International Journal of Agriculture, Forestry and Fisheries
2014; 2(5): 73-80
Published online November 10, 2014 (http://www.openscienceonline.com/journal/ijaff)

Selection of candidate indigenous browse plants for domestication in the rainforest zone of south - eastern Nigeria

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To cite this article

Okoli I. C., Ogundu E. C., Achonwa C. C., Obichili E., Kubkomawa H. I., Okoli C. G. Selection of Candidate Indigenous Browse Plants for Domestication in the Rainforest Zone of South - Eastern Nigeria. *International Journal of Agriculture, Forestry and Fisheries*. Vol. 2, No. 5, 2014, pp. 73-80.

Abstract

South-eastern Nigeria is home to sixty percent (60%) of the rainforest resources and biological diversity of Nigeria. Several studies have reported the increasing depletion of the rain forest resources by natural and anthropogenic factors, thus endangering the previously abundant ruminant browse resource of the region. This study utilized endogenous use ranking of identified browse plants of south-eastern Nigeria and the crude protein content of their leaves to select candidate plants for possible domestication by rural farmers. Ninety three plants identified as small ruminant feedstuff in the region were ranked 1 to 5 across their leaf, stem, root, fruit and fuel values to indigenous farmers. Thereafter, the leaves of these plants were collected, dried in the oven and subjected to crude protein analyses. The ranking and crude protein values were used to select the plants that may have the best potential of being domesticated for ruminant feeding in the region. Of the 93 plants studied, 18 were being used for only one purpose by the indigenes, while 27, 24, 16 and 8 plants had 2, 3, 4 and 5 indigenous use rankings respectively. Thirty eight of these plants yielded <15% CP, while 13. 16 and 24 yield CP values of 15 - 17.99%, 18 – 19.99% and >20% respectively. Seven plants under the single endogenous use ranking group recorded >20% CP value, while the 2, 3, 4 and 5 endogenous use rank groups had 5, 9, 2 and 1 plants that recorded >20% CP. Based on these results, 18 indigenous browse plants, having endogenous use rankings of 2 to 5 and leaf crude proteins of 14.88 to 32.27% were selected as candidate browse plants for possible domestication in the region. However, some of these plants are currently regarded as weeds and nuisance because of lack of adequate information on their biochemical compositions. There is therefore the need to investigate the agronomic characteristics of the plants before recommending them to farmers for adoption.

Keywords

Browse Plants, Rainforest, Crude Protein, Ruminants, Rural Farmers

1. Introduction

Browse plants constitute one of the cheapest sources of feed for livestock, especially ruminants in the tropics (Okoli *et al*., 2003a; Ahamefula, 2006). Browse plants are sources of essential nutrients such as proteins, carbohydrates, vitamins and minerals which are frequently inadequately represented in tropical grass pastures. Their abundance with evergreen foliage present year round forage resources in many marginal tropical lands, thus making it possible to produce livestock at such locations (Oji and Kalio, 2004).

Ruminants, especially sheep and goats but more likely goats can adapt to a wide variety of browse plants. In many tropical environments, these small ruminants roam about free and eat variety of browses, especially during the dry season when green forages particularly grasses are less nutritive as a

result of lignification (Mecha and Adegbola, 1980; Okoli *et al.,* 2003a).

The geographical location and the aerial extent of South-eastern Nigeria make the region home to sixty percent (60%) of the rainforest resources and biological diversity of Nigeria. These biological resources including browse plants have overtime supported sedentary small scale livestock and arable rural farmers, who depend on the diverse forest resources for livelihood. Several studies have reported the increasing depletion of the forest resources of South-eastern Nigeria by natural and anthropogenic factors (Njoku, 2006; Njoku, 2009). Being a fragile ecosystem, the rainforest in South-eastern Nigeria readily degrade under persistent human pressure as the dependant populations continue to meet their livelihood needs. Added to this, are the recent reports on the activities of migrant pastoralists in the region, which result in soil compaction, deforestation of remaining fragile vegetal cover thereby complicating the perilous forest ecosystem depletion of the region (Okoli *et al*., 2012). Other, entrenched human activities that drive environmental changes in the region, especially rapid urbanization, population growth and inefficient use and destruction of forest resources in the region create the need to study the issues surrounding the sustenance of plant biomass used by rural communities in feeding their livestock.

