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A Floristic Survey and Herbarium Documentation of Vascular Plants Collected from Sokoto State University and their Environments

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ABSTRACT
Four 30 m x 30 m plots at Sokoto State University were used in this study to evaluate the number and distribution of plant species. After counting 2,888 unique plants, 39 species—28 tree and 9 shrub species—from 21 families were identified. The Fabaceae, Combretaceae, and Anacardiaceae families were the most diversified, with only one species each representing 14 groups. Plot B had the highest species diversity (H'=3.168), followed by Plot A (H'=3.120), while Plots D (H'=3.112) and C (H'=2.928) had the lowest diversity, according to a diversity analysis using the Shannon Index. The results indicate that moderate disturbance levels, as observed in Plots A and B, support better species evenness and variety in comparison to the other sites. The patterns are influenced by a prevalence of planted and disturbance-tolerant plants, such as *Azadirachta indica* and *Mangifera indica*.
Keywords: Identification, Distribution, Species, Plants and Diversity

INTRODUCTION

A collection of dried and compressed plant specimens, including vascular plants, lichens, algae, fungi, and bryophytes, is called a herbarium (Bridson and Foreman 1998). It offers quick research recommendations and is an essential tool for botanical education (Setiawan et al. 2020). Despite its significance, maintaining Nigeria's varied flora is extremely difficult. Tree density is quickly declining in areas like Sokoto due to widespread deforestation for residential usage, firewood, and charcoal (Dankani, 2018). Even though there are programs like the Sokoto State University (SSU) tree planting organization, human behavior has hindered efforts to completely stop illegal logging. Nationally, forest cover is critically low, with most states having less than 2% of their land as forest reserves against a 20% federal minimum target (Tee *et al*. 2009).

Ironically, collections of herbarium specimens have recently attracted fresh interest as vital resources for recording biodiversity, or the richness of living things and their ecological complexity (Jaisankar *et al*. 2018), and monitoring environmental shifts. By documenting changes in the growth patterns and distributions of species throughout time, they serve as markers of climate change (Primack *et al*. 2004). Preservation efforts have become more difficult, nevertheless, as the focus of botanical research has changed over the last 20 years from field taxonomy to experimental molecular biology. In Northwestern Nigeria, these issues of deforestation and insufficient plant inventories pose a threat to sustainable ecosystems, particularly in light of climate change. Wu and Yan (1996) emphasize the importance of conservation by stating that whereas disrupted, simpler settings impede biodiversity, stable, complex ecosystems promote it.

Thus, conservation of vegetation cover and biodiversity recording at SSU depend on the identification and documentation of plant species. This project will map the spatial distribution and density of tree species, identify and catalogue plant species in and around SSU, and measure species diversity using diversity indices. If successful, it will support university conservation efforts by providing an accessible plant archive for accurate specimen identification and plant-based research, helping to combat illegal tree-logging.

MATERIALS AND METHODS

Study Area:

The sampling area was the approved university land (to be governed by the master plan), and the study was carried out on the main campus of Sokoto State University, Sokoto (SSU). At an elevation of around 350 meters above sea level, Sokoto is situated between latitude 13°03′N and longitude 5°14′E. The region has a Sahelian climate with long dry seasons and short rainy seasons, which adds to the variety of xerophytic and prickly plant species that are well suited to the semi-arid conditions (Muhammad *et al*., 2020).

Google Earth Map, 2025

Plant Collection for Herbarium Specimen:

In addition to having all the traits needed for herbarium identification—flowers, fruits, leaves, roots (if possible), date of collection, GPS location, habitat, collector's name, local name, scientific name, family name, habit, and uses—the specimen was collected during the appropriate time of year when the plant was in flower. Sampling for species richness and tree stand location.

Pre-treatment:

Before putting the specimens in the Plant-Press, a few additional steps were taken: Assigning field numbers to each duplicate; Trimming the specimens to the proper size; Using chemicals like diluted formalin to fix the entire specimen or the delicate areas, like flowers or leaf bases; Dipping in a particular solution to preserve color, etc. (FMEnv, 2010).

