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Diversity and Phytogeographic Investigation into Woody Plants of West Tangaza Forest Reserve, Sokoto State, Nigeria

Daniel A. Zhigila[1,*], Fatima B. J. Sawa[2], Suleiman D. Abdul[2], Halima M. Abba[3], Murna Tela[1]

[1]Botany Programme, Department of Biological Sciences, Gombe State University, Gombe, Nigeria
[2]Biological Sciences Programmes, Abubakar Tafawa Balewa University, Bauchi, Nigeria
[3]Biology Unit, S.B.R.S., Gombe State University, Gombe, Nigeria

Abstract The diversity and phytogeography of woody plant species in the West Tangaza Forest Reserve, Sokoto, Nigeria was studied. Taxonomic/floristic and geographical diversity were integrated to put the forest in focus for the local and global conservation efforts that it deserves. Stratified random sampling using point centred quarter (PCQ) method was employed. A total of 22 species of trees and shrubs belonging to 19 genera and 12 families were identified. The family Combretaceae had the highest number of species (6); followed by the family Fabaceae (5), families Anacadaceae, Asteraceae, Asclepediaceae, Euphorbiaceae, Rhamnaceae, Tiliaceae and Lamiaceae were represented by one species each. The Importance Value Indices revealed that the forest was dominated by *Guiera senegalensis* (127.70) – *Phyllanthus amarus* (43.08) – *ASpilia africa* (22.24) *complex.* The lowest importance value indices were observed for *Combretum glutinosum, Detarium micranthum* and *Lannea microcarpa* with 2.68 each. These species showed the urgent need for conservation efforts. The Simpson's index of diversity was 0.5268 and the species richness was 0.8029. The values were high indicating a more complex and healthier community because a greater variety of species allows for more species interactions, hence greater system stability, and indicates good environmental conditions.

Keywords West Tangaza, Forest, Taxonomy, Diversity, Conservation, Shrubs, Trees

1. Introduction

Living things are interdependent, intricately linked in birth, death and renewal. Human beings are just one small part of the vibrant component of the biological systems on the earth but human beings are the vital and key biological system and put tremendous amount of pressure on species and the environment and ecosystem. As a result, many plants and animals are at risks as well as natural processes such as pollination by insects and the regeneration of soils by microorganisms and also the survival of microorganisms. Woody plants are such vital components of the ecosystem that have productive, protective and recreational functions (Atiku *et al*., 2013). They control soil erosion, stabilize regional and global climates; provide carbon sinks, and acts in pollution control (Adamu, 2006). The extent to which forest trees are being exploited calls for urgent attention (Zaki, 2004). The world forests are diminishing rapidly and each year about 294,020 square kilo meters of forest disappear (Fries and Herman, 1990).

Taxonomic diversity mostly interpreted as the variation among and within species which includes the variation of taxonomic unities such as Phyla, Orders, Families, Genera and Species (Moksia *et al*., 2012). Ecosystem diversity or even better biogeographic diversity concerns with the variation in biogeographic regions, landscapes and habitats. The problems facing at present is the over exploitation of bio-resources/natural resources which would not only have negative impact on the environment but also sometimes totally destroy and erode the important bio-resources which are available at local level, regional level and national levels. Therefore, ecosystem management in a particular location is important and integral part for the conservation and protection of biological diversity of Nigeria (Bello, 2005).

By understanding the status of the natural forest in terms of tree species composition, richness and diversity, recommendations can be made for the restoration and future management of the reserve. The study was a step in that direction. Specifically, the objectives of the study were: (1) to capture the composition, diversity and richness or otherwise rarity of tree species in West Tangaza Forest Reserve (2) to compare the tree species composition, diversity and richness between climax vegetation within the

* Corresponding author:
dandrawuszhigila@gmail.com (Daniel A. Zhigila)
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same environment and (3) Taxonomic/floristic and biogeographical studies are integrated to investigate the biodiversity in West Tangaza Forest Reserve and to put the region in focus for the local and global conservation efforts that it deserves.

2. Materials and Methods

2.1. The Study Area

Tangaza Local Gov't Area, Sokoto state (Nigeria) is locate at latitude N13.56 to 13.57 and E4.42 to 4.46° (Figure 1) while West Tangaza Forest Reserve is located at Latitude 13° 25' 00" N and Longitude 4° 30' 00" E (NGIA, 2012). Some of the villages surrounding the reserve include Yartagimba, Mulawa: Tungarnoma, Tungarfilani, Daiji, Marakenbori, Wassanniya and Jimajimi 1 and Jimajimi 2 (Atiku *et al*., 2013). Most of the inhabitants are Peasant farmers, Cattle rearers and Local wood carvers all of whom are dependent on forest resources for raw materials. Gazetted by colonial order number 38 in December 1937, the reserve covers an area of 174 square miles (Abegunde *et al*., 2001).