Information is also generally needed on the diversity, nutrient compositions, indigenous use ranking and other biophysical characteristics of plants used for ruminant feeding in the tropics. A preliminary survey carried out by Okoli *et al.* (2003a) to determine the diversity of plants utilized for small ruminant feeding in selected areas of South-eastern Nigeria yielded 163 plants. Other studies in our station have tried to determine other indigenous uses of these browse plants which could be used to rank their rural importance. Such rankings across leaf, stem, root, fruit and fuel values could be used to select candidate browse plants for domestication, since most rural farmers tend to selectively allow plants of more than one value in their compound farms. Such a study is imperative and could easily be replicated to generate a broader database for the entire country and other tropical rainforest zones of Africa.

The objective of the present study is to select candidate tropical browse plants of South-eastern Nigeria for domestication studies using their indigenous use ranking and crude protein content of their leaves.

2. Materials and Methods

Study area: The study was carried out in the South-eastern agro-ecological zone of Nigeria. The climatic data of the area has been summarized by Okoli *et al*. (2003a). The land area lies between the latitude of 5^0N and $7^0$15E. The mean annual rainfall is 2200 mm, while temperature and humidity ranges between 26 - 27.5^{0}C and 70 - 80% respectively. The mean annual evaporation is greater than 1450 mm, while the average duration of the dry season is four months. The soil is sandy with an average pH of 5.50. The land surface is elevated associated with the Okigwe uplands (Ofomata, 1975). Vegetation is typically of humid rainforest which has been variously modified by high population pressure into farm fallow, oil bush and compound mosaic.

Sampling of plants: Based on the previous research (Ebere, 2000) on the Diversity Ethno-veterinary uses and Nutrient Composition of plant used for ruminant feeding in South-eastern Nigeria and the number of browse plants were listed by the Department of Forestry Services, Ministry of Agriculture and Environment, Owerri, Imo State, Nigeria. A list containing about 180 browse plants consumed by ruminants in the area was made.

Botanical identification of collected sampled plants: Identification of the listed sampled species of browse plants were made at the Department of Forestry, Imo State Ministry of Agriculture and Environment with the help of the Director of Forestry Services. The lists of these plants were arranged according to their family, genus, their native name and indigenous use ranking.

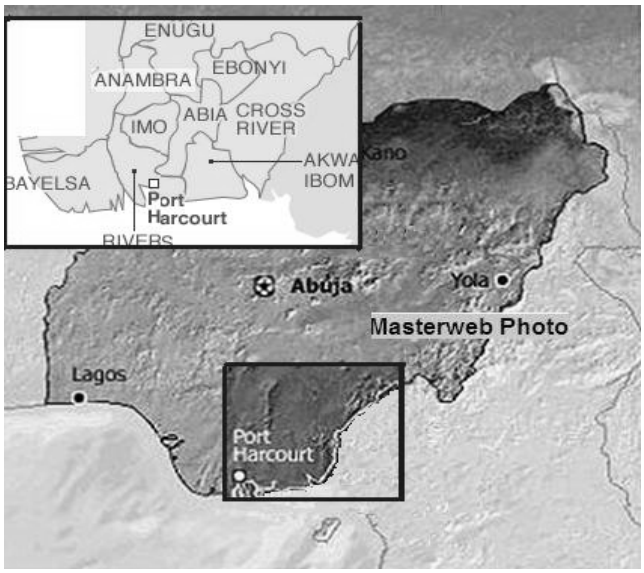

Fig. 1. *Map of South eastern Nigeria (Source: http://nigeriamasterweb.com)*

Sample collection and preparation: Fresh foliage of the selected browse plants were sun-dried for 3 days, cut into pieces (2 - 5 cm), oven dried at 60-70^{0}C for 24 hours and ground through 1 mm screen for subsequent analysis.

