

SURVEY OF THE DIVERSITY AND PROXIMATE COMPOSITION OF SELECTED MOST PREFERRED BROWSE PLANTS UTILIZED FOR GOAT FEEDING IN IMO AND ENUGU STATES OF SOUTHEASTERN NIGERIA

Obua, B.E

**Department of Animal Production and Livestock Management
College of Animal Science and Animal Production
Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria
E mail. benobua@gmail.com Tel. +2348033676606**

ABSTRACT

A survey was conducted in three hundred households across two Local Government Areas (L.G.As), Ohaji/Egbema/Oguta L.G.A of Imo State and Nsukka L.G.A of Enugu State, Southeastern Nigeria, with the aid of structured questionnaires, farm visits and interactive interviews, to determine the diversity of most preferred browse plants utilized for feeding West African dwarf goats. Questionnaires were administered to 15 households that kept West African dwarf goats in each of the 20 communities that make up the survey area. The proximate composition of leaves of selected ten most preferred browse plants was also evaluated. Data generated were analyzed using descriptive statistics such as percentages and means. Thirty-eight (38) plant species which comprised trees, shrubs, lianas, woody vines, herbs and forbs belonging to 22 families and 34 genera were identified. Important plant families that contributed to the most preferred forage resource base of goats included legumes, which formed 15.80% of which families Fabaceae, Caesalpinaceae and Mimosaceae comprised 2.63%, 2.63% and 10.53%, respectively. The families, Eurphobiaceae, Moraceae, Asteraceae, Loganiaceae, Amaranthaceae and Anarcadiaceae formed 13.15%, 10.52%, 7.9%, 7.9%, 5.26%, and 5.26% of the identified browse plants, respectively. Proximate composition of *Pentaclethra macrophylla*, *Ricinodendron heudelotti*, *Pterocarpus santalinoides*, *Tridax procumbens*, *Alternanthera bettzickiana*, *Telfaria occidentalis*, *Palisota hirsuta*, *Costus afer*, *Asystasia gangetica* and *Syndrella nodiflora* revealed that the plants had low to moderate crude fibre content, averaging 15.03% (9.30 - 22.62%), with moderately high crude protein values (15.32 to 28.40%), with a mean of 19.58%. The study highlights the importance of indigenous knowledge residing in goat farmers which often compliments empirical knowledge.

Keywords: Diversity, goat, preferred browse plants, proximate composition, Nigeria.

INTRODUCTION

Plant species in Nigeria have been estimated at about 5,000 species (FGN, 2002). Recently, dwindling proceeds of browse feed resource for ruminant livestock due to deforestation, urbanization, diminishing farmlands, shorter fallows, bush burning and industrialization have been reported (Okeke, 1996; Ahamefule *et al.* 2006a). This has altered the rich floral diversity of the region (Okeke, 1996) and has narrowed farmers' choices and plant diversity

even further (Shelton, 2000). Of the over 7,000-10,000 trees and shrubs listed as being suitable for feeding livestock in Africa and Asia (Wickens, 1980; Brewbacker, 1986), it has been suggested that only 80 are of real fodder value while 5 may be recorded as good. There is an emerging practice of introduction of browse plants which are more palatable, well accepted by ruminants and are available throughout the year (Topps, 1992) into goat feeding system. This would contribute to meeting the nutrient and dry matter needs of goats, a common constraint on the use of browse for feeding goats.

However, available information on the diversity and proximate composition of most preferred browses and other forage crops of Southeastern (SE) Nigeria are also scanty, mostly informal assessment and unpublished reports (Okigbo, 1980; Obua, 1992; Okeke, 1996; Ebere, 2000). Okoli *et al.* (2003b) and Onyeonagu and Ashiegbu (2006) listed 163 and 86 indigenous and exotic plants respectively utilized as primary food and fodder for sheep and goats in SE Nigeria, of which 30 and 20 species were most preferred species. Earlier, Okoli *et al.* (2001) had reported on 6 most preferred browse plants of SE Nigeria and indicated that their preference was due to high crude protein and ether extract content.

The relevance of evaluating the proximate values of our indigenous trees, shrubs and browse plants is evident (Cerrillo and Juarez, 2004) as their foliage can make important contribution to the protein and energy consumption of ruminant animals. Moreover, for better management and use of trees in livestock feeding system, information on their palatability, in addition to chemical composition is necessary (Abdulrazak *et al.*, 2001).

The relationship between browse palatability and their chemical composition have been reported (Ben Salem *et al.*, 1994; Nefzaoui *et al.*, 1995) and contrasting opinions concerning the effect of the nutritive characteristics of browse plants on their palatability by sheep and goat are reported in the literature (Genin, 1991; Nefzaoui *et al.*, 1995; Nolan and Nastis, 1997, Ben Salem *et al.*, 2000). Martz *et al.* (1967) acknowledged that in theory the chemical composition of forages should influence their preference but several reports do not seem to highlight a consistent correlation between forage and their chemical composition (Carew *et al.*, 1980; Kaitho *et al.*, 1998). Palatability is often seemingly unrelated to the proximate composition analysis of plants (Yabann *et al.*, 1987). Yet, preference has been associated with proximate composition of

browse plants (Okoli *et al.*, 2001; Rogosic *et al.*, 2006). Ahamefule *et al.* (2006a) reported that preference shown by goats for forages may not necessarily be in relation to high nutritional content but may be in response to other factors as palatability or some intrinsic properties of feedstuff.

However, Hussain and Durrani (2009) reported that the chemical composition is a key factor determining palatability but that the effective constituents associated with palatability are situation specific rather than universal. Previous studies on these browse plants have not been exhaustive and have concentrated on their agronomic characteristics and proximate composition (Larbi *et al.*, 1993; Okeke, 1996), with little information relating the proximate composition to their utilization as most preferred browse plants.

A survey of the diversity and proximate composition of most preferred browse plants of the region is therefore needed to provide a data bank on the important plant families and most preferred browse species that contribute significantly to the forage resource base of goats. This paper presents an assessment of the diversity and proximate values of selected most preferred browse plants of SE Nigeria, with a view of elucidating some of the reasons for the preference by goats offered these plants.

MATERIALS AND METHODS

Study area:

Southeastern (SE) Nigeria is situated between latitude 04° 15' and 07° North and longitude 05° 49' and 09° 39' East and occupies an area of 75,000 km² (Okafor and Fernandez, 1989). Two states situated within SE Nigeria were selected for the study, Imo state and Enugu state. Nsukka and Ohaji/Egbema/Oguta Local Government Areas (L.G.As) were selected from Enugu and Imo states respectively. Nsukka L.G.A lies within latitude 6° 45' N and 7° N and longitude 7° 12.5' E and 7° 36' E (Ofomata, 1975). It has a total land area of 475 square kilometers, situated at an altitude of 447.26 meters, with a population of about 309,448 people (FRN, 2009). Ohaji/Egbema/Oguta L.G.A lies within latitude 5° 12' N and 5° 48' N and longitude 6° 35' E and 7° 00' E (Ofomata, 1975). Ohaji/Egbema/Oguta L.G.A now is split into two L.G.As, Ohaji/Egbema and Oguta L.G.As. It has a population of about 325, 231 people, made up of 182,891 and 142,340 people (FRN, 2009). Southeastern Nigeria is characterized by 3 and 9 months of dry and rainy seasons, respectively.

The Study:

A survey was conducted with the aid of questionnaires, personal interviews and observations in ten out of the seventeen communities in Nsukka L.G.A of Enugu state and in ten out of the twenty-eight communities in Ohaji/Egbema/Oguta(O/E/O) L.G.A now split into Ohaji/Egbema and Oguta L.G.A s, Imo state, Southeastern Nigeria.

