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Assessment of Herbaceous Species Diversity in Lede and Galumji, Wawa-Zange Forest Reserve, Gombe State, Nigeria

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Abstract

The study was carried out in Wawa-Zange Forest Reserve. The aim was to investigate the Herbaceous Species Composition and Diversity. Point Centered Quarter (PCQ) Sampling method was used to conduct the study. Data obtained was analyzed for Frequency, Relative Frequency, Density, Relative Density and Importance Value Index. The result obtained showed a total number of twenty. Herbaceous Plant Species. Out of this number 17 were Forbs and 3 were Grasses. They belonged to 9 families and 19 genera. The family Fabaceae (Subfamily Caesalpinoideae, Papilionoideae and Mimosoideae) had 5 species, and Malvaceae had 5 species while Poaceae had 3 species, Rubiaceae had 2 species. Euphorbiaceae, Linderniaceae, Acanthaceae, Commelinaceae and Arecaceae had 1 species each. Simpson's index of diversity (1 − D) was (0.60) while Shannon-Wiener index was (2.21). The species with the highest importance value index was *Urena lobata* L. (65.47%) and the species with lowest importance value index were *Palisota hirsuta*, *Cassia rotundifolia*, *Amorphophallus abyssinicus*, and *Corchorus olitorius* with (2.93%). These plants therefore require urgent conservation measures.

Keywords

Herbaceous, Species Diversity, Composition, Wawa-Zange Forest Reserve

1. Introduction

Herbaceous plants are defined as plants without woody stems above ground [1]. They are usually small tender plants and they exist in different life forms (Annual, Biennial and Perennial Plants). Due to their diverse nature, they serve as habitats for a wide array of animals, are basis for complex food webs [2] [3] [4]

[5] [6] and are involved in the stabilization of topsoil, improving water penetration into soils as well as water holding capacity of the soil [3] [7] [8]. Despite this huge ecological prominence and significant proportions to plant biodiversity, they remain understudied and are usually not included in most floristic studies [9] [10]. Although there have been studies on woody species diversity and impact of medicinal plant and deforestation on communities in Wawa-Zange Forest Reserve, Gombe State Nigeria by Umar [11]. No study on herbaceous species is available in Lede and Galumji, Wawa-Zange. Therefore, this study aims to provide information on the composition, distribution and diversity of the herbaceous species in Lede and Galumji, Wawa-Zange. It will also serve as a guide to improve conservation efforts towards ensuring their continual existence.

2. Materials and Methods

2.1. Description of the Study Area

The study was carried out in Lede and Galumji, Wawa-Zange Forest Reserve, Gombe State, Nigeria. It was gazetted in 1962 and is located in the Sudan Savannah vegetation of Sub-Saharan Africa. Wawa-Zange Forest Reserve (**Figure 1**) lies between Latitude 10˚49'22.7"N to longitudes 10˚46'23.97"E with an altitude of 411 m above sea level and is located in Dukku and Funakaye Local Government Area with the edges of the reserve in Kwami area of 779.70 km^2 [12]. The vegetation is characterized by shrubs, scattered trees and herbs. There is reduced forest fauna, important birds and wildlife. The climate of the area is characterized by two distinct seasons: The rainy season lasts from May through October and the dry season lasts from November through April. The temperatures are high throughout the dry season beyond 40˚C during the hottest months (March-April) while during wet season the averaged temperature is usually within 24˚C. The soil type is classified as Sandy-loamy. The topography is mainly mountainous, undulating and hilly to the South-East and flat open plains in the central, North, North-east, west and North-West.

2.2. Experimental Design

The study area comprises two sites, Lede and Galumji Wawa-Zange Forest Reserve (*i.e.* Lede and Galumji) (**Figure 1**). The size of the sampling sites is 19 hectares each.