2.2. Vegetation Cover Sampling Procedures

The materials used for the field work include secateur polythene bags, large jute bags, pen, labelling tapes, specimen bottles, hand lens, improvised hook and measuring/calibrated tapes. Sampling for diversity and abundance was carried out randomly in every community. The point centered quarter method procedure of vegetation estimation was used in data collection as described by Mueller and Ellenberg (1974). The plant species includes all the saplings, shrubs and trees present in the study areas.

2.3. Plant Collection and Identification

Species were identified on site with the help of taxonomic keys, field guides and floras and texts containing coloured photographs (Von Maydell, 1990; Akobundu and Agyakwa, 1998; Blench and Dendo, 2007 and Odugbemi, 2008). The unidentified plant samples collected from the study areas were flattened-out on flimsies and pressed between the absorbents under heavy pressure immediately after collection on the field; these were packaged with ventilators in the plant press for drying in the oven. The dried plants were separated and properly identified with appropriate labels for easy reference with herbarium specimens of the Gombe State University and Biological Sciences Programme Tafawa Balewa University, Bauchi., Nigeria. Unidentified specimens were deposited at the herbarium of Gombe State University. Nomenclature of the species follows Hutchinson and Dalzeil (1972). The list of identified plants was presented in Table 1.

2.4. Species-Effort Curve

The thoroughness of the survey, in terms of the proportion of plant species surveyed, was estimated using a species-effort curve (Figure 2). The species effort curve shows the cumulative number of plant species per section of the four different sites. The curve shows that new species were added more quickly at the beginning of sections as it lengthened. The curve reached a clear plateau at some point and continued on an upward trend where it levels up. It became less likely that more species would be found; indicating that enough total area had been sampled to give a reliable picture of variation in plant species richness and diversity in West Tangaza Forest Reserve.

Figure 1. Map of Nigeria Showing the location of West Tangaza Forest Reserve (Map Data, 2015)

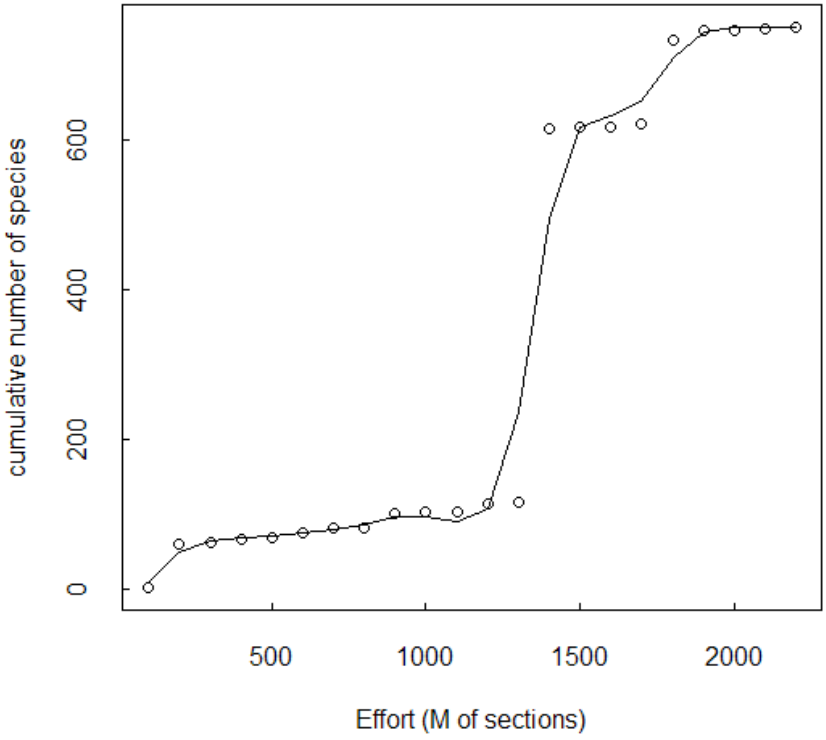

Figure 2. Overall species accumulation during survey effort at West Tangaza Forest Reserve

3. Data Analyses

Data obtained were quantitatively analyzed for Relative density, Relative frequency, relative abundance and Importance value index and calculated as follows (Curtis and McIntosh, 1951).