Drying:

The creation of the herbarium sheet included this crucial step. If the field or study area is in a remote location and the collectors will not be returning to the main laboratory on the same day, specimens should be shifted to a larger, heavier plant-press upon return to the laboratory. Initially, one compact portable plant-press should be used for drying in the field. Blotting paper or, in its absence, folded newsprint can be used to make blotters. Because glossy, high-quality newspapers absorb water slowly, they should not be utilized for this purpose (FMEnv, 2010).

Poisoning:

In order to shield the plant specimens from these critters, one or more chemicals are used. The most common is mercuric chloride. A 4–6% solution in rectified spirit (90–95% ethanol) is frequently consumed in a PVC or enamel-coated tray because $HgCl_2$ is a highly corrosive chemical. Well-dried specimens are dipped into the solution, allowed to sit for one to two minutes, taken out of the solution with broad-tipped forceps, and then placed on the wire-net to drip off the excess liquid for a while, even though the use of $HgCl_2$ is no longer recommended. If the specimens are allowed to dry outdoors, they will curl severely, which could lead to fragmentation and material loss (FMEnv, 2010).

Mounting:

Mounting dry and poisoned specimens on an herbarium mount also calls for additional creative sense. The location of the specimen's main component, together with any additional flowers, fruits, seeds, or other desired elements, requires a basic understanding of morphology. Making the specimen attractive was also essential (FMEnv, 2010).

Labelling:

This was also an important phase in the entire process. An "Herbarium Label" is usually formatted in accordance with the specifications of the collection (Voss, 1999). Nonetheless, any such label must to offer some basic details.

Field and Laboratory Procedures

According to Victor *et al*. (2004) and ANBG (2017), a variety of instruments, kits, equipment, and facilities were needed for the correct collecting of vascular plant material and processing of specimens leading to the ultimate insertion to the Herbarium-cabinet.

Data Analysis

The following diversity indices were used to examine data on the plant species gathered within the study area:

Estimating species richness and frequency of occurrence

A species check list was created by summarizing the data in tabular form. Species identification, botanical names, family names, and order were established; the number of individual species found in each plot was calculated by counting and tabulating the frequency of occurrence of each species.

Importance Value Index: In accordance with Mohammed *et al*. (2015), this index was utilized to calculate each species' overall significance in the study area. Relative frequency and relative density are added together.

Species Richness, Diversity and Dominance Indices: Margalef's measure of richness (Magurran, 2004) was used to determine the species richness of the vascular plant species;

a) Margalef's index of richness (Dmg): Dmg = (S-1)/In N. Where: S = total number of species, and N = total number of individual species in a sampling plot.

Species diversity and dominance were evaluated using Shannon's Wiener diversity index (Nodza *et al*. 2014) and Simpson's index of dominance:

b) Shannon's Wiener diversity index; H' = -Σ. Where: H' = Shannon-Wiener index, S = number of species, P**i =** proportion of individual or abundance of ith species expressed as a proportion of the total number of individuals of all species, and ln = log base 10.

c) Simpson's index of dominance (D): D = Σ (Pi)2. Where; Pi = the proportion of important value of the ith species, and D = Simpson index of dominance.

Species Equitability or Evenness Index

Species equitability or evenness index was used to calculate how evenly the species were distributed within the study area (Atsbeha *et al*., 2015).

a) Species equitability or evenness index: J = H'/H' max. Where; J = Pielous evenness, H' = Shannon diversity index, and H' max = In S (number of species).

RESULTS

Scientific, Common, Local, Family Names of Plant Collected

39 plant species in all were identified and listed in this study along with their scientific, common, local, family, and order names (Table 1). Nine of the 39 plant species were shrubs, belonging to seven families, while twenty-eight (28) were trees, belonging to sixteen families. The families Fabaceae (7 species), Combretaceae (6 species), Anacardiaceae (3 species), Meliaceae, Rhamnaceae, Myrtaceae, and Moraceae (2 species each) contributed the greatest diversity of species, while the remaining 14 families were all monotypic, represented by a single species (Table 2).