2.3. Vegetative Sampling

Vegetative sampling was conducted using Point Center Quarter (PCQ) methods [2] and [3]. P. C. Q was carried out by measurement of distances from randomly chosen points to the nearest herbs species. Ten random sampling points were located along a line of transects passing through the stand (compass direction). At each sampling point, 4 quarters (quadrants) were established using a cross. The individual nearest the point in each quadrant was located. The distances from

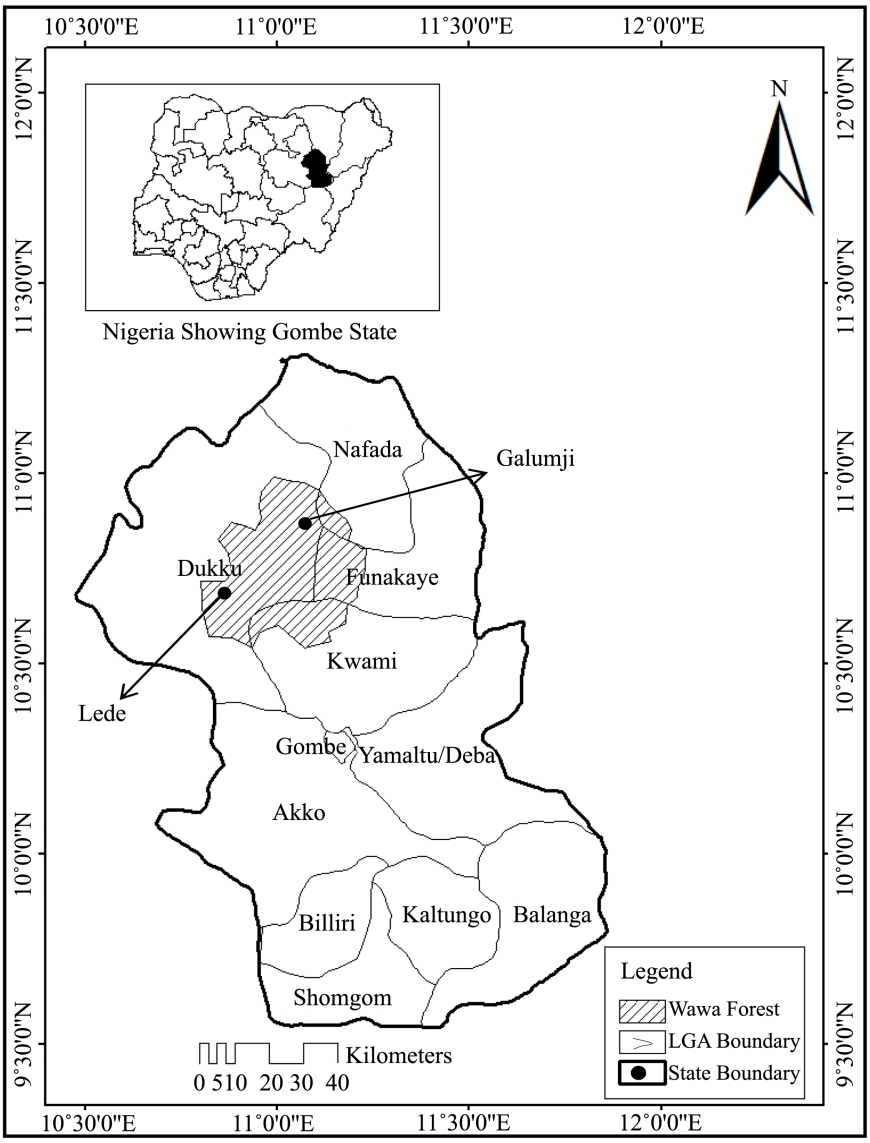

Figure 1. Showing Wawa-Zange Forest Reserve and the study sites. Source: (Field Work, 2019).

sampling points to the mid-point of the nearest herb plant in each quadrant was measured and recorded in meters within each quarter. The herbaceous plant within the quadrants was identified to species using floras and texts to level and counted. However, few individuals that could not be identified were counted and recorded against their respective sites of occurrence and taken to the herbarium of department of Botany, Gombe State University for Identification by a Specialist. Parameters obtained by this method include: Herbercious species composition, density and frequency. The following computations was made: 1) Plant species distance (m); 2) Herbaceous species mean point distance (m); 3) Mean area (M/A) herb species (m^2); 4) Total (absolute) density (herbs/hectare).

1) Plant species Point to Point distance (m) was obtained from the sum of the distances from the center of the quadrant to each of the four plants per station.