Communities were selected randomly and fifteen respondents were interviewed in each community making up a total of one hundred and fifty (150) respondents in each L.G.A. A total sample size of three hundred (300) households spread over the two L.G.As was drawn. Selected respondents were made up of households, which kept goat at the time of the study. The study was conducted between the months of January and December of the year to cover both dry and rainy seasons.

The aspects covered by the questionnaires were most preferred browse plant species used in feeding goats. Smallholder farmers were requested to indicate five most preferred browses in their localities, ten browse plants from the resultant list of thirty-eight plants were randomly chosen for the study. The ten plants are *Penthacllethra macrophylla*, *Ricinodendron heudelotti*, *Pterocarpus santalinoides*, *Tridax procumbens*, *Alternanthera bettzickiana*, *Telfairia occidentalis*, *Palisota hirsuta*, *Costus afer*, *Asystasia gangetica* and *Syndrella nodiflora*.

Each household was visited once during the study period. On each visit, sampling and identification of the plants was undertaken. Subsequently, in company of the farmers, plants were identified with their local names, collected, tagged and preserved for subsequent botanical identification. Plants sampled at the different sites were identified at the Botany Department, University of Nigeria, Nsukka, Enugu State and Forestry Department, Ministry of Agriculture and Environment, Owerri, Imo State, Nigeria.

Chemical and data analysis

Fresh leaf samples of each plant species were manually cut into pieces (2 - 5cm), weighed and oven dried at 60 °C for 48 hours, weighed again and ground through a 1mm screen mill for subsequent analysis. The plants were subjected to proximate analysis. Proximate composition was determined for percentage dry matter (DM), crude protein (CP), crude fibre (CF), ash, ether extract (EE) and nitrogen free extract (NFE) according to the methods of AOAC (1990). The data collected were analyzed using simple descriptive statistics such as averages, ranges and percentages.

RESULTS AND DISCUSSION

This study revealed a striking rich array of browse plants utilized by farmers for feeding goats. A total of 38 plant species comprising of trees, shrubs, herbs, forbs, woody vines and lianas belonging to 22 families and 34 genera were identified as most preferred plants by goats (Table 1). Forage plant species that are commonly preferred by grazing/browsing animals are selected first by choice and labeled as preferred species (Vallentine, 2001). The list of forage plants in the present study is more diverse than previously reported studies

Table 1: Diversity of most preferred browse plants used in feeding goats

<i>Family/Botanical names</i>	<i>Common name</i>	<i>Vernacular name</i>
Acanthaceae		
<i>Asystasia gangetica</i> (Linn.) T Anders	Chinese violet, bush green	Ekere
Amaranthaceae		
<i>Alternanthera bettzickiana</i> (Regel) Voss	Red Amaranth	
<i>Amaranthus hybridus</i> (L)	Green Amaranth	Inine
Anarcadiaceae		
<i>Mangifera indica</i> (L)	Mango	Mangolo
<i>Spondias mombin</i> (L)	Hog plum	Ijikara
Arecaceae		
<i>Elaeis guineensis</i> Jacq	Oil palm	Nkwu
Asteraceae =(Compositae)		
<i>Aspilia africana</i> Pers. C.D. Adams	Bush marigold	Nramejinla
<i>Syndrella nodiflora</i> Gaertn	Yellow starwort	
<i>Tridax procumbens</i> (L)	Tridax	
Burseraceae		
<i>Dacryodes edulis</i> (G.Don)	African native pear	Ube
Caesalpinoideae		
<i>Dialium guineense</i> Willd	Velvet Taramind	Icheku, Nchichi
Chrysobalanaceae		
<i>Dactyladenia bateri</i> (Hook. F.ex. Oliv)	Monkey fruit	Ahaba, Nkwa
Commelinaceae		
<i>Palisota hirsuta</i> (Thumb) K. Schum		Ikperere aturu
Costaceae		
<i>Costus afer</i> Ker-Gawl	Ginger lily	Okpete
Cucurbitaceae		
<i>Telfaria occidentalis</i> Hook.f.	Fluted pumpkin	Ugu
Eurphobiaceae		
<i>Alchornea cordifolia</i> (Schum & Thonn). Mull. Arg.	Christmas bush	Mbubo
<i>Euphorbia heterophylla</i> L	Spurge weed	Ogbara-ohu
<i>Manniophyton fulvum</i> Mull. Arg	Gasso nut	Egenwanu
<i>Manniophyton manii</i>		Ege
<i>Ricinodendron heudelotti</i> (Baill)	African–nut wood oil	Okwe
Fabaceae (Papilionaceae)		
<i>Baphia nitida</i> Lodd	Camwood	Aboshi
Lauraceae		
<i>Persea americana</i> Mill	Avacardo pear	Ube bekee
Loganiaceae		
<i>Anthocleista djalonensis</i> A.Chev	Cabbage tree	Oroghopo
<i>Anthocleista vogelii</i> Planch	Cabbage tree	
<i>Spigelia anthelmia</i> (L)	Worm bush	
Maranthaceae		
<i>Maranthochoaleucantha</i>		Etere
Meliaceae		
<i>Khaya senegalensis</i> (Desr.) A. Juss	Mahogany	Ono
Mimosoideae (Mimosaceae)		
<i>Albizia ferruginea</i> (Guill & Perr) Benth		Ngwu
<i>Albizia lebbek</i> (Linn.) Benth	Indian walnut	Avu nkirishi
<i>Pentaclethra macrophylla</i> Benth	Oil bean tree	Ugba/Ukpaka
<i>Pterocarpus santalinoides</i> L'Her ex Dc		Nturukpa
Moraceae		
<i>Ficus thonningii</i> Blume		Ogbu
<i>Ficus ingens</i> (Miq.)		Ogbu
<i>Milicia excelsa</i> (Welv.)	African oak	Oji
<i>Treculia africana</i> Decne	African bread fruit	Ukwa
Pandaceae		
<i>Microdesmis puberula</i> (Hook.f.) ex Planch	Little clusters	Mkpiri
Tiliaceae		

Glyphaea brevis (Spreng.) Monachino

Anyachu

Verbanaceae*Gmelina arborea* Roxb

Gmelina

(Mecha and Adegbola, 1980; Okoli *et al.*, 2001; Okoli *et al.*, 2003b; Onyeonagu and Ashiegbu, 2006).

In Southeastern Nigeria, Okoli *et al.* (2001), Okoli *et al.* (2003b) and Onyeonagu and Ashiegbu (2006) listed 6, 30 and 20 most preferred browse species respectively for feeding sheep and goats. These are indications that there is much more preferred and palatable browse and forage resources in the region than the few highlighted by these studies.

It is noteworthy that in this study out of 38 browse plants listed, 6 (15.80%) were legumes which spread across 5 genera. Important plant families that contributed to the most preferred forage resource base of goats include the legume families, which formed 15.80% of which families Fabaceae (Papilionaceae), Caesalpinaceae and Mimosaceae comprised 2.63%, 2.63% and 10.53% respectively (Table 2). Mimosaceae was represented by 3 genera while Fabaceae and Caesalpinaceae were represented by one genus each. Majority of legumes identified in the present study were in the family of Mimosaceae. Agishi (1985) had identified 143 legume genera in Nigeria rangelands, in which 55.0% were in the family Mimosaceae.

The family Euphorbiaceae accounted for 13.15%, the highest proportion of browse plants recorded in the survey while the several other families such as Amaranthaceae and Anarcadiaceae formed 5.26% each respectively. The families Asteraceae and Loganiaceae formed 7.89% each of the browse plants identified in this study. These families are therefore important plant families that contribute to the forage resource base of goats in the study area. Each of these families, Pandaceae, Tiliaceae, Maranthaceae, Meliaceae, Lauraceae, Chrysobalanaceae, Commelinaceae, Costaceae, Cucurbitaceae and Verbanaceae also formed 2.63%, respectively of the plants identified in this study (Table 2).

