported a crude protein value for *R. vomitoria* to be 27.14% in their work while [20], reported a crude protein value of 15.34% for *Palisota hirsuta* which was comparable to the value obtained in this work which was 14.65%. [24] concluded that crude protein values of certain indigenous browse species including *S. mombin* were considered as protein supplements suitable for feeding to livestock.

The carbohydrate value for *S. mombin* (43.13%), *M. fulvum* (52.85%), *P. hirsuta* (33.88%) and *R. vomitoria* (34.56%) were comparable to values obtained by [25] for *Justicia insularis*

(45.14%) and [20] for *Ricinodendron heudelotti* (46.27%) and *Vernonia amygdalina* (40.08%). Carbohydrate is the main source of energy for man and animals as a result these browse plants are necessary for the goats. [20], however reported higher carbohydrate values for *Palisota hirsuta* (54.46%) and [21] reported a higher value (53.86%) for carbohydrate in *Rauvolfia vomitoria.*

The ash content in *S. mombin* (8.00%) and *M. fulvum* (5.00%) compared favourably with that of *Alchornea cordifolia* (5.20%), *Urena lobata* (7.00%) and *Calopogonium mucunoides* (6.00%) as reported by [19]. In *P. hirsuta*, the ash content of 10.66% obtained in this work was similar to the value (10.80%) obtained by [20] while the ash value for *R. vomitoria* (8.00%) was found to differ from the value (5.20%) reported by [21].

Anti-nutrient composition of the browse plants (Table 5) for phytic acid were higher [*S. mombin* (42.46mg/100g), *M. fulvum* (41.52mg/100g), *P. hirsuta* (27.59mg/100g) and *R. vomitoria* (45.27mg/100g)] than the range of values (13.80mg/100g to 25.20mg/100g) reported by [20] for browse plants including *P. hirsuta*. [30] reported a phytic acid value of 89.2mg/100g for *Cajanus cajan*. According to him, concentration of phytic acid in forages may chelate several mineral elements especially calcium, magnesium and iron and also interferes with their absorption and utilization. Oxalic acid values ranged from 202.40mg/100g in *R. vomitoria* to 598.40mg/100g in *M. fulvum.* [15] stated that ruminants can consume considerable amounts of high oxalate plants without adverse effects due to microbial decomposition in the rumen. Tannic acid content ranged from 3.11mg/100g in *R. vomitoria* to 10.31mg/100g in *S. mombin*. These values were much lower than those obtained for other anti-nutrients in the browse plants.

Minerals are vital for normal growth, reproduction and proper functioning of the body [26]. They protect and maintain the structural components of the body, organs and tissues. They catalyse several enzymatic processes and hormone systems and maintain acid-base balance, water balance and osmotic pressure in the blood and cerebral spinal fluids [27]. In Table 6, the potassium content was very high in *R. vomitoria* (256mg/100g) and according to [28], the concentration of potassium required by livestock during lactation is 7.0mg/100g. Potassium deficiency causes a decrease in feed intake and reduces weight gain. Values for calcium, potassium and phosphorous were high in the browse plants and such high dietary mineral content are good for foetal development and lactation according to [29]. The values of iron in *P. hirsuta and R. vomitoria* were quite high compared to those of *S. mombin* and *M. fulvum.* Iron functions in the immune system of animals and is a constituent of several enzymes associated with the mechanism of electron transport [29]. On the whole, the value for minerals obtained in *S. mombin* and *M. fulvum* were below required levels for goats. The differences in values obtained could be due to the level of the minerals in the soil, climate, and stage of growth or the portion of material used for the analyses [31]. These plants were analysed from samples collected in the rainy season. Dry season samples may provide different results.

4. CONCLUSION

The efficiency of goat production considering high local demand, depends on adequate fodder production. The production, management and sustainable use of fodder will enhance the economic benefits for indigenous goat farmers. A total of 20 plant species in 19 genera and 13 families have been identified in this work as common plants used by indigenous goat farmers as fodder and as herbal cures for various ailments in goats. Results of phytochemical, nutrient, anti-nutrient and proximate analyses have shown that four of the