In each the 10 stations, the distance of 4 points to the nearest herbs distance will be recorded in each 4 quarters *i.e.*, D_1, D_2, D_3 and D_4 summed. The sum of the total distance of the quarter in 10 station giving the species point to point distance.

Mathematically:-

$D_1 + D_2 + D_3 + D_4$ = species distance (spd) per station.

Then $spd_1 + spd_2 + \ldots + spd_{20}$ = point to point distance

D = Distance (m)

Spd = species distance.

Spd_{20} the species point to point distance in the 10^{th} station.

2) Species mean Point to Point distance (m), was averaged to give plant species mean point to point distance. For instances, in the 10 stations, the herbs species mean point to point distance was calculated by dividing point to point distance (m) by the 10 stations.

3) Mean area/plant species (m^2) represent the average area of ground surface on which one herbs occur. The mean area/herbs (M/A) = D_2 Where D = the mean distances of 4 point to the nearest herbs distance taken in each of four quarter *i.e.*, D_1, D_2, D_3 and D_4.

4) Total (absolute) density (herbs/hectare). The total density of herbs in the area sampled was then obtained by dividing the MA/herbs in to the unit area on the basis of which density was expressed. Total density of all species = unit area divided by mean point to point distance squared. Unit area refers to the size of the area in the same units as those of MA/point on the basis of which density (per hectare) was expressed.

Vegetation analysis was quantitatively analyzed for Total Density, Relative density, Frequency, Relative frequency and Importance value index [5].

1) Calculating density and relative density by species.

Density is the numerical strength of a species in a community and is described as number of individual per unit area.

$$\text{Density}(\text{D}) = \frac{\text{Number of individuals of a species in all the sample plots}}{\text{Total number of sample plots studied}}$$

$$\text{Relative Density}(\text{R.D}) = \frac{\text{Number of individuals of a species}}{\text{Total Number of individuals of all species}} \times 100$$

$$\text{Absolute Density}(\text{A.D}) = \frac{\text{Relative density of a species}}{100} \times \text{Total density of all species}$$

2) Calculating Frequency and Relation frequency of a species.

Species frequency was given by the number of occurrence of a species in the sampling unit and thus expresses the dispersion of the species in the community and measures commonness and distribution.

$$\text{Frequency}(\text{F}) = \frac{\text{Number of points at which a species occurs}}{\text{Total number of points sampled}}$$

Relative Frequencies are also calculated from the frequency of a species and the total frequency of all species.

$$\text{Relative Frequency}\left(\text{R.F}\right)=\frac{\text{frequency of a species}}{\text{Total frequencies ofallspecies}}\times 100$$

3) Calculating importance value index (IVI).

Importance value calculated is of significance in Savanna vegetation. The IVI from the herbaceous data was calculated by summing relative frequency and relative density for each species. For the calculation the following formulae were used.

$$\text{Importance Value Index}\left(\text{IVI}\right)=\frac{\text{Relative Density}+\text{Relative Freqency}}{2}$$

4) Species diversity was calculated using Simpson's index (Simpson, 1949) with this formula: $D = [N(N - 1)]/[\text{summation of } n(n - 1)]$, where D is the diversity index, N is the total number of individuals of all plant species found, n is the number of individuals of a particular species. Species diversity index was also calculated using the Shannon-Weiner index [13].

5)

$$\text{HI} = -\sum_{i=1}^{R} P_i \ln P_i$$

where H' is the = Shannon-Wiener index P_i = is the proportion of each species in the sample. R = represents the total number of species.

2.4. Method of Data Analysis

2.4.1. Measurement of Alpha Diversity

Two common approaches for measuring alpha diversity are species richness and evenness/heterogeneity [14]. Species richness simply refers to the number of species in the community while evenness/heterogeneity refers to the distribution of individuals among the species in this study. Species richness was computed as the total number of herbs species encountered in each site. Simpson and Shannon-Wiener indices were computed for each of the site using the Paleontological statistics (PAST) software.

Simpsons Index of Diversity

Simpson's Diversity Index is a measure of diversity. In ecology, it is often used to quantify the biodiversity of a habitat. It takes into account the number of species present, as well as the abundance of each species.