In the present study, the most preferred browse plants were ranked based on the rating by the smallholder farmers on the acceptability and preferences of the plants. They are also referred as ice cream plants in range management jargon. They

include *Microdesmis puberula*, *Glyphea brevis*, *Albizia lebbek*, *Albizia feruginea*, *Alchornea cordifolia*, *Anthocleista djalonensis*, *Anthocleista vogeli*, *Aspilia africana*, *Dialium guineense*, *Elaeis guineensis*, *Treculia africana*, *Pentaclethra macrophylla*, *Ficus ingens*, *Ficus thonningii*, *Gmelina arborea*, *Khaya senegalensis*, *Euphorbia heterophylla*, and *Manniophyton fulvum*, *Manniophyton mannii*, *Mangifera indica*, *Persea americana*, *Pterocarpus santalinoides*, *Ricinodendron heudelotti*, *Baphia nitida*, *Tridax procumbens*, *Dacryodes edulis*, *Melicia excelsa*, *Amaranthus hybridus*, *Dactyladenia bateri*, *Alternanthera betzickiana*, *Maranthocloa leucantha*, *Syndrella nodiflora* and *Telfairia occidentalis*. Forbs such as *Palisota hirsuta*, *Costus afer*, *Asystasia gangetica* and *Spigelia anthelmia* were also among the most preferred plants (Table 1). Generally, it could be observed in this study that there were eighteen (18) tree species, twelve (12) forbs or soft stemmed herbaceous plant species, eight (8) shrub species and no trailing legumes among the most preferred browse species in Southeastern Nigeria. This is consistent with observation by several authors that goats prefer tree, shrub and forbs species compared to trailing legumes and grasses (Omphile *et al.*, 2004; Pande *et al.*, 2002).

Similar forage plants have been reported as highly preferred in the region (Umoh and Udoh, 1993; Larbi *et al.* 1993; Okoli *et al.*, 2003b; Bamikole *et al.*, 2004; Oji and Kalio, 2004; Aju and Okwulehie, 2005; Larbi *et al.*, 2005; Onyeonagu and Ashiegbu, 2006; Ahamefule *et al.*, 2006a; Kalio *et al.*, 2006; Onyeonagu and Ashiegbu, 2008). The diversity of the most preferred browse plants utilized in feeding goats in the present study is largely comparable with the diverse forage crops reported in the area (Mecha and Adegbola, 1980; Okeke, 1996; Okoli *et al.*, 2003b; Ahamefule *et al.*, 2006b; Onyeonagu and Ashiegbu, 2008; Onyeonagu *et al.*, 2011).

Table 2: Proportion, number of species and genera of most preferred browse plants used in feeding goats

Family	Number of species	Number of genera	Percentage of plants (%)
Acanthaceae	1	1	2.63
Amaranthaceae	2	2	5.26
Anarcadiaceae	2	2	5.26
Arecaceae	1	1	2.63
Asteraceae	3	3	7.89
Burseraceae	1	1	2.63
Caesalpinoideae	1	1	2.63
Chrysobalanaceae	1	1	2.63
Commelinaceae	1	1	2.63
Costaceae	1	1	2.63
Cucurbitaceae	1	1	2.63

Dioscoreaceae	1	1	2.63
Euphorbiaceae	5	4	13.15
Fabaceae	1	1	2.63
Lauraceae	1	1	2.63
Loganiaceae	3	2	7.89
Maranthaceae	1	1	2.63
Mimosaceae	4	3	10.53
Moraceae	4	3	10.53
Pandaceae	1	1	2.63
Tiliaceae	1	1	2.63
Verbanaceae	1	1	2.63
Total	38	34	100.0

The most important factor affecting choice of feed is the availability of a variety of feed (Ademosum and Mshelbwala, 1992). Yet many wild browse and bush species are undervalued because of insufficient knowledge about their potential feeding value (Boufennara *et al.*, 2012). Forage species availability and palatability are major factors determining feeding behaviour in goats in SE Nigeria (Odo *et al.*, 2001). Feeding a variety of most preferred browse plants available in a locality to goats would ensure adequate dry matter and nutrient intake from the forage and contribute to overcoming low dry matter intake, a constraint to the use of browse plants in small ruminant feeding. In the range, animals concentrate on the palatable plant species, the effect is that the favoured ones particularly the juveniles are rendered weak as a result of repeated browsing thereby, putting them at a comparative disadvantage

within the ecosystem. In such a situation, the species are gradually replaced by more vigorous ones, thereby threatening their continued existence (Jimoh, 2005).

The proximate composition of the browse plants is as shown in Table 3. The crude protein content ranged from 15.32% in *Alternanthera bettzickiana* to 28.40% in *Telfairia occidentalis*, respectively. Generally, variations were observed between the CP values obtained in the present study and other reported values. For example Okoli *et al.* (2003a) reported values of 18.23% and 15.34% CP for *Ricinodendron heudelotti* and *Palisota hirsuta* respectively while in the present study CP values of 17.32% and 19.40% were obtained for the same plants. Similarly, Oji and Isilebo (2000) reported a CP value of 20.90% for *P. hirsuta*.

Table 3: Proximate composition of selected most preferred browse plants used in feeding goats

Browse plants	DM	CP	Proximate CF	Composition EE	(% air dry ASH)	basis) NFE
<i>Pentaclethra macrophyla</i>	89.50	18.03	20.20	3.30	2.20	45.77
<i>Ricinodendron heudelotti</i>	90.70	17.32	13.90	5.60	8.20	45.68
<i>Pterocarpus santalinoides</i>	88.30	16.50	10.80	12.20	7.60	41.20
<i>Tridax procumbens</i>	89.30	21.70	9.30	4.60	8.40	45.30
<i>Alternanthera bettzickiana</i>	86.70	15.32	15.60	2.59	10.96	42.23
<i>Telfairia occidentalis</i>	88.40	28.40	11.80	6.50	8.70	33.00
<i>Palisota hirsuta</i>	85.60	19.40	11.20	2.0	8.30	44.70
<i>Costus afer</i>	90.80	19.72	22.62	4.82	9.10	34.54
<i>Asystasia gangetica</i>	90.60	18.60	16.50	4.60	12.90	38.0
<i>Syndrella nodiflora</i>	90.50	20.80	18.40	4.65	11.60	35.05
Mean	89.04	19.58	15.03	5.08	8.79	40.54
S.E.M.	0.56	1.15	1.39	0.89	0.91	1.58

DM = Dry matter, CP = Crude protein, CF = Crude fibre, EE = Ether extract, NFE = Nitrogen-free extract. SEM = Standard Error of Mean.

Crude protein values of 21.12% and 20.23% reported by Okoli *et al.* (2001) and Oji *et al.* (1998), respectively for *P. hirsuta* are in agreement with the value of 19.72% reported in the present study for the same plant. Proximate analysis of these most preferred browse plants have been reported. Nworgu and Hammed (2009) reported CP, CF, EE, ash and NFE contents of 19.92, 15.53, 6.75, 13.27 and 38.33%, respectively for *Alternanthera bettzickiana*.