Table 1: Scientific, Common, Local, Family and Order names of the plant species found in the study area

S/N	Scientific Name	Common Name(s)	Local Name	Family	Order
1	*Ziziphus spina-christi*	Christ's Thorn Jujube, Sidr	Kurna	Rhamnaceae	Rosales
2	*Piliostigma thonningii*	Camel's Foot, Monkey Bread	Kalgo	Fabaceae	Fabales
3	*Anacardium occidentale*	Cashew Tree	Kanju	Anacardiaceae	Sapindales
4	*Ficus thonningii*	Strangler Fig, Wild Fig	Cediya, Baure	Moraceae	Rosales
5	*Ficus sycomorus*	Sycamore Fig	Baure	Moraceae	Rosales
6	*Vernonia amygdalina*	Bitterleaf	Shiwaka	Asteraceae	Asterales
7	*Moringa oleifera*	Moringa, Drumstick tree	Zogale, Gawara	Moringaceae	Brassicales
8	*Mangifera indica*	Mango	Mangwaro	Anacardiaceae	Sapindales
9	*Faidherbia albida*	Apple-ring Acacia, Winter Thorn	Gawo	Fabaceae	Fabales
10	*Balanites aegyptiaca*	Desert Date, Soapberry tree	Aduwa	Zygophyllaceae	Zygophyllales
11	*Acacia nilotica*	Gum Arabic Tree, Babul	Gabaruwa, Bagaruwa	Fabaceae	Fabales
12	*Phoenix dactylifera*	Date Palm	Dabino	Arecaceae	Arecales
13	*Citrus limon*	Lemon	Lemu	Rutaceae	Sapindales
14	*Sclerocarya birrea*	Marula	Danya	Anacardiaceae	Sapindales
15	*Ziziphus jujuba/mauritiana*	Jujube/Ber	Magarya	Rhamnaceae	Rosales
16	*Gmelina arborea*	Beechwood	Kumbar	Lamiaceae	Lamiales
17	*Leucaena leucocephala*	Lead Tree	Lusina	Fabaceae	Fabales
18	*Terminalia catappa*	Indian Almond	Baushe	Combretaceae	Myrtales
19	*Psidium guajava*	Guava	Goba	Myrtaceae	Myrtales
20	*Flueggea virosa*	White Berry Bush	Tsada	Phyllanthaceae	Malpighiales
21	*Khaya senegalensis*	African Mahogany	Madachi	Meliaceae	Sapindales
22	*Olea europaea*	Olive Tree	Zaitun	Oleaceae	Lamiales
23	*Eucalyptus camaldulensis*	River Red Gum	Turare	Myrtaceae	Myrtales
24	*Terminalia mantaly*	Madagascar Almond	-	Combretaceae	Myrtales
25	*Tamarindus indica*	Tamarind	Tsamiya	Fabaceae	Fabales
26	*Azadirachta indica*	Neem Tree	Darbejiya	Meliaceae	Sapindales
27	*Adansonia digitata*	Baobab	Kuka	Malvaceae	Malvales
28	*Cycas revoluta*	Cycad or sago palm	Kaba	Cycadaceae	Cycadales
29	*Guira senegalensis*	Senegal tea plant or wild	Sabara	Combretaceae	Myrtales

		coffee			
30	*Albizia lebbeck*	Lebbek tree	Noonon kurciya	Fabaceae	Fabales
31	*Ficus polita*	Heart-leaved fig	Durumi	Moraceae	Rosales
32	*Combretum miranthium*	Kinkeliba	Geza	Combretaceae	Myrtales
33	*Vitex doniana*	Black plum	Dinya	Verbenaceae	Lamiales
34	*Parkia biglobosa*	African locust bean	Dorowa	Combretaceae	Myrtales
35	*Jatropha curcas*	Barbados nut or Purging nut	Binidazugu	Euphorbiaceae	Malpighiales
36	*Calotropis procera*	Giant milk weed	Tumfafiya	Apocynaceae	Gentianales
37	*Acacia seyal*	Red acacia or whistling thorn	Farar kaya	Fabaceae	Fabales
38	*Combretum glutinosum*	Bushwillow	Taramniya	Combretaceae	Myrtales
39	*Boswellia odorata*	Frankincense	Hano	Burseraceae	Sapindales