Simpson's Diversity Indices.

The term "Simpson's Diversity Index" can actually refer to any one of 3 closely related indices. Simpson's Index (D) measures the probability that two individuals randomly selected from a sample will belong to the same species (or some category other than species).

$$\text{Simpsons Index of Diversity}\quad D=\frac{\sum n\left(n-1\right)}{N\left(N-1\right)}$$

n = the total number of organisms of a particular species

N = the total number of organisms of all species

The value of D ranges between 0 and 1. With this index, 0 represents infinite diversity and 1, no diversity. That is, the bigger the value of D, the lower the diversity. This is neither intuitive nor logical, so to get over this problem, D is often subtracted from 1 to give:

Simpson's Index of Diversity $1 - D$

The value of this index also ranges between 0 and 1, but now, the greater the value, the greater the sample diversity. This makes more sense. In this case, the index represents the probability that two individuals randomly selected from a sample will belong to different species.

Another way of overcoming the problem of the counter-intuitive nature of Simpson's Index is to take the reciprocal of the Index:

Simpson's Reciprocal Index $1/D$

The value of this index starts with 1 as the lowest possible figure. This figure would represent a community containing only one species. The higher the value, the greater the diversity. The maximum value is the number of species (or other category being used) in the sample. For example if there are five species in the sample, then the maximum value is 5.

2.4.2. Measurement of Beta Diversity

Sorrenson's similarity index was used to measure beta diversity who [15] suggested the use of the many similarity indices for measuring beta diversity [1] had earlier opined that, of the similarity indices, only three of them (the Ochiai, the Jaccard and the Sorrenson) are worth considering. Sorrenson's index expressed as-

$$R1 = 100^{a/a+a+b+c}$$

where:

a. number of species present in both site under consideration.

b. number of species present in site 1 (one) but absent in site 2 (two).

c. number of species present in site 2 (two) but absent in site 1 (one).

3. Results

A total number of twenty [16] herbaceous Plant species were obtained. Out of which 17 were Forbs and 3 were Grasses. They belonged to 9 families and 19 genera. The highest relative density was *Urena lobata*. L. 62.0% while the lowest relative density was obtained from: *Palisota hirsuta* (Thunb) K. SCHUM, *Cassia rotundifolia* L., *Amorphophallus abyssinicus* (A. Rich), *and Corchorus olitorius L.* with 5.00%. The highest absolute density was *Urena lobata*. *L.* with 0.094%, and the lowest absolute density was: *Palisota hirsuta* (Thunb) K. SCHUM, *Cassia rotundifia* L., *Amorphophallus abyssinicus* (A. Rich), and *Corchorus olitorius* L. 0.001%.

The highest Frequency was found on *Urena lobata*. L. 2.58% and the lowest frequency were *obtained on Palisota hirsute* (Thunb) K. SCHUM, *Cassia rotun-*

difolia L., *Amorphophallus abyssinicus* (A. Rich), *and Corchorus olitorius* L. with 0.03%. The highest Relative frequency was *Urena lobata*. L. 68.94% and the lowest relative frequency were: *Palisota hirsuta* (Thunb) K. SCHUM, *Cassia rotundifolia* L., *Amorphophallus abyssinicus* (A. Rich), and *Corchorus olitorius* L. with 0.85%. The highest relative frequency in the study area was *Urena lobata*. L. (68.94%) and the lowest relative frequency were:-*Palisota hirsuta* (*Thunb*) *K. SCHUM*, *Cassia rotundifolia* L., *Amorphophallus abyssinicus* (A. Rich), and *Corchorus olitorius* L. with (0.85%). The highest relative density was *Urena lobata*. L. (62.0%) and the lowest relative density were *Palisota hirsuta* (Thunb) K. SCHUM, *Cassia rotundifolia* L., *Amorphophallus abyssinicus* (*A. Rich)*, and *Corchorus olitorius* L. with (5.00%). The plant with the highest importance value index was *Urena lobata* (65.42%) and the plants with the lowest importance value index were: *Palisota hirsuta* (Thunb) K. SCHUM, *Cassia rotundifolia* L., *Amorphophallus abyssinicus* (A. Rich), and *Corchorus olitorius* L. with (2.93%).