Okeke *et al.* (2009) reported CP, CF, EE, ash and NFE values of 19.30, 15.30, 12.70, 1.74 and 39.12 %, respectively for *Asystasia gangetica*. In this study, lower CP values of 15.32 and 18.60 % were reported for *Alternanthera bettzickiana* and *Asystasia gangetica*, respectively. The CP content of *Pterocarpus santalinoides* (16.50 %) in the present study was similar to the CP values of 15.26% and 16.69 % reported by Arigbede *et al.* (2008) and

Osuagwu (2008), respectively. Taiwo *et al.* (2008) reported CP values of 24.39, 29.18 and 26.78% for *Aspilia africana*, *Asystasia gangetica* and *Syndrella nodiflora*, respectively. Babayemi and Bamikole (2006) reported a CP value of 20.35% for *Syndrella nodiflora* which is comparable to the value of 20.8% obtained for the same plant in this study. Dike (2009) reported lower CP values of 13.65 and 16.80% for *R. heudelotti* and *Costus afer* compared to the CP values of 17.32 and 19.72% obtained for the same plants in the present study. Okoli *et al.* (2003a) reported a higher CP value of 18.32% compared to the value of 17.32% reported for *R. heudelotti* in the present study. Similarly, the CP value obtained for *Tridax* (21.70%) in the present study is lower than 24.06% (Ibeawuchi *et al.*, 2002) but higher than the values of 16.35% and 17.80% reported by Bello (2003) and Ahamefule *et al.* (2006b) respectively for the same plant.

The CP range of 15.32 - 28.40%, with a mean value of 19.58%, recorded for the foliage of the browse plants in this study was fairly high. It is higher than the range of 13.75 - 21.25 % reported for browse plants of West Africa (Rittner and Reed, 1992) but is in agreement with the earlier reports (Okoli *et al.*, 2001; Anele *et al.*, 2008; Taiwo *et al.*, 2008). Similar studies from other parts of southern Nigeria recorded crude protein range of 15.59 to 20.99 % (Oji *et al.*, 1998; Oji and Isilebo, 2000) while Okoli *et al.* (2001) reported a CP range of 15.22 - 33.33% for most preferred browse in SE Nigeria.

The CP contents are higher than the range of 11.0 - 20.0 % CP reported for non-leguminous browse plants in southern Nigeria (Larbi *et al.*, 1993) but within the range of 10.51-37.87% CP (Mecha and Adegbola, 1980) and 15.22-33.33% CP (Okoli *et al.*, 2001) reported for trees, shrubs and herbs in SE Nigeria. The relatively high crude protein values in the foliages studied appeared satisfactory for animal production since they exceeded the minimum protein requirement of 10 - 12% for ruminants (ARC, 1985).

The ether extract content ranged from 2.0% in *P. santalinoides* to 12.20% in *P. hirsuta*, respectively. The mean ether extract (EE) content of 5.08% obtained in the present study fall within the range of 2.30% - 5.80% reported by Mecha and Adegbola (1980), and similar to the value of 5.30% obtained by Okoli *et al.* (2001) for selected most preferred browse plants of SE Nigeria. Le - Houerou (1980) reported an average ash content of 10.90% for West African browse plants, while Mecha and Adegbola (1980) reported a value of 7.19%. Mean ash content of 8.80% obtained in this study is close to the values of 7.50% and 8.51% obtained by Okoli *et al.* (2001) and Okoli *et al.* (2003a) respectively, for most preferred browse and other Southeastern Nigerian browse plants. Little *et al.* (1989) reported a decline in ash content with age. The leaves of forage plants used in this study were relatively fresh re-

growths and could have contributed to the values obtained. Oji and Ndiomu (2002) and Mecha and Adegbola (1980) 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 crude fibre (CF) content of the forage obtained in this study was low to moderate averaging 15.03%, and ranging from 9.30 - 22.62%, but was lower than the average CF content reported by Mecha and Adegbola (1980) and Le-Houerou (1980) (18.30%; 20.82%) for browses of southern Nigeria and West Africa, respectively. Considerable variations in the crude fibre contents of edible tree and shrub leaves have been reported to be due to leafiness, extent of stemmy and more fibrous materials, stage of maturity, season of harvest (dry and wet) and type of browse plants (Skerman *et al.*, 1988; Devendra, 1995). The low to moderate fibre content of browse foliages would positively influence voluntary intake and digestibility of the foliages (Bakshi and Wadhwa, 2004) and consequently preference. This variability in the nutrient content of the browse plants has been attributed to within species differences, plant parts, season, harvesting regimen, location, soil type and age (Norton, 1994; Ajayi, 2012).

Proximate evaluation of some of these plants (Mecha and Adegbola, 1980; Okoli *et al.* 2001; Okoli *et al.* 2003a; Ahamefule *et al.*, 2006a; Ahamefule *et al.*, 2006b; Obua, 2007; Taiwo *et al.*, 2008; Taiwo *et al.*, 2009; Nworgu and Hammed, 2009; Okeke *et al.* 2009) have yielded promising nutrient values thus highlighting the importance of indigenous empirical knowledge residing in goat farmers on nutritional potential of browse plants (Devendra, 1995; Gbejo and Van den Broek, 1996; Okoli *et al.*, 2001; Komwihangilo *et al.*, 2001). It is accepted that indigenous knowledge is a powerful resource on its own right and complementary to knowledge available from western scientific source (Denevan, 1995).

In several separate studies which involved preference trials and ranking using sheep and goats, *A. gangetica* (Asiedu *et al.*, 1978), *M. puberula* (Meregini, 1985; Okoli *et al.*, 2003b; Ayo-Enwerem *et al.*, 2009), *G. brevis* (Umoh and Udoh, 1993; Larbi *et al.*, 1993), *D. bateri* (Okoli *et al.*, 2003b), *M. fulvum* (Larbi *et al.*, 1993; Kaitho *et al.*, 1998; Okoli *et al.*, 2001), *A. cordifolia*, *D. guineense* (Fadiyimu, 2000; Kalio *et al.*, 2006), *P. macrophylla* (Aju and Okwulehie, 2005), *M. indica* (Ikhimiyoa, 2008), *S. mombin* and *G. arborea* (Ahamefule *et al.*, 2006a) were among the prominent most preferred browse plants. Research reports on plants such as *Tridax procumbens* (Anugwa *et al.* 2000), *P. santalinoides* (Arigbede *et al.*, 1997; Ayo-Enwerem *et al.*, 2009; Anyanwu *et al.*, 2011), *A. vogelli*, *P. americana* and *A. africana* (Ayo-Enwerem *et al.*, 2008; Ayo-Enwerem *et al.*, 2009) and *S. mombin*, *T. africana*,

Mangifera indica and *Ficus thonningii* (Ogunbosoye and Babayemi, 2010) indicate that these plants were prominent most preferred browse plants to goats.

Preferences of forage plants have been associated with succulence or moisture content (Gesshe and Walton, 1980; Kothmann, 1984; Orok and Umorem, 1990; Omokanye *et al.*, 2001a,b), high crude protein (Bamikole *et al.*, 2001; Anyanwu *et al.*, 2001; Okoli *et al.*, 2001; Rogosic *et al.*, 2006), high ash content (Ikhimiyoa, 2008) and ether extract content (Louw *et al.*, 1967; Okoli *et al.*, 2001; Obua, 2007) of the forage. Several researchers have found that plants high in ether extract are very palatable to small and large ruminants (Okoli *et al.*, 2001; Obua, 2007). Goats prefer shrubs low in fibre and lignin (Ben Salem *et al.*, 2000). This tends to support the present study, as average CF content of the most preferred plants was low, relative to average CF values reported for browse plants in SE Nigeria (Mecha and Adegbola, 1980; Okoli *et al.*, 2003a).

In the present study no attempt was made to directly determine the factors that influenced animal preference, though some observations and deductions were made. Factors other than nutritional composition such as physical and morphological characteristics were complimentary to the intake and palatability of browse to ruminants (Kaitho *et al.*, 1997; Laca *et al.*, 2001; Ibeawuchi *et al.*, 2002; Ahamefule *et al.*, 2006a; Obua, 2007; Provenza *et al.*, 2007). Preference is determined by several factors such as taste, odour and texture (Kaitho *et al.*, 1997). Other factors such as digestibility, nutrient content, smell, taste, tactile feel of feed and physical properties (e.g., hairs, thorns) influence the palatability or preference of plant species (Pande *et al.* 2002; Ngwa *et al.*, 2003).