Table 2: Total number of species per family encountered in the study area

S/N	Family	No. of Species
1	Fabaceae	7
2	Combretaceae	6
3	Anacardiaceae	3
4	Rhamnaceae	2
5	Meliaceae	2
6	Myrtaceae	2
7	Moraceae	2
8	Asteraceae	1
9	Moringaceae	1
10	Zygophyllaceae	1
11	Arecaceae	1
12	Rutaceae	1
13	Lamiaceae	1
14	Phyllanthaceae	1
15	Oleaceae	1
16	Malvaceae	1
17	Cycadaceae	1
18	Verbenaceae	1
19	Euphorbiaceae	1
20	Apocynaceae	1
21	Burseraceae	1

Vascular Plants Species Collected from the Study Area

Plot A contained thirty different plant species, with *Azadirachta indica* being the most common (151 stands), followed by *Ziziphus jujuba/mauritiana* (60), *Adansonia digitata* (57), *Eucalyptus camaldulensis* (50), *Terminalia mantaly* and *Psidium guajava* (30 stands each), *Cycas revoluta* (26 stands), *Citrus limon*, *Moringa oleifera*, and *Anacardium occidentale* (each 25 stands).

Azadirachta indica showed the highest frequency of occurrence (63 stands) among the thirty plant species in plot B, followed by *Ziziphus jujuba/mauritiana* (55). These were followed by *Adansonia digitata* (53 stands), *Mangifera indica* (51 stands), *Guira senegalensis* (43 stands), *Acacia nilotica* (33 stands), *Khaya senegalensis* (30 stands), and *Combretum miranthium* (26 stands).

Azadirachta indica was the most common of the 28 plant species in plot C (106 individual stands), followed by *Ziziphus jujuba/mauritiana* (63), *Adansonia digitata* (51), *Mangifera indica* (45), and *Acacia nilotica* (40).

Azadirachta indica had the highest frequency of occurrence (146 stands total), followed by *Mangifera indica* (95 occurrences), according to Plot D's results, which showed a collection of 35 plant species. *Adansonia digitata* made 60 separate stands, whereas *Ziziphus jujuba/mauritiana* made 57 appearances.

Table 3: Individual Plants, Species and Family Number of Vascular Plants Collected from the Study Area

	PLOT A	PLOT B	PLOT C	PLOT D
Number of Individual Plants	831	648	577	832
Number of Individual Species	30	30	28	35
Number of Individual Family	16	13	12	14

Species Diversity, Richness and Abundance

Location B had the highest species diversity (Shannon_H' = 3.168), location A had the second-largest species diversity (Shannon_H' = 3.120), and sites D and C had the lowest diversity (H=3.112 and H=2.928, respectively), according to plant diversity data. site B had the lowest species dominance (D=0.051; 1-D=0.949), whereas site C had the greatest (D=0.076; 1-D=0.924). While location B has the most balanced community with no dominant species, location C is greatly impacted by a small number of numerous species, which lowers effective diversity. While site E had the highest species richness (6.38), locations B and C shared the same dominance of 0.73 each. Furthermore, the evenness value was highest at position B (0.792) and lowest at place D (0.642) (Table 4).

Table 4: Diversity of Vascular Plants Collected in the Study Area

	PLOT A	PLOT B	PLOT C	PLOT D
Margalef`s index	4.299	4.480	4.247	5.057
Pilou Evenness	0.754	0.791	0.667	0.641
Simpson_1-D	0.937	0.949	0.924	0.932
Shannon_H	3.120	3.168	2.928	3.112
Dominance_D	0.062	0.051	0.076	0.067

Ecological Implication of Land Use

The predominance of planted and disturbance-tolerant plants, like Ziziphus spp., Azadirachta indica, and Mangifera indica, greatly influences diversity patterns. Intermediate disruption supports more evenness and variation (Sites A and B). High disturbance or severe land use reduces richness and increases dominance (Site C). Recovery or enrichment planting (Site D) increases richness but does not always improve evenness.

Table 5: Land-Use Disturbance History

Sites	Diversity Pattern	Likely Land-Use History
A	High evenness and diversity	Semi-natural vegetation, with long-term stability but moderately disturbed
B	Highest Simpson, evenness and Shannon	A well-managed agroforestry system or least disturbed
C	Lowest richness, Shannon and Simpson	Mostly disturbed (recent cultivation, logging, or selective planting)
D	lowest evenness and Highest richness	A mixed-use area with species enrichment or secondary regrowth

Land-Use Disturbance

The observed decline in diversity and evenness from Site B to Site C is indicative of increasing disturbance severity. Despite having a high species richness, Site D's reduced evenness suggests ecological instability brought on by recent or current land-use changes. These findings are consistent with the traditional disturbance ecology theory, which maintains that moderate disturbance boosts diversity while high disturbance simplifies community structure.