Diversity Indices of Herbaceous Species in Galumji and Lede, Wawa-Zange, Forest Reserve. The Simpson's diversity of index (D) was (0.15), Simpson's index of diversity ($1 - D$) was (0.50) and Simpson's reciprocal index ($1/D$) was (5.00), While Shannon-wiener index for the study area was (2.21) for the herbs species in Wawa-Zange Forest Reserve Gombe State, Nigeria (**Tables 1-5**).

4. Discussion

Knowledge on species diversity and distribution patterns is important for density evaluation and projection of ecosystem of an area [13]. Our present study recorded 20 species of herbaceous plants which is not consistent with the works of [16] who recorded 35 species of herbs in Kanawa Forest Reserve, and also is not consistent with the works of Oni and Ndiribe [17] who recorded only 47 species in University of Lagos and also is not consistent with the works of George [18] who recorded 75 species in University of Lagos. The result in the present study was lower probably because of the soil type, low moisture contents in the soil and geographical location of Wawa-Zange Forest Reserve in the sudan Savannah Vegetation. The highest families were Fabaceae (Sub-families Caesalpinoideae, Papilionoideae and Mimosoideae) and Malvaceae had five species within each families, these Fabaceae families were also known to be dominant and native species in most savannah-woodland mosaics in Africa and more typical of the Sudano-Sahelian zone. A similar study was carried out by Atiku [19] at Wassaniya Forest Reserve of Sokoto State, Nigeria, using the point centered quarter method and another investigation was carried out in Yankari Game Reserve (YGR), in the Savanna-Woodlands of Northern Nigeria by Abdullahi [20]. Forbs constitute the largest number in the categories of herbs species while grasses are the lowest within the categories of the herbs species in Wawa-Zange Forest Reserve. The lowest families were Poaceae had three species, Rubiaceae had two species while Aracaceae, Euphorbiaceae, Linderniaceae, Commelinaceae and Acanthaceae had one species within each family. The Poaceae family is

Table 1. Species composition of herbaceous species in Galumji and Lede, Wawa-Zange Forest Reserve.

S/No	Species	Life form	Families	Genera	Common names	Hausa names
1	*Urena lobata* L.	Forbs	Malvaceae	Urena	Caesarweed	Kafi-rama
2	*Sida spinosa* L.			Sida	Pricky funpetal	Namijin hankufa
3	*Waltheria indica*. L.			Waltheria	Speeping morning	Hankufa
4	*Truimfetta rhomboidae* (Jacq).			Truimfetta	Diamond burbark	Yankan-dafi
5	*Corchorus olitorius* L.			Corchorus	Naita jute	Lalo
6	*Pennisetum polystachion* L.	Grass	Poaceae	Pennisetum	Mission grass	Hura (kafirimi)
7	*Dactyloctenium aegyptiaca* (L). Willd			Dactyloctenium	Crowfoot grass	Guda-gude (Kirikiri)
8	*Eragrostis ciliaris* (L). R. BR			Eragrostis	Gophertail lovegrass	Aman mussa
9	*Mimosa spp* L.	Forb	Fabaceae	Mimosa		Kaidaji
10	*Senna obtusifolia* (L) H. S. Irwin			Senna	Coffe weed	Tafasa (Bazanfara)
11	*Centrosema molle*. Mart. ex benth			Centrosema	Butterfly pea	
12	*Cassia mimosoidae*			Cassia		Marga/Malga
13	*Cassia rotundifolia* L.			Cassia	Goiden shower	
14	*Mitracarpus villosus* (SW.) DC		Rubiaceae	Mitracarpus	Tropical girdle pod	Harwati
15	*Oldenlandia corymbosa* L.			Oldenlandis	Diamon flower	Rata-hanji
16	*Euphorbia heterophylla* L.		Euphorbiaceae	Euphorbis	Wild poinsettia	Kaimin kadangare
17	*Linderia spp* (L.) PENNEL		Linderniaceae	Linderia	Yellow seed false	Riimin saurii
18	*Justicia insularis* L.		Acanthaceae	Justicia	Water-willow	Budidiyo
19	*Palisota hirsuta* (Thunb) K. SCHUM		Commelinaceae	Palisota		
20	*Amorphophallus abyssinicus* (A. Rich)		Araceae	Amorphophallus	Black arum	Kunnen jaakii