Leaves of browse plants that are tender and of low tensile strength are generally preferred. Preferred plant species were generally short and not stemmy and had leaves of low dry matter, low tensile strength and high crude protein (O'Reagain, 1993). Soft-leaved, low growing shrubs with small-diameter twigs are generally preferred over their opposites (Vallentine, 2001).

Animals generally prefer fresh foliage over dried and non-succulent forage that can be eaten faster (Hussain and Durrani, 2009). Leaf toughness is regarded as the most important mechanical attribute influencing grazing (Coley, 1983). Provenza and Cincotta (1994) reported that plant physical structure and chemical composition are the most vital factors that influence preference for food. The structure of the plant and presence of spines, hairs or a wax covering may also influence intake (Spedding, 1970). Preference of plants could therefore be said to be determined by the interplay between plant structure and leaf quality attributes (Vallentine, 2001). The size of the leaves or leaflets may also influence intake and preference. The small size of *Ziziphinus mauritiana*, mostly small leaflets around 5mm long,

could have influenced intake of the plant by goats (Njidda *et al.*, 2010), in so far as goats are shown to be extremely sensitive to fibre or forage characterized by small particles, which decreases the rumen pH, resulting in a fall in intake (Morand-Fehr, 2005).

O'Reagain and Schwartz (1995) reported that considering the same availability and heights, animals select different species according to the amount of stem and accessibility of leaves of high nutrient content and low tensile strength. Hussain and Durrani (2009) reported that relative seasonal availability of plant composition, its morphological and chemical nature affects the relative palatability. A decrease in the availability of preferred plant species can lead to a change in the preference and selectivity of the animal. Crawley (1983) supported this assertion that access to and the availability of plant materials affect animal preference. Lacher *et al.* (1982) also reported that when preferred browse species were available, less preferred browse species were either rejected or rarely consumed regardless of their abundance.

CONCLUSION

There is wide variety of most preferred browse plants utilized as forage for goats in Southeastern Nigeria. The most preferred browses were low in crude fibre, high in crude protein and ether extract and their exploitation reflects availability of the browse plants, indigenous small ruminant production paradigms and diverse goat management systems adopted by the farmers in the study area. Important plant families that contribute to the most preferred forage resource base of goats include tree and shrub legumes, which formed 15.80% of which families Fabaceae (Papilionaceae), Caesalpinadeae and Mimosaceae comprised 2.63%, 2.63% and 10.53% respectively. The other families were Eurphobiaceae, Moraceae, Asteraceae, Loganiaceae, Amaranthaceae and Anarcadiaceae which formed 13.15%, 10.52%, 7.9%, 7.9%, 5.26%, and 5.26% of the plants surveyed.

REFERENCES

- Abdulrazak, S.A., Nyangaga, J. and Fujihara, T. (2001). Relative palatability to sheep of some browse species, their in sacco degradability and *in vitro* gas production characteristics. Asian- Australian Journal of Animal Science 14(11): 1580 -1584.
- Ademosun, A.A and Mshelbwala, G. (1992). Nigerian livestock sub-sector review (Working paper No. 5A): Small ruminant LIMECU, FDLPCS, Abuja, Nigeria, April, 1992. pp. 6 - 10.
- Agishi, E.C. (1985). Forage resources of Nigerian rangelands. In: Small Ruminant Production in Nigeria. Proceedings of National Conference

- on Small Ruminant Production, 6th -10th October, 1985, Zaria, Nigeria. pp. 115 - 140.
- Ahamefule, F.O., Ibeawuchi, J.A. and Agu, C.I. (2006a). Comparative evaluation of some forages offered to goats in Umudike Southeastern Nigeria. *Journal of Sustainable Tropical Agricultural Research* 18: 79 - 86.
- Ahamefule, F.O., Obua, B.E., Ibeawuchi, J.A. and Udosen, N.R. (2006b). Nutritive value of some plants browsed by cattle in Umudike, Southeastern Nigeria. *Pakistan Journal of Nutrition* 5(5): 404 - 409.
- Ajayi, F.T. (2012). Dry matter yield, mineral contents and proximate composition of *Panicum maximum* (Jacq var Ntchisi) sown with forage legumes. *Nig. J. Anim. Prod.* 39 (1): 180 - 189.
- Aju, P.C. and Okwulehie, C. (2005). *Pentaclethra macrophylla* (Bentham): An important but neglected indigenous fruit tree species in Southeastern Nigeria. Proceedings of the 30th Annual Conference of the Forestry Association of Nigeria, Kaduna, Nigeria. 7th - 11th November, 2005. pp. 196 - 216.
- Anele, U.Y., Arigbede, O.M., Olanite, J.A., Adekunle, I.O., Jolasho, A.O., Onifade, O.S. and Oni, A.O. (2008). Early growth and seasonal chemical composition of three multipurpose tree species (MPTS) in Abeokuta, Nigeria. *Agroforestry System* 73: 89 - 98.
- Anugwa, F.O.I., Okwori, A.I. and Ekwuno, P.O. (2000). Feed intake, nutrient digestibility and nutrient value for goats of *Panicum maximum* and selected browse in the southern guinea savannah zone of Nigeria. Proceedings of the 25th Annual Conference of Nigerian Society for Animal Production, Umudike, Nigeria. pp. 63 - 66.
- Anyanwu, N.J., Etela, I. and Anegbeh, P.O. (2011). Voluntary feed intake and dry matter digestibility of three acid-tolerant multipurpose tree species by West African Dwarf sheep. Proceedings 36th Annual Conference of Nigerian Society for Animal Production, March 13th -16th, 2011, Abuja, Nigeria, pp. 516 - 518.
- Anyanwu, N.J., Oji, U.I. and Anegbeh, P.O. (2001). Voluntary feed intake and dry matter digestibility of indigenous browse species among sheep and goats in the humid zone of Southeastern Nigeria. Proceedings 6th Annual Conference of Animal Science Association of Nigeria, September, 2001, Maiduguri, Nigeria. pp. 145 - 147.
- AOAC (1990). Official methods of Analysis, 15th edition. Association of Official Analytical Chemists, Washington DC.
- A.R.C. (1985). Agricultural Research Council. The nutrient requirement of farm animals Technical Review and summaries, Agricultural Research Council, London, UK.
- Arigbede, O.M., Tan, Z.L., Dele, P.A., Anele, U.Y. and Oni, A.O. (2008). Chemical composition of six Nigerian multi-purpose tree species. Proceedings of the 13th Ann. Conf. of Animal Science Assoc. of Nigeria, September, 15 - 19th, 2008, Zaria, Nigeria, pp: 581- 585.
- Arigbede, O. M. and Tarawali, S. A. (1997). Preliminary evaluation of the biomass production, seasonal chemical composition and relative preference of some indigenous multipurpose tree species by goats in southwestern Nigeria. Proc. 2nd Annual Conference of Animal Science Association of Nigeria, September 16 - 17th, 1997, Lagos, Nigeria. pp: 177-187
- Asiedu, F.H.K., Oppong, E.N.W. and Opoku, A.A. (1978). Utilization by sheep of herbage under tree crops in Ghana. *Trop. Anim. Hlth. Prod.* 10: 1 - 10.
- Ayo-Enwerem, M.C., Oji, U.I., Etela, I. and Ahaotu, E.O. (2008). Nutrient composition and preferences of selected multipurpose fodder trees and shrubs fed to West African dwarf goats. Proceedings of the 13th Ann. Conf. of Animal Science Assoc. of Nigeria, September, 15 - 19th, 2008. Zaria, Nigeria. pp: 647 - 649.
- Ayo-Enwerem, M.C., Oji, U.I., Obua, B.E. and Ahaotu, E.O. (2009). Chemical composition and preferences of some browse plants of the humid zone by West African dwarf sheep. Proceedings of the 34th Ann. Conf. of Nigerian Society for Animal Production, March 15th - 18th, 2008, Uyo, Nigeria. pp: 534 - 536.
- Babayemi, J. and Bamikole, M. (2006). Supplementary value of *Tephrosia bracteolata*, *Tephrosia candida*, *Leucaena leucocephala* and *Gliricidia sepium* hay for West African Dwarf goats kept on range. *Central European Journal of Agriculture* 7(2): 323 - 328.
- Bakshi, M.P.S and Wadwa, M. (2004). Evaluation of forest tree leaves of semi-hilly arid region as livestock feed. *Asian-Australian Journal of Animal Science* 17: 777 - 783.
- Bamikole, M.A., Ikhatua, U.J., Arigbede, O.M., Babayemi, O.J. and Etela, I. (2004). An evaluation of the acceptability as forage of some nutritive and anti-nutritive components and dry matter degradation profiles of five species of *Ficus*. *Tropical Animal Health and Production* 36: 157 - 167.
- Bamikole, M.A., Ikhatua, U.J., Babayemi, O.J., Arigbede, O.M. Etela, I. and Osajie, P. (2001). Assessment of forage acceptability, some nutritive and anti-nutritive components of