Crude protein: The crude protein (Nx6.25) was determined by the macro-Kjedahl method, according to AOAC (2002). The percentage of nitrogen in the sample was multiplied by a factor of 6.25 to obtain the crude protein content.

Ranking of the study plants: Direct interviews of at least twenty five ruminant farmers in the study area were conducted to determine the various endogenous uses of the selected plants. Information collected from the Department of Forestry, Imo State Ministry of Agriculture and Environment was also used to compute these before a final ranking was determined. The ranking was based on a score of 1 to 5, depending on whether the leaf, bark, root, log and fruit of the

plants were being utilized endogenously.

3. Results and Discussion

There is a wide variety of browse plants utilized as forage for goats in Southeastern Nigeria. This is due to location and availability of browse plants, feeding/ management system of goat rearing adopted by the farmers (Obua, 2013). In earlier studies in southern Nigeria, Okigbo (1980), Reynolds and Atta-Krah (1987), Orok and Duguma (1987) and Okafor and Fernandez (1987), listed 14, 30, 44 and 27 browse species, respectively for feeding ruminants. In more recent times, Okoli *et al.* (2003a), Onyeonagu and Ashiegbu (2006) and Chah and Igbokwe (2011) listed 163, 46 and 46 indigenous and exotic browse plants, respectively utilized as primary food and fodder for sheep and goats in the area. These are indications that there is much more browse and forage resources in the region than the few highlighted by these studies.

Of the 93 plants analyzed in the present studied, 18 were being used for only one purpose by the indigenes, while 27, 24, 16 and 8 plants had 2, 3, 4 and 5 indigenous use rankings respectively (Table 1). Thirty eight of these plants yielded <15% CP, while 13. 16 and 24 yield CP values of 15 - 17.99%, 18 – 19.99% and >20% respectively (Table 1) Okoli *et al.* (2002) had established that the most preferred browses in the region had leaf crude protein contents ranging from 17 to more than 30%. However, these browses were being harvested mostly from the wild.

Table 1. *Endogenous use and crude protein rankings grouping of the study plants*

Endogenous use rankings of study plants	*Number of plants in group*	*<15% CP*	*CP of 15 -17.99%*	*CP of 18 – 20.00%*	*>20% CP*
The plants that ranked 1	18	6	3	1	7
The plants that ranked 2	27	12	5	4	5
The plants that ranked 3	24	8	4	3	9
The plants that ranked 4	16	7	1	6	2
The plants that ranked 5	8	5	-	2	1
Total	93	38	13	16	24

Table 2. *Taxonomic details and crude protein content of the plants having one endogenous use*

S/N	*Family*	*Genus*	*Local name*	*% CP*
1	Anonaceae	*Enatia chloranta*	-	17.32
2	Apocynaceae	*Horeheuna floribudum*	-	11.71
3	Asteraceae/compositeae	*Ipoteria Odoratum*	Ogbara-ohu	20.58
4	Commelinaceae	*Commelina benghalensis*	-	12.60
5	Convolvulaceae	*Kuerstingunella geocarpa*	-	15.00
6	Cyperaceae	*Kyllinga squamulata*	-	7.10
7	Leguminoseae/papilionoideae	*Calopogonium mucunoides*	Agbara	24.50
8	Malvaceae	*Centrosema pubescence*	Ndowu-akpu	24.85
9	Onagraceae	*Justica spp*	Ebintakpocha	20.13
10		*Justica spp*	Okochi	18.88
11	Poaceae	*Echinochloa rostrata*	-	11.92
13		*Emilia coccinaea*	Nti ogini	27.63
13		*Panicum maximum*	Achara	9.36
14		*Pennisetum purpureum*	Achara	15.20
15	Portulacaceae	*Talinum triangulare*	Mgborodi	11.81
16	Rubiaceae	*Nauclea laxiflora*	-	13.32
17	Spindaceae	*Allophylus africana*	-	21.60
18	Sterculiaceae	*Landolphia owerrensis*	-	22.80