Density is calculated by the equation:

$$\text{Density} = \frac{Total\ numbe\ r\ of\ individuals\ \ of\ a\ species\ \ in\ all\ quadrats}{Total\ \ number\ \ of\ \ quadrats\ \ studied}$$

$$\text{Relative Density} = \frac{Number\ \ of\ individuals\ \ \ of\ one\ species}{Total\ \ number\ \ of\ all\ individuals\ \ counted}\ X\ 100$$

$$\text{Frequency} = \frac{Number\ \ of\ quadrats\ \ in\ which\ the\ species\ \ occures}{Total\ \ number\ \ of\ quadrats\ \ sampled}$$

$$\text{Relative Frequency} = \frac{Frequency\ \ of\ one\ species}{Total\ \ frequency\ \ \ of\ all\ species}\ X\ 100$$

$$\text{Abundance} = \frac{Total\ \ Number\ \ of\ individuals\ \ \ of\ a\ species\ \ in\ all\ quadrats}{Total\ \ number\ \ of\ quadrats\ \ \ in\ which\ the\ species\ \ occured}$$

$$\text{Relative Abundance} = \frac{The\ abundance\ \ \ of\ one\ species}{Total\ \ \ all\ species\ \ counted}\ X\ 100$$

Importance Value Index = Relative Frequency + Relative Density + Relative Abundance

Species diversity index was calculated using Simpson's index as follows:

$$D = \sum\left(\frac{n}{N}\right)^2$$

Where:

D = diversity index

N = Total number of organisms of all species found

n = number of individuals of a particular species

The value of D ranges between 0 and 1.

With this index, 0 represents infinite diversity and 1 no diversity.

Species Richness = $D = \frac{S}{\sqrt{N}}$

Where D = the Menhinick's index; S = the number of different species represented in the sample and N = the total number of species in the sample.

The important quantitative analysis such as density, frequency, and abundance of tree species, shrubs and herbs species were determined as per Curtis and McIntosh (1951).

4. Results and Discussion

A total of 22 species of trees and shrubs belonging to 19 genera and 12 families were identified in West Tangaza Forest Reserve (Table 1). Plant species such as *Gueira senegalensis* (shrub), *Combretum spp* (shrubs), *Piliostigma thonningii* (shrub), *Acacia senegalensis* (shrub), *Zizziphus mauritiana* (shrub), *Aspilia Africana* (shrub) and *Calatropis procera* (shrub) were identified to be most common. The family Combretaceae had the highest number of species (6). This was followed by the family Fabaceae with five species. The families Anacadaceae, Asteraceae, Asclepediaceae, Euphorbiaceae, Rhamnaceae, Tiliaceae and Lamiaceae were represented by one species each. These finding are in confirming that Fabaceae and Combretaceae are families known to be native species in most savannah-woodland

mosaics in Africa and are important families in tropical deciduous forests (Ceccon *et al.,* 2002). Moksia *et al.* (2012) and Sawadogo *et al.* (2007) reported that families Combretaceae and Fabaceae were the important families in Kalfou Forest Reserve, Cameroon and Tiogo forest in Burkina- Faso respectively which are also in the Savannah region.

Table 3 shows that *Guearea senegalensis* recorded the highest (127.70) Important Value Index, it was followed by *Phylanthus amarus* and *aspilia africana* with 43.03 and 22.24 respectively. The lowest IVI was recorded by *Combretum glutinosum, Detarium microcarpum* and *Lannea microcarpa* with 2.68 each. According to (Curtis and McIntosh, 1951; Cumming, 1990; Cox *et al.,* 1994; Abdullahi, 2010, Abba *et al.,* 2013), high importance value index (IVI) of a species indicated its dominance and ecological success, its good power of regeneration and greater ecological amplitude and also those plants need-monitoring management, while, species which were grouped as low therefore need high conservation efforts.