- Ficus* species in Benin, Nigeria. Proc. of the 26th Annual Conference of the Nigerian Society for Animal Production, Zaria, Nigeria, pp: 310 - 313.
- Bello, K.M. (2003). Chemical composition of some plants used as feed for rabbits in Bauchi metropolis. Nig. J. Anim. Prod. 30(1): 32 - 36.
- Ben Salem, H., Nefzaoui, A. and Abdouli, H. (1994). Palatability of shrubs and fodder trees measured on sheep and dromedaries. 1. Methodological approach. Anim. Feed Sci. Technol., 46: 143 - 153.
- Ben Salem, H., Nefzaoui, A. and Ben Salem, L. (2000). Sheep and goat preferences for Mediterranean fodder shrubs. Relationship with the nutritive characteristics. Cah. Options Mediterr., 52: 155 - 159.
- Boufennara, S., Lopez, S., Bousseboua, H., Bodas, R. and Bouazza, L. (2012). Chemical composition and digestibility of some browse plant species collected from Algerian arid rangelands. Spanish Journal of Agricultural Research 10(1): 88 - 98.
- Brewbacker, J. L. (1986). Leguminous trees and shrubs for southeast Asia and the south Pacific. In: Forages in southeast Asia and south Pacific Agriculture. Blair, G. J., Ivory, D. A. and Evans, J. R. (Eds.). ACIAR Proceedings No. 12, ACIAR, Canberra. pp: 43 - 50.
- Carew, B.A.R., Mosi, A.K., Mba, A.U. and Egbunike, G.N. (1980). The potential of browse plants in the nutrition of small ruminant in the humid forest and savanna zones of Nigeria. In: Browse in Africa: The current state of knowledge. Le-Houerou, H.N. (Ed.). ILCA, Addis Ababa, Ethiopia. pp: 307 - 312.
- Cerrillo, M.A. and Juarez, R.A.S. (2004). In-vitro gas production parameters in cacti and tree species commonly consumed by grazing goats in a semi-arid region of North Mexico. Livestock Research for Rural Development 16: 4 - 9.
- Coley, P.D. (1983). Herbivorous and defensive characteristics of tree species in a lowland tropical forest Ecologica Monograph 53: 209 - 233.
- Crawley, M.J. (1983). Herbivory: The dynamics of animal plant interactions. Oxford, Blackwell Scientific.
- Denevan, D.W. (1995). Prehistoric agricultural methods as models for sustainability. Advanced Plant Pathology 2: 21 - 43.
- Devendra, C. (1995). Tropical legumes for small ruminants. In: Tropical legumes in Animal Nutrition. D'Mello, J.P.F. and Devendra, C. (eds.). CAB International, Wallingford, UK. pp: 231 - 245.
- Dike, M.C. (2009). Proximate and phytochemical composition of some browse plant species of southeastern Nigeria. Global Journal of Agricultural Sciences 8(1): 87 - 93.
- Ebere, C.S. (2000). Studies on the diversity, ethno-veterinary uses and nutrient composition of plants used for ruminant feeding in Southeastern Nigeria. B. Agricultural Technology (Animal Science) Project Report, Federal University of Technology, Owerri, Nigeria.
- Fadiyimu, A. A. (2000). Chemical composition, dry matter degradability and preference by West African dwarf goats of some multipurpose trees in Nigeria. Proceeding of the 25th Annual conference of the Nigeria Society for Animal Production, 19th - 23rd, March, 2000 at Michael Okpara University of Agriculture Umudike, Abia State, Nigeria. pp: 76 - 77.
- FGN (2002). (Federal Government of Nigeria) National Assessment Report on sustainable development in Nigeria. Ten years after Rio (UNICED). World summit in Sustainable Development. Abuja. Government Press, Abuja, Nigeria.
- FRN (2009). (Federal Republic of Nigeria) Official gazette No 2 Abuja, 2nd February, 2009, Vol. 96. Legal notice on Publication of 2006 Census, Final results. Federal Government Printer, Abuja, Nigeria. pp 30.
- Gbejo, I.J. and Van den Broek, A. (1996). Rapid appraisal and in Depth tropical surveys in participatory diagnostic research on small ruminant systems: Southern Benin. In: Focusing Livestock System Research In: Reoleveld, A.C.W. and Van den Broek, A. (Eds.). Royal Tropical Institute, KIT Press, Amsterdam, Netherlands.
- Genin, D. (1991). Feeding behaviour of goat and chemical composition of feeds in the coastal shrub of Baja California (Mexico): A functional relation. In: IV International Rangeland Congress, Montpellier, 22 - 26 April, 1991.
- Gesshe, R.H. and Walton, P.D. (1980). Forage preferences. Alberta Agr. Forest. Bull. 3: 10 - 13.
- Hussain, F. and Durrani, M. J. (2009). Seasonal availability, palatability and animal preference of forage plants in Harboi arid rangeland, Kalat, Pakistan. Pak. J. Bot. 41(2) : 539 - 554.
- Ibeawuchi, J. A., Ahamefule, F.O. and Oche, J.E. (2002). An assessment of the nutritive value of browse plants in Makurdi, Nigeria. Nigerian Agricultural Journal 33: 128 - 135.
- Ikhimiyo, I. (2008). Acceptability of selected common shrubs /tree leaves in Nigeria by West African Dwarf goats. Livestock Research for Rural Development 20(6): <http://www>.