Fifty three of these plants had CP content greater than 15%, while 38 were below 15%. The high CP content of browse species is well documented and is one of the main distinctive characteristic of compared to most grasses. Norton (1998) reported CP content from 12 to 30% for tropical tree legumes, and Le Houerou (1980) found a mean of 12% in West African browse species, with 17% for the leguminous species. The differences in CP content between species can be explained by inherent characteristics of each species related to the ability to extract and accumulate nutrients from the soil and/or to fix atmospheric nitrogen, which is the case for leguminous plants. Other factors causing variations in the chemical composition of browse forages include soil type, plant part age of leaves and season (Njidda, 2010).

Tables 2 to 6 showed the taxonomic details and crude protein content of the plants having one, two, three, four and five endogenous use rankings respectively. Of the 18 browse plants recorded under the single endogenous use ranking group (Table 2), seven plants (*Ipoteria Odoratum, Calopogonium mucunoides, Centrosema pubescence, Justica spp, Emilia coccinaea, Allophylus africana and Landolphia owerrensis*) had >20% CP values. Another four of the plants (*Enatia chloranta, Kuerstingunella geocarpa, Justica spp* and *Pennisetum purpureum*) recorded 15.0 to 19.0% crude protein content. While these plants may be regarded as excellent browse recourses for ruminant feeding in the study area, it may be difficult to adopt them for domestication because of their single use ranking by the farmers. There is however the need to investigate other potential scientific uses of these plants in other to recommend them to the rural

farmers (Okoli *et al.,* 2003a and b).

Table 3. *Taxonomic details and crude protein content of the plants having two endogenous uses*

S/N	*Family*	*Genus*	*Local name*	*% CP*
1	Amaranthaceae	*Anaranthus spinosus*	Inine ogwu	18.00
2	Asteraceae/ Compositeae	*Bidens pilosa*	-	14.02
3		*Synedrella nodiflora*	-	13.59
4	Bombaceae	*Ceiba pentandra*	Akwu	11.95
5	Caesalpinaceae	*Brachystegia nigerianae*	-	7.04
6	Cucurbitaceae	*Cucurbita meschata*	Ugboguru	13.70
7	Euphobiaceae	*Alchornea cordifolia*	Agbarigba	21.88
8		*Hevea bransiliensis*	Panaroba	8.65
9		*Recinodendion heudulloti*	Okwe	16.63
10	Fabaceae	*Arachis hypogea*	Okpa-ala	21.06
11	Fabaceae	*Leucaena leucocephala*	Ukpaka	24.50
12	Gnetaceae	*Gnatum montana*	Okazi	15.52
13	Malvaceae	*Urena lobata*	Oke-udo	15.24
14	Mimosaceae	*Albizzia zygia*	-	16.17
15	Moraceae	*Millitia exelsa*	Oji	13.85
16	Myristicaceae	*Persea americana*	Ube-oyibo	10.03
17		*Pyacanthus angolensis*	-	13.90
18	Papilionaceae	*Baphia nitida*	Abosi	25.38
19		*Pterocarpus osun*	Oha	18.23
20	Poaceae	*Dactylocetenium spp*	-	11.15
21	Rosaceae	*Acioa barterii*	Ahaba	13.65
22	Sapotaceae	*Mimusop djave*	-	7.69
23	Sterculiaceae	*Sterculia tragacantha*	-	22.10
24		*Waltheria indica*	Olugbu agu	14.00
25	Tiliaceae	*Glyphea brevis*	Anyachu	19.25
26		*Triumfetta petandra*	Agbarigba	18.23
27	Verbenaceae	*Gmelina arborea*	Melina	16.80