Species diversity

The alpha (within-site) diversity for the four sites is shown in Table 3. The Simpson's index of diversity (1-D) was 0.5267668415 and the species richness was 0.802919708 (Table 3). The values were average indicating a more or less complex community because a community dominated by one or two species is considered to be less diverse than one in which several different species have a similar abundance and greater variety of species allows for more species interactions, hence greater system stability, and indicates good environmental conditions (Abba *et al*., 2013). The high diversity could also be due to the high fertility related parameters and low moisture contents at some sites. A similar study was carried out by Abdullahi (2010) where it was reported that Simpson's index of diversity for trees in Yankari National Park which is also found in savannah region was (0.984). Richard *et al.* (2011) similarly reported Simpson's index of diversity as (0.957) for the Miombo woodland of Bereku Forest Reserve, in Tanzania. These values were higher than those of the present study because of the statute of Yankari as a National Park and Bereku Forest Reserve as a Forest Reserve and also the sizes of their reserves were larger. It is on these bases that the statute of West Tangaza Forest Reserve should be changed to have more species diversity. Results from the general linear model (Table 4) showed that study sites showed significant differences in plant species diversity. Relative to other study sites, site 4 had the highest species diversity while Site 2 had the least.

Table 1. Nomenclature of Trees and shrubs in West Tangaza Forest Reserve, Sokoto State

S/N	Family	Scientific Name and Authority	Hausa Name	Common Name
1	Anacadiaceae	*Lannea microcarpa*	Faru	Lannea
2	Asclepiadeae	*Calatropis procera* R. Br.	Tumfafiya	Giant swallow wort
3	Asteraceae	*Aspilia africana* (Pers.) C.D. Adams	Kalankuwa	Haemorrhage plant
4	Caesalpiniaceae	*Detarium microcarpum*	Taura	Tallow tree
5		*Piliostigma thonningii* (Schum.)	Kalgo	camel`s foot
6	Combretaceae	*Anogeisus leiocarpus*	Marke	Axlewood
7		*Combretum ghaselense* Engl. & Diels	Bakin taramniya	Combretum
8		*Combretum glutinosum* Perr. ex DC.	Jar taramniya	Combretum
9		*Combretum micranthum*	Geiza	Combretum
10		*Combretum nigricans* Guill. & Perr.	Tsiriri	Combretum
11		*Gueira senegalensis*	Sabara	Gueira
12	Euphorbiaceae	*Phyllanthus amarus Schum. & Thon*	Riyariaya	Amarus plant, Phyllanthus
13	Fabaceae	*Bauhinia rufescens*	Jirga	
14		*Parkia aculeate*	Bagaruwar kara	Parkia
15		*Prosopis africana*	Kirya	Iron tree
16		*Dichrostachys cinera*	Ɗunɗu	West African sickle bush
17	Lamiaceae	*Hyptis suaveolense* Poit		Bush tea
18	Mimosaceae	*Acacia sieberana*	Farar kaya	Acacia
19		*Mimosa pigra* Linn.	Gumbi	Sensitive plant
20	Papilionaceae	*Pterocarpus erinaceus*	Madobiya	African rose wood
21	Rhamnaceae	*Ziziphus abyssinica*	Magarya	Jujub tree
22	Tiliaceae	*Grewia mollis*	Kamomowa	Moshi medicine

Table 2. The occurrence of trees and shrubs species at the four sites in West Tangaza Forest Reserve

Scientific Name	Site I	Site II	Site III	Site IV	Total	Mean
Acacia sieberana	1		1		2	0.50
Ageratum conyzoides	12	34	12		58	14.50
Anogeisus leiocarpus	1			1	2	0.50
Aspilia africana	1	2	1		4	1.00
Bauhinia rufescens	1	1			2	0.50
Calatropis procera	1			6	7	1.75
Combretum ghaselense	1	4			5	1.25
Combretum glutinosum				1	1	0.25
Combretum micranthum	6	1	8	4	19	4.75
Combretum nigricans	1			1	2	0.50
Detarium microcarpum				1	1	0.25
dichrostachys cinera dundu	1	7	3		11	2.75
Grewia mollis				2	2	0.50
Gueira senegalensis	179	71	162	88	500	125.00
Lannea microcarpa				1	1	0.25
Mimosa pigra	1				1	0.25
Pakia aculeate Bagaruwar kara	2		1		3	0.75
Phyllanthus amarus			55	58	113	28.25
Piliostigma thonningi		2		11	13	3.25
Prosopis africana		1			1	0.25
Pterocarpus erinaceus		1			1	0.25
Ziziphus abyssinica			1	1	2	0.50
Total	208	124	244	175	751	187.75
Mean	29.71	22.55	48.80	26.92	65.30	16.33

Table 3. Importance Value Index (IVI) and Diversity index of Woody plants in West Tangaza Forest Reserve