species (*S. mombin, M. fulvum, P. hirsuta and R. vomitoria*) contain bioactive compounds such as saponins, tannins, anthraquinones, flavonoids, alkaloids, cardiac glycosides which suggests that the plants are of high medicinal value. This may be a validation of their use in herbal care by the indigenous goat farmers. Nutritionally, the browse plants were also found to compare favourably with other introduced fodder such as *Leucaena* sp. and *Gliricida* sp. These plants were also found to be rich in minerals which improve the productivity of the goats. Based on the high anti-nutrient contents there is need for developing methods of processing these browse plants in order for the goats to benefit maximally from them. It is recommended that indigenous goat farmers be encouraged to cultivate browse plants along with goat rearing. This could also serve as a means of income as they go into fodder production and sales. There should be concerted efforts to conserve forests around cities, towns and villages. Sustainable utilization of forest resources should also be emphasised. These measures would encourage more people to get involved in indigenous goat farming so that they do not become endangered and eventually extinct.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Wena OA. Essential Agricultural Science for Senior Secondary Schools. 4th ed. Ikeja, Lagos: Tonad Publisher; 2002.
2. Devendra C. Small farm systems combining crops with livestock. Proceedings of the world Conference on animal production. 1983;1:173-91.
3. Jurgens MH. Animal Feeding and Nutrition 8th ed. Iowa: Kendall/ Hunt Publishing Company; 1997.
4. Aganga AA, Tshwenyane SO. Feeding values and Anti-nutritive factors of Forage tree legumes. Journal of Nutrition. 1999;2(3):170-77.
5. Le Houerou HN. Chemical composition and nutritive value of browse in tropical West Africa. In: Le Houerou HN. editor. Browse in Africa, the current state of knowledge. Addis- Ababa: International Livestock Centre for Africa (ILCA); 1980.
6. Akusu MO, Ajala OO. Reproductive performance of West African Dwarf Goats in the Humidtropical environment of Ibadan. Ibadan: Department of veterinary surgery and reproduction; 2000.
7. Ivory DA. Major characteristics, Agronomic Features and Nutritional Value of shrubs and tree fodder. In: Devendra C. editor. Shrubs and Tree Fodder for Farm animals. Denpasar: Proceedings of a workshop; 1989.
8. Atta-krah AN, Sumberg JE, Reynolds L. Leguminous fodder trees in farming system. Addis- Ababa; 1986.
9. A.O.A.C. Official Methods of Analysis, 15th ed. Association of Official Analytical Chemists. Washington D.C.; 1990.
10. Sofowora A. Medicinal plants and traditional Medicine in Africa. Ibadan: Spectrum Books Ltd.; 1993.
11. Rajagopalan R. Environmental Studies; From Crisis to Cure. New York: Oxford Press; 2008.

12. Bassey ME, Silas K. Ethnic Usage of Mistletoes in Parts of AkwaIbom State, Nigeria. Int. J. Chem., Environ, Pharm. Res. 2010;1(3):124-28.
13. Bassey ME, Isu PO. Ethnobotanical Survey of Indigenous Herbs used by Traditional Birth Attendants (TBAs) in AkwaIbom State. A Journ. of Gender and Comm. Health. 2011;2(1):30-48.
14. Howel JM. Toxicities and excessive intake of minerals. Detection and treatment of Minerals; 1996.
15. Onwuka CF. Nutritional Evaluation of some Nigerian browse plants in the humid Tropics. Nigeria: University of Ibadan; 1983.
16. McLeod MN. The digestibility and nitrogen, phosphorus and ash contents of the leaves of some Australian trees and shrubs. Australian Journal of Experimental Agric. and Animal Husbandry. 1974;13:245-250.
17. D'Mello JPF, Fraser KW. Nutritional potentialities of fodder trees and shrubs as protein sources inmonogastric nutrition. In: Speedy A, Pugliese PL. editors. Legume trees and other fodder. Rome: Food and Agriculture Organisation; 1992.
18. Okwu DE, Josiah C. Evaluation of the Chemical Composition of two Nigerian medicinal plants. African Journal of Biotechnology. 2006;5(4):357-361.
19. Ahamefule FO, Obua BE, Ibeawuchi JA, Udosen NR. The Nutritive Value of Some plants Browsed by Cattle in Umudike, South Eastern Nigeria. Pakistan Journal of Nutrition. 2006;5(5):404-409.
20. Okoli IC, Anunobi MO, Obua BE, Enemuo V. Studies in Selected Browse of South Eastern Nigeria with particular reference to their proximate and some Endogenous anti-nutritional constituents. Umudike: University of Agriculture; 2003.
21. Mecha I, Adegbola TA. Chemical composition of some Southern Nigeria Forage Eaten by goats. In. Le Houerou, H.N. editors. Browse in Africa the current state of Knowledge. Addis-Ababa, Ethiopia: ILCA; 1980.
22. Agricultural Research Council (ARC), The Nutrient requirements of farm animals. Ruminants. Tech. Rev. of Summaries. 1985;150-200.
23. Tian G, Broussard L, Kang BT. The role of plant residues with different Chemical Composition in sustaining maize productions in sub-mined tropical environment. In: Badejo MA, Togun AO, editors. Strategies and tactics of sustainable agriculture in the Tropics; 1985.
24. Wumbei IM, Laryea TT, Awauh-Kyei E, Odoi FNA. Nutritional composition and Potential Feeding for Livestock. Journal of Ghana Science Association. 2005;147-150.
25. Bassey ME, Etuk EUI, Bala D, Ajibesin KK, Nworu F. Phytochemical and Nutritional assessment of *Justicia insularis*. Journal of Environmental Design. 2003;1(2):41-47.
26. McDowell LR. Minerals in animals and Livestock Nutrition. California: Academic Press Inc.; 1992.
27. Underwood EJ, Suttle NF. The mineral nutrition of livestock, 3rd Edition. Wallingford, UK: CAB International; 1999.
28. National Research Council (NRC), Nutrients Requirements of Goats. No. 15. Washington D.C., USA: National Academy of Sciences; 1981.
29. Manske LL. Mineral Requirement for Native range land In: Jarrige, R. editors. Ruminant Nutrition. Eurotext Publication; 2002.

30. Ologhobo AD. Biochemical and Nutritional Studies of cowpea and lima bean with particular reference to some inherent anti-nutritional components. Nigeria: University of Ibadan; 1980.
31. Minson DJ. Forage in Ruminants. California, USA: Academic Press Inc; 1990.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history.php?iid=547&id=24&aid=5266