- cipav.org.co/lrrd/lrrd20/6/Ikhi.206.htm.
- Jimoh, S.O. (2005). Non-timber forest products in phytomedicine and culinary uses. *Nigerian Journal of Forestry* 35(1): 25 - 38.
- Kaitho, R.J., Nsahlai, I.V., B.A. Williams., Umunna, N.N., Tamminga, S., Van Bruchem, J (1998). Relationships between preference, rumen degradability, gas production and chemical composition of browses. *Agroforestry Systems* 39: 129 - 144.
- Kaitho, R.J., Umunna, N.N., Nsahlai, I.V., Tamminga, S., Van Bruchem, J. and Hanson, J. (1997). Palatability of wilted and dried multipurpose tree species fed to sheep and goats. *Anim. Feed Sci. Technol.* 65: 151 - 163.
- Kalio, G.A., Oji, U.I. and Larbi, A. (2006). Preference and palatability of indigenous and exotic acid-soil tolerant multipurpose trees and shrubs by West African Dwarf sheep. *Agroforestry Systems* 67: 123 - 128.
- Komwihangilo, D.M., Sendalo, D.S.C., Lekule, F.P., Mtenga, L.A. and Temu, V.K. (2001). Farmers knowledge in the utilization of indigenous browse plants for feeding goats in semi arid and central Tanzania. *Livestock Research for Rural Development* 13: 1 - 7.
- Kothmann, M.M. (1984). Concepts and principles underlying grazing systems. A discussant paper. In: *Natl. Res. Council/Natl. Acad. Sci. Developing Strategies for rangeland Management*, Denver, Co. pp: 17 - 22.
- Laca, E.A., Shipley, L.A. and Reid, E.D. (2001). Structural anti-quality characteristics of range and pasture plants. *Journal of Range Management* 54: 413 - 419.
- Lacher, T.E., Willing, M.R. and Mares, M.A. (1982). Food preference as a function of resource abundance with multiple prey types: an experimental analysis of optimal foraging theory. *The American Naturalist* 120: 297 - 314.
- Larbi, A., Anyanwu, N.J., Oji, U.I., Etela, I., Gbaraneh, L.D. and Ladipo, D.O. (2005). Fodder yield and nutritive value of browse species in West African humid tropics: response to age of coppice regrowth. *Agroforestry Systems* 65: 197 - 205.
- Larbi, A., Jabber, M.A., Orok, E.J., Idiong, N.B. and Cobbina, J. (1993). *Alchornea cordifolia*, a promising indigenous browse species adapted to acid soils in southeastern Nigeria for integrated crop-livestock agroforestry production systems. *Agroforestry Systems* 22(1): 33 - 41.
- Le – Houerou, H. N. (1980). Chemical composition and nutritive value of browse in West Africa. In: *Browse in Africa, the current state of knowledge*. Le – Houerou, H. N. (Ed.). ILCA, Addis Ababa, Ethiopia. pp: 329 – 338.
- Little, D. A., Kompiang, S and Petheram, R. J. (1989). Mineral composition of Indonesian forages. *Tropical Agriculture (Trinidad)* 66: 33 – 37.
- Louw, G.N., Steenkamp, C.W.P. and Steenkamp, E.L. (1967). Diet verwantstkap tussen die eterekstrakinhoud van karoobossies en hul smackliheid vir skape S. Afr. Tydsk. Landbouwet, 10: 867 - 873.
- Martz, F.A., Brown, J.R., Das, B.K. and Padgin, D.D. (1967). Effect of top dressed nitrogen and potassium on the feed value of orchard grass hay for lactating dairy cows. *Agron. J.* 59: 555 - 568.
- Mecha, I. and Adegbola, T.A. (1980). Chemical composition of southern Nigerian forages eaten by goats. In: *Browse in Africa: The current state of knowledge*. Le-Houerou, H.N. (Ed.). ILCA, Addis Ababa, Ethiopia pp: 303 - 306.
- Meregini, A.O. (1985). Microdesmis and other fodder plants for rearing goats in parts of Imo state, Nigeria. *Proceedings of Annual Conference of the Ecological Society of Nigeria (ECOSAN)*, 3rd -5th May, 1985, Port-Harcourt, Nigeria .9: 111 - 119.
- Morand-Fehr, P. (2005). Recent development in goat nutrition: A review. *Small Ruminant Research* 3: 1 - 8.
- Nefzaoui, A., Ben Salem, H., Abdouli, H. and Ferchichi, H. (1995). Palatability for goats of some Mediterranean shrubs. Comparison between animal browsing time and cafeteria technique. *Ann. Zootech.*, 44 (Suppl): 117.
- Ngwa, A.T., Nsahlai, I.V. and Bonsi, M.L.K. (2003). Feed intake and dietary preferences of sheep and goats offered hay and legume–tree pods in South Africa. *Agroforestry Systems* 57: 29 - 37.
- Njidda, A.A., Ikhimioya, I. and Mohammad, I.R. (2010). Feed potentials of *Ziziphinus mauritiana* as browse to goats in sudano-sahelian region of Nigeria. *Proc. 35th Annual Conference of Nigerian Society for Animal Production*, Ibadan, Nigeria, pp: 473 - 476.
- Nolan, T. and Nastis, A. (1997). Some aspects on the use of vegetation by grazing sheep and goats. *Options Mediterraneennes Series A* 34: 11 - 25.
- Norton, B.W. (1994). The nutritive value of tree legumes. In: *Forage Tree legumes in Tropical Agriculture*. Gutteridge, R.C and Shelton, H.M.(eds.). CAB International, Wallingford, UK. pp: 177 - 191.
- Nworgu, F.C. and Hammed, M.O. (2009). Performance of rabbits fed *Alternanthera bettzickiana* supplements. *Proceedings of the 34th Annual Conference of Nigerian Society for Animal Production*, March 15 – 18th, 2009, Uyo, Nigeria. pp: 644 – 647.