Table 4. *Taxonomic details and crude protein content of the plants having three endogenous uses*

S/N	*Family*	*Genus*	*Local name*	*% CP*
1	Apocynaceae	*Funtumia elastica*	-	12.19
2	Asteraceae/Compositeae	*Aspilia africana*	Urumenjune	21.00
3		*Eupatorium odoratum*	Agbaraohia	21.88
4		*Vernonia authelmintica*	Onugbu	9.50
5	Bignoniaceae	*Newbouldes lewis*	Ogirisi	15.80
6	Bombaceae	*Ximenia americana*	Utunwakwari	19.10
7	Caesalpinaceae	*Acacia senegalensis*	Ahaba	11.20
8		*Cajanus cajan*	Fio-fio	27.00
9		*Detarium macrocapum*	Ofo	15.10
10		*Mucuna slonei*	Agbara	20.30
11	Caricaceae	*Carica papaya*	Une-ezi	18.40
12	Euphobiaceae	*Uapaca togoensis*	Ubia	12.80
13	Gramineae	*Zea mays*	Oka	15.32
14	Lamiaceae	*Ocimum gratissimum*	Nchuanwu	11.15
15	Lecythidaceae	*Napoleona volgii*	Mgbodo	25.55
16	Malvaceae	*Sida stipulata*	Udo	21.00
17		*Sida acuta*	Udo	14.88
18	Mimosaceae	*Albizzia ferruginea*	Ngwu	32.27
19		*Tetraplura tetrapetra*	-	24.10
20	Moraceae	*Ficus elasticodes*	Ogbu	13.85
21	Movaceae	*Bosque angolense*	Oze	20.58
22	Rutaceae	*Citrus sinensis*	Oroma	16.58
23	Sapotaceae	*Chysophyllum albidum*	Udara	10.85
24	Sterculiaceae	*Cola hipsida*	Mkpisiaka umuaka	19.08

Among the 27 plants having two endogenous uses (Table 3), five plants (*Alchornea cordifolia, Arachis hypogea, Leucaena leucocephala, Baphia nitida* and *Sterculia tragacantha*) recorded >20% crude protein in their leaves. One of these plants, *Arachis hypogea* is already domesticated and used as important human food, while *Leucaena leucocephala* and *Alchornea cordifolia* have received scientific attention in alley farming and as phytomedicine and leaf meals in monogastric animal nutrition in recent times (Devendra, 1995; Emenalom *et al.,* 2012). Nine plants (*Anaranthus spinosus, Recinodendion heudulloti, Gnatum montana, Urena lobata*, *Albizzia zygia, Pterocarpus osun,*

Glyphea brevis, Triumfetta petandra and *Gmelina arborea*) on the other hand recorded 15 to 20% crude protein in their leaves. *Gmelina arborea plantations abound in Nigeria since the wood is an important timber for house construction and electric poles. Recinodendion heudulloti* also serves for boundary demarcation and other cultural activities such as making musical flutes and masquerade masks.

Table 4 showed that out of the 24 plants listed as having three endogenous uses, nine (*Aspilia africana, Eupatorium odoratum, Cajanus cajan, Mucuna slonei, Napoleona volgii, Sida stipulata, Albizzia ferruginea, Tetraplura tetrapetra* and *Bosque angolense*) recorded >20% crude protein in their leaves. *S*even of these plants (*Newbouldes lewis, Ximenia americana, Detarium macrocapum, Carica papaya, Zea mays, Citrus sinensis* and *Cola hipsida*) contain 15 to 20% crude protein in their leaves.

Among these, *Cajanus cajan, Carica papaya, Zea mays* and *Citrus sinensis* are already domesticated and serve as important human foods in southeastern Nigeria. However, the other plants among this group that have >15% crude protein need to be investigated for new applications in animal production, since they could serve as leaf meals, medicines and flavorants, thus lending to adoption for domestication by rural farmers (Okoli *et al.,* 2002).