DISCUSSION

The intent of this study was to identify and evaluate the species distribution and abundance of plants that were collected from Sokoto State University in Sokoto. A total of 39 plant species were identified and listed in this study along with their scientific, common, local, family, and order names. There were 9 shrub species in 7 families, 28 tree species in 16 families, and 39 plant species in 21 families. The families Fabaceae, Combretaceae, Anacardiaceae, Meliaceae, Rhamnaceae, Myrtaceae, and Moraceae provided the greatest diversity of species. This is in line with the results of Abdullahi and Abba (2021), who found that in Kumo, a local government in Gombe state, the Fabaceae family is the most common. Yar'adua and Amenu's 2022 study indicates that the Fabaceae family has the greatest number of species. Deka *et al*. (2012) attributed the success of the Fabaceae to their rapid germination ability, which was associated with symbiotic traits that facilitated species' establishment in a variety of habitat types. Because of their thorny character, Fabaceae can also be difficult for domestic collection and grazing animals. Another reason could be the species' ability to adapt to a variety of environmental conditions, such as drought, full sun to partial shade, direct exposure to salt spray, and a range of soils, including alkaline soils.

Plot B, which is close to the school faculty buildings, had the most variety and the lowest species dominance, while Plot C had the highest species domination. Plot B had the most balanced ecosystem with no dominant species, but plot C is significantly impacted by a few abundant species, which reduces effective diversity. The pollination or dispersal tactics used in the various plots, as well as environmental conditions, could account for these variations in species distribution between the plots. Austin *et al*. (1996) found that edaphic factors, or soil nutrients, had a substantial impact on species richness and establishment in an ecosystem. Dominance may also be influenced by habitat adaptation and favorable environmental conditions that encourage pollination, dispersal, and eventually species establishment (Azila *et al.*, 2022). The edaphic parameter, or soil nutrient, had a major impact on the species richness of an ecosystem. Anthropogenic activity may be a major factor in the low occurrence of certain species in some locations. Azila *et al*. (2022) suggest that the lowest species and poor establishment of certain families may be due to competition for nutrients.

According to the data, nine species were shrubs from seven families, with Rhamnaceae recording the highest number. These families include Moringaceae, Euphorbiaceae, Apocynaceae, Asteraceae, and Burseraceae. The results of Njoh *et al*. (2013) and Musa *et al*. (2025), who observed that the Rubiaceae was the most common family in the shrub layer at the site, are in line with this result. Azila *et al*. (2022) also discovered that the following families have poor richness: Poaceae, Melianthaceae, Lauraceae, Phyllanthaceae, Dioscoreaceae, Cucurbitaceae, Convolvulaceae, Clusiaceae, Burseraceae, Malvaceae, Bignoniaceae, Apiaceae, Araliaceae, and Aparagaceae. The Asteraceae family of herbaceous plants is the most prevalent, according to Azila *et al.* (2022). This finding is in contrast to that of George *et al*. (2021), who discovered that the Asteraceae and Euphorbiaceae were the largest families of herbs identified; it is also in line with the findings of Oni and Ndiribe (2019). Additionally, this outcome runs counter to similar research done in Calabar by Iwara *et al*. (2014), who discovered that the most common families among the herbs studied were the Asteraceae and Poaceae.

The dominance of planted and disturbance-tolerant species, including *Azadirachta indica*, *Mangifera indica*, and *Ziziphus* spp., significantly shapes patterns of diversity; intermediate disturbance supports higher variety and evenness (Sites A and B); high disturbance or intense land use decreases richness and increases dominance (Site C); recovery or enrichment planting increases richness (Site D), though evenness is not always improved; Chauhan *et al*. (1996) noted similar reports in a disturbed and naturally regenerating forest in Korup National Park, and Egbe *et al*. (2012) noted similar reports in a disturbed and naturally regenerating forest. According to the findings of Abdullahi and Abba (2021), *Azadirachta indica* is the species with the highest relative density and relative frequency in Kumo Town and its surrounding areas; Abba *et al*. (2015) found that *Azadirachta indica* has the highest relative density and frequency in Kanawa Forest Reserve (KFR); and Idris *et al*. (2017) found that *Azadirachta indica* had the highest relative density and diversity of trees and shrubs in Gombe State, Nigeria's Tumfure and Shongom Villages. The intermediate disturbance-tolerant planted species at sites A and B provide higher diversity and evenness and shape diversity patterns. This could be because there aren't as many buildings, there are people around, or the university administration is planting trees.