- Obua, B.E. (1992). Survey of smallholder sheep and goat production systems in selected Local Government Areas of Imo and Enugu States of southern Nigeria. MSc Thesis, Dept. of Animal Science, University of Nigeria, Nsukka, Enugu State. 259. pp.
- Obua, B.E. (2007). Utilization of selected browse plants by West African dwarf goats in Southeastern Nigeria. Ph.D Dissertation, Michael Okpara University of Agriculture, Umudike, Nigeria. 335 pp.
- Odo, B.I., Omeje, F.U. and Okwor, J.N. (2001). Forage species availability, food preference and grazing behaviour of goats in Southeastern Nigeria. *Small Rumin. Res.* 42: 163 - 168.
- Ofomata, G.E.K. (1975). Nigeria in maps, Eastern states Ethiope Publishing House, Benin City, Nigeria. pp. 52.
- Ogunbosoye, D.O. and Babayemi, O.J. (2010). Voluntary intake of non-legume fodders offered simultaneously to West African Dwarf goats for a period of 6 hours. Proceedings of the 35th Annual Conference of the Nigerian Society of Animal Production, Ibadan, Nigeria, pp: 518 – 520.
- Oji, U.I., Dabibi, V.I. and Okeke, G.C. (1998). Chemical characteristics of selected multi-purpose tree and shrub fodder of the humid zone of southern Nigeria. Proceedings of 3rd Annual Conference of Animal Science Association of Nigeria, September 22nd - 24th, 1998, Lagos, Nigeria.
- Oji, U.I. and Isilebo, J.O. (2000). Nutrient characterization of selected browse plants of the humid tropics. Proceedings 25th Annual Conf. of Nigeria Society for Animal Production, 18th -21st March, 2000, Umudike, Abia State, Nigeria. pp: 54 – 56.
- Oji, U.I. and Kalio, G.A. (2004). Dry matter degradation characteristics and preferences of acid tolerant multipurpose fodder trees by West African Dwarf sheep. Proceedings 9th Annual Conference of Animal Science Association of Nigeria, September 13th - 16th, 2004, Abakiliki, Nigeria. pp: 126 - 129.
- Oji, U. I. and Ndiomu, F. O. (2002). Chemical composition of edible portions of selected browse species of the humid forest zone. Proc. 7th Annual Conf. of Animal Science Association of Nigeria, Sept. 16th – 19th, 2000, Abeokuta, Nigeria. pp: 201 - 204.
- Okafor, J.C. and Fernandez, E.C.M. (1989). The compound farms of Southeastern Nigeria. A predominant agroforestry home garden system with crops and small livestock: In: Nair, P.K. (ed.). *Agroforestry Systems in the tropics*. Pp. 411 - 426. Kluwer Academic Publishers, Dordrecht, Netherlands.
- Okeke, A.I. (1996). The distribution of browse plants in Southeastern Nigeria and the management of selected species in agroforestry ecosystems. Ph.D Thesis, University of Nigeria, Nsukka, Nigeria. 367 pp.
- Okeke, E.N., Usman, J.M., Akoun, J., Akinola, O.O., Essien, N.E. and Odozie, E. (2009). Replacement value of wheat offal with bush green (*Asystasia gangetica* Linn T. Anders) leaf meal on the carcass and sensory characteristics of weaner rabbits. Proceedings of the 34th Annual Conference of Nigerian Society for Animal Production, March 15th – 18th, 2009, Uyo, Nigeria. pp: 146 – 149.
- Okigbo, B.N. (1980). Plants and foods in Igbo culture. Ahiajoku Lecture, 28th November, 1980. Imo State Government Press, Owerri.
- Okoli, I.C., Ebere, C.C.S., Emenalom, O.O., Uchegbu, M.C. and Esonu, B.O. (2001). Indigenous livestock paradigms revisited. 11: Assessment of proximate value of most preferred indigenous browses of southeastern Nigeria. *Tropical Animal Production Investigation* 4(2): 99 - 107.
- Okoli, I.C., Anunobi, M.O., Obua, B.E. and Enemu, V. (2003a). Studies on selected browses of Southeastern Nigeria with particular reference to their proximate and some endogenous anti-nutritional constituents. *Livestock Research for Rural Development* 15(9): <http://www.cipav.org.co/lrrd/lrrd15/9/okol.159.htm>
- Okoli, I.C., Ebere, C.S., Uchegbu, M.C., Udah, C.A. and Ibeawuchi, I.I. (2003b). Survey of diversity of plants utilized for feeding small ruminant feeding in Southeastern Nigeria. *Agriculture, Ecosystem and Environment* 96: 147 - 154.
- Omokanye, A.T., Balogun, R.O., Awemu, E., Afolayan, R.A., Olayemi, M.E. and Onifade, O.S. (2001a). Crude protein content, preferences and short term intake of nine herbaceous legumes by adult Yankasa sheep. *Proceedings of Nigerian Society for Animal Production* 26: 297 - 300.
- Omokanye, A.T., Balogun, R.O., Onifade, O.S., Afolayan, R.A. and Olayemi, M.E. (2001b). Assessment of preferences and intake of browse species by Yankasa sheep at Shika, Nigeria. *Small Ruminant Research* 42: 203 - 210.
- Omphile, U.J., Aganga, A.A., Tshireletso, K. and Nkele, R. (2004). Foraging strategies of sheep and goats under semi-intensive management in Botswana. *South African Journal of Animal Science* 34(1): 120 - 122.
- Onyeonagu, C.C. and Ashiegbu, J.E. (2006). Frequency of collection, distance from source

- of collection, seasonality and preference rating of identified forage species in Nsukka rural communities of Enugu State, Nigeria. *Journal of Tropical Agriculture, Food, Environment and Extension* 5(2): 33 - 39.
- Onyeonagu, C.C. and Ashiegbu, J.E. (2008). Estimation of availability and distribution of browse species and number of small ruminant animals among farmers in selected communities of Nsukka area of Enugu state. *Nigerian Journal of Animal Production* 35(2): 252 - 258.
- Onyeonagu, C.C., Ashiegbu, J.E., Nweke, A.R. and Akagha, C.S. (2011). Multiple uses of forage species, estimation of availability and distribution of grass species and effect of location on the crude fibre and ash contents of common browse species in Nsukka, Nigeria. *Nigerian Journal of Animal Production* 38(1):116 - 124.
- O'Reagain, P.J. (1993). Plant structure and acceptability of different grasses to sheep. *Journal of Range Management* 46: 232 - 236.
- O'Reagain, P.J. and Schwartz, J.C. (1995). Dietary selection and foraging strategies of animals on rangeland, Coping with spatial and temporal variability. In: *Recent developments in the nutrition of herbivores*. M. Journet, E. Grenet, M.H. Farce, M. Theriez and C. Demarquilly(eds. (. INRA editions. Paris pp 407 - 423.
- Orok, E. J. and Umorem, U. E. (1990). Voluntary intake of selected species of indigenous browse plants by West African dwarf goats. ILCA humid zone programme, Ibadan Nigeria. Pp. 1 – 3.
- Osuagwu, G.G.E. (2008). Proximate and vitamin content of four Nigerian *Pterocarpus* species. *Nigerian Food Journal* 26: 21 - 26.
- Pande, R.S., Kemp, P.D. and Hodgson, J. (2002). Preference of goats and sheep for browse species under field conditions. *New Zealand Journal of Agricultural Research* 45: 97 - 102.
- Provenza, F.D. and Cinacotta, R.P. (1994). Foraging as a self-organisational learning process: accepting adaptability at the expense of predictability . In: Hughes, R.N. (Ed.), *Diet selection*. Blackwell Scietific Publication, Oxford, pp. 79 - 101.
- Provenza, F.D., Villalba, J.J., Haskell, J., MacAdams, J.W., Griggs, T.C. and Wiedmeir, R.D. (2007). The value of herbivores of plant physical and chemical diversity in time and space. *Crop Science* 47: 382 - 398.
- Rittner, U, and Reed, J.D. (1992). Phenolics and in vitro degradability of protein and fibre in West African browse. *J. Sci. Food Agric.* 58: 21 - 28.
- Rogosic, J.B., Pfister, J.A., Provenza, F.D. and Grbesa, D. (2006). Sheep and goats preference for and nutritional value of Mediterranean marquis shrubs. *Small Ruminant Research* 64: 169 - 179.
- Shelton, H, M. (2000).Tropical forage tree legumes in agroforestry systems. *Unasylva* 200: 51: 25 - 32.
- Skerman, P. J., Cameron, D. G. and Riveros, F. (1988). *Tropical Forage legumes*. 2nd edition. Food and Agricultural Organization of United Nations Plant Production Services No. 2, Rome, Italy, 629 pp.
- Spedding, C.R.W. (1970). *Sheep Production and Grazing Management*. 2nd Ed. Bailliere Tindall and Cassell, London.
- Taiwo, B.B.A., Adekunmisi, A.A. and Adeyemi, A.A. (2009). Browse plants of Egbado North rangelands: Distribution and chemical composition. *Proceedings of 14th Annual Conference of Animal Science Association of Nigeria, September 14th-17th, 2009, Ogbomosho, Nigeria.* pp: 603 - 605.
- Taiwo, B.B.A., Sekoni, A.O. and Fayemi, A.O. (2008). Floral composition of range land of Egbado north, Ogun state, Nigeria. *Proceedings of the 13th Annual Conference of Animal Science Association of Nigeria, September 15th-19th, 2008, Zaria, Nigeria.* pp: 629 - 634.
- 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
- Umoh, B.I. and Udoh, U.J. (1993). Plant preferences for goats. *Book of Abstracts, 18th Annual Conference of Nigerian Society for Animal Production, Federal University of Technology, Owerri, Nigeria, 21st - 26th March, 1993.* pp: 103.
- Vallentine, J.F. (2001). *Grazing Management*. Academic Press, London, UK. pp: 659.
- Wickens, G. E. (1980). Alternative uses of browse species. In: *Browse in Africa: The current state of knowledge*, Le-Houerou H. N. (ed.). ILCA, (International Livestock Centre for Africa), Addis Ababa, Ethiopia. pp: 155.
- Yabann, W. K., Burrit, E. A. and Malecheck, J. C. (1987). Sagebrush (*Artemisia tridentate*). Monoterpenoid concentrations as factors in diet selection by free grazing sheep. *USDA for serv. Gen. Tech. Rep. INT. 222*, pp: 64 – 70.