Again table 5 showed that only three (*Spondia mombin, Rauwofia vomitoria* and *Cola accuminata*) of the 15 browse plants that had four endogenous uses recorded >20% crude protein in their leaves, While seven (*Denettia trepitala, Terminalia catapa, Dacroydes edulis, Dialium guineansis, Azadracta indica, Musa sapiatum* and *Lonchocarpus sericeus*), recorded between 15 and 20%.

Again some of these plants such as *Terminalia catapa, Dacroydes edulis, Azadracta indica, Musa sapiatum, Cola accuminata* are domesticate and serve various functions in the local culture. Because of the diverse functions of trees in this group it may be necessary to *Castus afer (*14.88% CP) also as candidate for domestication, while *Treculia africana* with 14.00% leave CP is already an important food and fire wood compound tree among other functions in the culture of the people.

Among the plants having five endogenous uses (Table 6), three (*Manihot utilissima, Ficus exasperata* and *Pentachothra macrophylla*) had more than 15% leaf crude protein content. Among these, *Manihot utilissima* is the most important energy food in the region, however its leaf is regarded as waste material and abandoned in the farm after harvest, possibly because of its high content of cyanogenic glycosides. *Pentachothra macrophylla* is also a popular three in the region since the seed is used to produce an important fermented food, while the wood is one of the hardest. Information on the biochemical compositions of the leaf is however lacking.

Table 5. *Taxonomic details and crude protein content of the plants having four endogenous uses*

S/N	*Family*	*Genus*	*Local name*	*% CP*
1	Anacardiaceae	*Spondia mombin*	Ijikara	20.13
2	Anonaceae	*Denettia trepitala*	-	15.60
3	Apocynaceae	*Rauwofia vomitoria*	Mgbugba	28.00
4	Asteraceae/Compositeae	*Terminalia catapa*	Frutu	19.54
5	Burseraceae	*Canarium schwafurtii*	Ube agba	10.59
6		*Dacroydes edulis*	Ube	19.69
7	Caesalpinaceae	*Cesalpenia pulcharima*	Agbugbu	12.35
8		*Dialium guineansis*	Icheku	19.74
9	Hypericaceae/Guuttiteraceae	*Haruguna madagascariensis*	Oturu	11.25
10	Meliaceae	*Azadracta indica*	Dogoyaro	18.17
11	Moraceae	*Treculia africana*	Ukwa	14.00
12	Musaceae	*Musa sapiatum*	Ogede/Ukpoko	18.97
13	Myrtaceae	*Psidium guajava*	Gova	12.25
14	Papilionaceae	*Lonchocarpus sericeus*	-	16.61
15	Sterculiaceae	*Cola accuminata*	Oji	20.46
16	Zinyiberaceae	*Castus afer*	Okpete	14.88

Table 6. *Taxonomic details and crude protein content of the plants having five endogenous uses*

S/N	*Family*	*Genus*	*Local name*	*% CP*
1	Anacardiaceae	*Anacardium occidentalis*	Kashu	13.13
2		*Magnifera indica*	Mangolo	10.00
3	Euphobiaceae	*Manihot utilissima*	Akpu	33.25
4	Malvaceae	*Gossypium barbadense*	Owu	12.25
5	Movaceae	*Ficus exasperata*	Anwurinwa	18.24
6	Papilionaceae	*Pentachothra macrophylla*	Ugba/Uburu	19.25
7	Plamaea	*Elaeis guinensis*	Igu nkwu	11.67
8	Rubiaceae	*Nauclea diderrechi*	Uburuilu	11.00