CONCLUSION

Strong plant diversity on the campus of Sokoto State University promotes ecological health. Unbalanced species abundance in one region, however, suggested niche dominance. The entire diversity was significantly shaped by hardy or planted plants, such as mango and neem. The most prevalent family in the region is Fabaceae, which includes valuable economic and medicinal plants.

RECOMMENDATIONS

1. All mapped and existing areas of the University should be surveyed and illegal encroachment should be avoided.
2. Identification of the medicinal plants used to cure the most prevalent diseases most especially plant belonging to family Fabaceae and Combretaceae.

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REFERENCES

Abba, H.M., Sawa, F.B.J., Gani, A.M., Abdul, S.D. and Zhigila, A.D. (2015). An Assessment of the Shrub Species of Kanawa Forest Reserve (KFR), in Gombe State, Nigeria. *Greener J. Biol. Sci.*, 5(2): 026-036.

Abdullahi, S. and Abba, H.M. (2021). Floristic composition and Diversity of tree species in Kumo Town and its environs, Gombe state, Nigeria. *Fudma J. Sci*., 5(2): 560-566.

ANBG (2017). Plant Collection Procedures and Specimen Preservation. Australian National Botanic Gardens, Australian Government, Canberra www.anbg.gov. au/cpbr/herbarium/collecting/index.html.

Austin, M.P., Pausas, J.G., and Nicholls AO (1996). Patterns of tree species richness in relation to environment in south-eastern New South Wales. *Aust. J. Ecol*., **21**:154-164.

Atsbeha, G., Demissew, S., Woldu, Z. and Edwards S. (2015). Floristic composition of herbaceous flowering plant species in Lalay and Tahtay Michew districts, central zone of Tigray, Ethiopia. *Afr. J. Ecol. Ecosyst*. 2(6): 159-169.

Azila, J.J., Jeridas, D.D. Mbah, J.J. Longtau, S. R. Nwafor, F. I and Tumba, Y. C. (2022). Species Composition and Diversity of Vascular Plants in Rhizha Mountain Forest Jos, Plateau State Nigeria. *International Journal Research in Biological Science.* e-ISSN 2795-3276 p-ISSN 2795-3272.

Bridson, D. and Foreman, L. (1998). *The Herbarium Handbook*. Royal Botanic Gardens, Kew, Great Britain. Third edition.

Chauhan, D.S., Dhanai, C.S., Bhupendra, S., Chauhan, S., Todaria, N.P., Coley, P.D. and Barone, J.A. (1996). Herbivory and plant defenses in tropical forests. *Ann. Rev. Ecol. Syst*., **27**:305-335.

Dankani, I.M. (2018). Assessment of Perception and Attitude of City Dwellers on Urban Forestry in Sokoto Metropolis. *Journal of Agriculture and Environment.* **14** (2): 233-243.

Deka, J., Tripathi, P.O. and Khan, L.M. (2012). High Dominance of *Shorea Robusta* Gaertn.in Alluvial Plain Kamrup Sal Forest of Assam, N. E. *India Int. J. Ecosyst.,* **2**(4): 67-73.

Egbe, E.A., Chuyong, G.B., Fonge, B.A. and Namuene, K.S. (2012). Forest disturbance and natural regeneration in African rainforest at Korup National Park, Cameroon. *Int. J. Biodiver. Conserv.* **4**(11):377-384.

FMEnv, (2010). Nigeria Fourth National Biodiversity Report, Federal Ministry of Environment, Abuja. 42P.

George, I., Nodza, Ruth U. Anthony, Temitope O. Onuminya, and Oluwatoyin T. Ogundipe (2021). Floristic Studies on Herbaceous and Grass Species Growing in the University of Lagos, Nigeria. *Tanzania Journal of Science*. 47(1): 80-90, 2021 ISSN 0856-1761, e-ISSN 2507-7961.