Scientific Name	Relative Frequency	Relative Density	Relative Abundance	IVI	Diversity Index
Acacia sieberana	4.26	0.27	0.42	4.94	0.0000070921
Ageratum conyzoides	6.38	7.72	8.14	22.24	0.0059645280
Anogeisus leiocarpus	4.26	0.27	0.42	4.94	0.0000070921
Aspilia africana	6.38	0.53	0.56	7.48	0.0000123687
Bauhinia rufescens	4.26	0.27	0.42	4.94	0.0000070921
Calatropis procera	4.26	0.93	1.47	6.66	0.0000868793
Combretum ghaselense	4.26	0.67	1.05	5.97	0.0000443262
Combretum glutinosum	2.13	0.13	0.42	2.68	0.0000017730
Combretum micranthum	8.51	2.53	2.00	13.04	0.0006400698
Combretum nigricans	4.26	0.27	0.42	4.94	0.0000070921
Detarium microcarpum	2.13	0.13	0.42	2.68	0.0000017730
dichrostachys cinera	6.38	1.46	1.54	9.39	0.0002145386
Grewia mollis	2.13	0.27	0.84	3.24	0.0000070921
Gueira senegalensis	8.51	66.58	52.61	127.70	0.4432616250
Lannea microcarpa	2.13	0.13	0.42	2.68	0.0000017730
Mimosa pigra	4.26	0.13	0.42	4.81	0.0000017730
Pakia aculeat	4.26	0.40	0.63	5.29	0.0000159574
Phyllanthus amarus	4.26	15.05	23.78	43.08	0.0226400300
Piliostigma thonningii	4.26	1.73	2.74	8.72	0.0002996449
Prosopis africana	4.26	0.13	0.42	4.81	0.0000017730
Pterocarpus erinaceus	4.26	0.13	0.42	4.81	0.0000017730
Ziziphus abyssinica	4.26	0.27	0.42	4.94	0.0000070921
Total	100.00	100.00	100.00	300.00	0.4732331585
Simpson's index of Index	= 1 - D =	0.526766841			
Species Richness	=	0.802919708			

Table 4. Comparing plant species diversity across the four different study sites – Model (diversity ~ site 1 + site 2 + site 3 +site 4). N = 4, Adjusted R = 0.99

	ANOVA values			Parameter estimate values				
	DOF	F value	P value		Estimate	SE	t- value	P-value
Intercept					-2.35	9.86	-2.34	0.029
Sites	4	4.5	**0.001**	Site 1	2.52	1.34	18.86	**<0.001**
				Site 2	-5.68	1.56	-3.64	**0.002**
				Site 3	-4.26	3.19	-0.13	0.89
				Site 4	4.65	3.03	1.53	0.14

P values in bold are significant. Diversity is set at zero based on alphabetical order and it is the intercept

5. Conclusions and Recommendations

The Tangaza West Forest Reserve could be best described by the following plant types *Guearea senegalensis – Phylanthus amarus – Ageratum conyzoide* complex. The lowest IVI was recorded by *Combretum glutinosum, Detarium microcarpum* and *Lannea microcarpa* indicates the need for urgent conservation efforts for those species and the following recommendations are made.

- Alternative source of energy should be provided to the masses so that less tension may deter people from cutting trees as source of energy
- Government should initiate programs that promote the farming of forest trees and their products (fruits, wood, gums) around the reserve to avoid cutting down of trees in the forest
- Strategic coaching assistance to Forest Guards at the Reserve should be provided.
- From a socio-economic sustainable development point of view, the Forest Reserve if enhanced properly will increase employment opportunities and improve the standard of living of the surrounding communities in the long run
- Local farmers should be involved in all activities of forest development within their domain
- The potentials of the forest to be diverse is evident from the results of this study but requires a change in its statute from government and the local community

REFERENCES

[1] Abba, H. M; Sawa F. B. J; Gani A. M. and Abdul S.D. 2013. Study of Kanawa Forest Reserve (KFR). Soil analysis. Unpublished field work for Ph.D thesis submitted to Biological Science Progrmme, Abubakar Tafawa Balewa University, Bauchi, Nigeria.

[2] Abdullahi, M.B. 2010. Phytosociological Studies and Community Rural Appraisal Towards Biodiversity Consevation in Yankari Game Reserve, Bauchi State –Nigeria. An unpublished Ph. D Thesis. Abubakar Tafawa Balewa University, Bauchi, Nigeria, pp 99.