Table 7. *Candidate browse plants for domestication*

S/N	*Family*	*Genus*	*Local name*	*%CP*	*Ranking*
1	Apocynaceae	*Rauwofia vomitoria*	Mgbugba	28.00	4
2	Mimosaceae	*Albizzia ferruginea*	Ngwu	32.27	3
3	Lecythidaceae	*Napoleona volgii*	Mgbodo	25.55	3
4		*Tetraplura tetrapetra*	-	24.10	3
5	Fabaceae	*Leucaena leucocephala*	Ukpaka	24.50	2
6	Papilionaceae	*Baphia nitida*	Abosi	25.38	2
7	Sterculiaceae	*Sterculia tragacantha*	-	22.10	2
8	Euphobiaceae	*Alchornea cordifolia*	Agbarigba	21.88	2
9	Asteraceae/Compositeae	*Eupatorium odoratum*	Agbaraohia	21.88	3
10	Malvaceae	*Sida stipulata*	Udo	21.00	3
11	Asteraceae/Compositeae	*Aspilia africana*	Urumenjune	21.00	3
12	Anacardiaceae	*Spondia mombin*	Ijikara	20.13	4
13	Movaceae	*Bosque angolense*	Oze	20.58	3
14	Caesalpinaceae	*Mucuna slonei*	Agbara	20.30	3
15	Sterculiaceae	*Cola hipsida*	Mkpisiaka umuaka	19.08	
16	Bombaceae	*Ximenia americana*	Utunwakwari	19.10	3
17	Movaceae	*Ficus exasperata*	Anwurinwa	18.24	5
18	Zinyiberaceae	*Castus afer*	Okpete	14.88	4

Based on these results, 18 indigenous browse plants, having endogenous use rankings of 2 to 5 and leaf crude proteins of 14.88 to 32.27% were selected as candidate browse plants for possible domestication in the region. However, some of these plants are currently regarded as weeds and nuisance because of lack of adequate information on their biochemical compositions.

Typically, the bulk of these plants are found in bush fallows, secondary and road side bushes, near field farms, compound and distant farms in wet and dry seasons. The importance of distant farms (Okafor and Fernandez, 1987; Meregini, 1999), compound farms and near field farms (Meregini, 1985; Ugwu, 2006) in farming systems in Southeastern Nigeria and some other parts of the tropics as sources of forage for animal feeding and in biodiversity conservation (Meregini, 1999) have been reported. They serve as regular sources of fodder and in cases of emergency need for forage for feeding animals (Okigbo, 1990; Ugwu, 2006).

In several studies which involved preference ranking and trials, *Microdesmis puberula* (Meregini, 1985; Okoli *et al*., 2001), *Glypheae brevis,* (Umoh and Udoh, 1993; Larbi *et al*., 1993), *Dactyladenia bateri* (Okoli *et al*., 2001), *Manniophyton fulvum* (Larbi *et al*., 1993; Okoli *et al*., 2001), *Alchornea cordifolia, Dialium guineense* (Kalio *et al.,* 2006), *Spondias mombin* and *Gmelina arborea* (Ahamefule *et al*., 2006) were among the prominent most preferred browse plants. Some of these plants were not selected in the present study probably because they are currently known solely as browses in the region. However, anthropological information from southeastern Nigeria (Ebere, 2000) have shown that *M. puberula* was previously being used as leafy vegetable in preparing foods for malnourished children in the region. Such loss of important ethno knowledge, especially ethno veterinary knowledge among farmers in the region has been reported (Okoli *et al.,* 2010).

Obua (2013) observed that since man and his domestic animals such as ruminants still depend on the availability of biological diversity for sustenance, it brings to the fore a need for *in-situ* conservation of animal feeds genetic resources. Thus, the availability of useful information on the rich diversity of browse plants in southeastern Nigeria will enable the selection process to meet the preferences of the indigenous farmers (Okoli *et al.,* 2003a; Chah *et al*., 2009; Njidda and Ikhimioya, 2012).

4. Conclusion

There is a strong reason to believe that the future of livestock rearing in Southeastern Nigeria lies partly, in identification and domestication of selected highly nutritious plants that can be used for other purposes by farmers. This would contribute to ensuring year round feed availability and provide farmers with sustained knowledge of the use of plants as feed for livestock.

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