Idris, A.Y., Ayegba, P.O. and Mansur, A.M. (2017). Distribution and diversity of Trees and Shrubs in Tunfure and Shongo Villages of Gombe State Nigeria. *J. Appl. Res.* 3(3): 96-104.

Iwara, A.L., Offiong, R.A., Nar, G.N. and Ogundele, F.O. (2014). An assessment of herbaceous species diversity, density, cover in AgoiEkpo, Cross River State, Nigeria. *Int. J. Biol. Sci.,* 1(1): 21-29.

Jaisankar,C. Arunvasan,S and Shilpa ivin emimal,S. (2018). "A Modern Approach of Solving Fuzzy Transportation Problem Using Symmetric Triangular Fuzzy Number", *Journal of Emerging Technologies and Innovative Research*, **5**(2): 545-550.

Magurran A.E., (2004) Measuring Biological Diversity. 2nd edition Blackwell Science Limited, Oxford.

Mohammed AH, Jahun SF, Mohammed GA and Dangana AS (2015) Herbaceous species diversity in Kanawa forest reserve (KFR) in Gombe state, Nigeria. *Am. J. Agric. For.* 3(4): 140-150.

Muhammad, M., Dalhatu, J., Abdullahi, A., Yakubu, M., & Madinat, I. (2020). Survey of Flora Affected by Mistletoe Species and Identification of Chlorophyll Pigments in Sokoto State University, Sokoto, Nigeria. *East African Journal of Environment and Natural Resources*, 2(1), 24-30. https://doi.org/10.37284/eajenr.2.1.132.

Musa, U., Dangana, S. A., Dangana, S. A., Abalis, E. G., Sawa, F., Musa, B., Andrawus, D. Z., Zakariya'u, H. I., and Bello, A. (2025). Assessing Herbaceous Vascular Plants Diversity and Conservation Needs on Kir and Tala Mountains, Bauchi State, Nigeria. *UMYU Scientifica*, **4**(1), 179–188. https://doi.org/10.56919/usci.2541.018

Njoh, R. N., Egbe, E. A., and Eneke, B. (2013). Species composition, diversity and distribution in a disturbed Takamanda Rainforest, South West, Cameroon. *African Journal of Plant Science*., **7**(12): 577-585.

Oni, R. and Ndiribe, C. (2019) Vegetation analysis of herbaceous species in the University of Lagos, Nigeria. *UNILAG J. Med. Sci. Technol.*, **7**(1): 129-141.

Primack, D., C. Imbres, R. B. Primack, A. J. Miller-R Ushing, and P. Del Tredici. (2004). Herbarium specimens demonstrate earlier flowering in response to warming in Boston. *American Journal of Botany*. 91:1260–1264.

Setiawan, E., Darnaedi, D., Rachman, I., Triono, T. and Webb, C. O. (2020). The Digital Herbarium: Solutions for Data Collection and Identification of Indonesian Plant Diversity. *Biogenesis*. **8** (2) 203-209. pISSN 2302-1616, eISSN 2580-2909.

Staffan, M. W. (2006). Linnaeus herbarium cabinet: a piece of furniture and its function. *Endeavour*. **30** (2): 60–64.

Tee, T., Ogwuche, J. and Ikyaagba, E. (2009). The role of Locust bean and Ironwood trees in human nutrition and income in Nigeria. *Pakistan Journal of Nutrition*. **8**(8): 1172-1177

Victor, J.E., Koekemoer, M., Fish, L., Smithies, S.J. and Mossmer, M. (2004). Herbarium essentials: the southern African Herbarium user manual. *Southern African Botanical Diversity Network Report* No. 25. |

Yar'adua, S.S. and Amenu, S.G. (2022). Diversity and Distribution of Vascular Plants in Charanchi Local Government Area, Katsina State, Nigeria and their Medicinal Importance. *Ethiopian Journal of Environmental Studies & Management*. 15(5):573–587, 2022. ISSN:1998-0507. doi: https://ejesm.org/doi/v15i5.2.

Wu, H., and Yan-Go, F. (1996). Self-reported automobile accidents involving patients with obstructive sleep apnea. *Neurology*, **46**(5): 1254-1257.