[3] Abegunde, M.A., Adegoke, K.A., Onwumere, G. and Dahiru, A. 2001. Senior Secondary School Geography, Book 3, 2nd Edition; Lagos, Longman Nig. Plc pp 104-108.

[4] Adamu I.A. 2006. An Assessment of Floristic composition of Kwiambana Game Reserve, A Thesis presented to the Department of Geography, Usmanu Danfodiyo University Sokoto. (Unpublished).

[5] Akobundu, I.O. and Agyakwa C.W. 1998. A hand book of West African Weeds. International Institute of Tropical Agriculture, Ibadan, Nigeria. Pp 256 – 340.

[6] Atiku, M.; Bello, A.G.; Hassan, S.U. and Ribah, M.S. 2011. Woody composition of Tangaza north forest reserve in Sokoto state, Nigeria. Archives of Applied Science Research, 3(5):293-299.

[7] Atiku M., Bello A.G. and Alao J.S. 2013. Study of Some Tree Characteristics at Tangaza North Forest Reserve in Sokoto State Nigeria. Agricultural Science Research Journal 3(10): 318- 323.

[8] Bello A.G. 2005. The Role of Biodiversity on Sustainable Agriculture. A Paper Presented to a 2 Days Training Workshop on Rural Resource Utilization and Sustainable Agriculture. 7th and 8th April Unpublished.

[9] Blench, R. and Dendo, M. 2007. Hausa Names for Plants and Trees. 8 Guest Road, Cambridge CB1 2AL, United Kingdom. 2nd Edition.

[10] Ceccon, E., Omstead, I., Vuzquez-yanes, C. and Campo-Alves, J. 2002. Vegetation and soil properties in two tropical dry forests of differing regeneration status in Yucatan. Agrociencia, 36, 621-631.

[11] Cox, J.R. Kantz, MacLaughin M. and Gilbert, T. 1994. Closing the Gaps In Floridad wildlife habitat conservation system. Florida Game and Fresh. USA Pp. 76

[12] Cumming, D.H.M. 1990. Wildlife Conservation in African Parks. Progress, Problems and Prescriptions. Harare WWF Multispecies Production Systems Project. (Project paper no.15) 16.

[13] Curtis, J.T and McIntosh, R.P. 1951 An Upland continuum in the Praine Forest Border region of Wisconsin, *Ecology*, 32, pp 476 - 496.

[14] Fries J. and Hermans, J. 1990. Natural Forest Management in Semi-Arid Africa Status and Research Needs. Unasyla – No 168 – Arid Zone Forestry File Pp. 9.

[15] Hutchinson, J. and Dalzeil, J. M. 1972. 2nd Rev .Edition. *Flora of West Tropical Africa.* Vol.1-111. Millbank, London.

Pp 67.

[16] Moksia, F., Louis Z., Pierre M.M. and Bernard-A.N. 2012. Woody species composition, structure and diversity of vegetation of Kalfou Forest Reserve, Cameroon. Journal of Ecology and the Natural Environment, 4(13):333-343.

[17] Mueller D.D. and Ellenberg H. 1974. Aims and Methods of Vegetation Ecology. John Wiley and Sons ltd England, Pp. 206.

[18] National Atlas for Nigeria 1974. Department of Federal Survey Pp. 23-24.

[19] NGIA (2012). National Geospatial-Intelligence Agency. Bethesda, MD, USA**.** Pp. 76 http://www.geographic.org/geographic_names/name.php?uni=-2821375&fid=4316&c=nigeria.

[20] Richard A.G., Emmanuel K.B., Canisius J.K., Emmanuel B.M., Almas M.K. and Philipina F.S. 2011. Species Composition, Richness and Diversity in Miombo Woodland of Bereku Forest Reserve, Tanzania. Pp. 54.

[21] Sawadogo P., Tigabu M., Sawadogo L. and Oden P.C. 2007. Woody species composition, structure and diversity of vegetation patches of a Sudanian Savanna in Burkina Faso, Bois et Forets des Tropiques 294(4):5-20.

[22] Von Maydell, H. 1990. Trees and Shrubs of the Sahel. Their Characteristics and Uses. GTZ. Verlag Josef Margraf Sceintific Books. Weikershem, Germany. Pp. 67.

[23] Zaki M.A. 2004. Floristic Composition of Dogondaji and Dabagi Forest Reserves in Sokoto State, An M.Sc Thesis presented to Department of Forestry and Fisheries Usmanu Danfodiyo University Sokoto (unpublished).