mostly the dominant species in related place of study with larger population of species were obtained but is not the same in this study this is probably because of the over grazing by animals in the reserve. The abundance species in the Wawa-Zange Forest Reserve was *Urena lobata* L. with the highest value of density, relative density, frequency and relative frequency this is probably because it is naturally considered as a serious weed which grows along road site and it forms thickets, and is often abundant in swamp edges and in wet woodland. The lowest species in the Wawa-Zange Forest Reserve were *Palisota hirsuta* (Thunb) K. SCHUM, *Cassia rotundifolia* L., *Amorphophallus abyssinicus* (A. Rich), and *Corchorus olitorius* L., with the lowest value of density, relative density, frequency and relative frequency this is probably because they do not adapt well to

Table 2. Relative density and density of herbaceous species encountered in the study area.

S/No	Species names	Rellative density %	Density %
1	*Urena lobata* L.	62.0	0.094
2	*Sida spinosa* L.	88.6	0.01
3	*Waltheria indica*. L.	10.0	0.002
4	*Truimfetta rhomboidae* (Jacq).	64.3	0.011
5	*Corchorus olitorius* L.	5.00	0.001
6	*Pennisetum polystachion* L.	61.6	0.032
7	*Dactylocteniumaegyptiaca* (L). Willd	27.1	0.005
8	*Eragrostis ciliaris* (L). R. BR	69.3	0.012
9	*Mimosa spp* L.	283.6	0.038
10	*Senna obtusifolia* (L) H. S. Irwin	90.0	0.013
11	*Centrosema molle*. Mart. ex benth	19.3	0.002
12	*Cassia mimosoidae*.	25.0	0.005
13	*Cassia rotundifolia* L.	5.00	0.001
14	*Mitracarpus villosus* (SW.) DC	78.6	0.013
15	*Oldenlandia corymbosa* L.	58.6	0.009
16	*Euphorbia heterophylla* L.	249.3	0.04
17	*Linderia spp* (L.) PENNEL	33.6	0.004
18	*Justicia insularis* L.	26.4	0.003
19	*Palisota hirsuta* (Thunb) K. SCHUM	5.00	0.001
20	*Amorphophallus abyssinicus* (A. Rich)	5.00	0.001
	TOTAL NUMBER	1825.2	0.297

Table 3. Frequency and relative frequency of herbaceous species encountered in the study area.

S/No	Species	Frequency %	Relative frequency %
1	*Urena lobata* L.	2.58	68.94
2	*Sida spinosa* L.	0.33	8.40
3	*Waltheria indica*. L.	0.05	1.42
4	*Truimfetta rhomboidae* (Jacq).	0.30	8.33
5	*Corchorus olitorius* L.	0.03	0.85
6	*Pennisetum polystachion* L.	0.85	22.2
7	*Dactyloctenium aegyptiaca* (L). Willd	0.13	3.58
8	*Eragrostis ciliaris* (L). R. BR	0.33	9.18
9	*Mimosa spp* L.	1.06	27.88
10	*Senna obtusifolia* (L) H. S. Irwin	0.38	10.16

Continued

11	*Centrosema molle*. Mart. ex benth	0.08	2.10
12	*Cassia mimosoidae*.	0.13	3.68
13	*Cassia rotundifolia* L.	0.03	0.85
14	*Mitracarpus villosus* (SW.) DC	0.35	9.57
15	*Oldenlandia corymbosa* L.	0.60	16.56
16	*Euphorbia heterophylla* L.	1.01	26.68
17	*Linderia spp* (L.) PENNEL	0.13	3.34
18	*Justicia insularis* L.	0.11	2.84
19	*Palisota hirsuta* (Thunb) K. SCHUM	0.03	0.85
20	*Amorphophallus abyssinicus* (A. Rich)	0.03	0.85
	TOTAL NUMBER	8.54	228.26

Table 4. Importance value index of herbaceous species encountered in the study area.

S/no	Species	Rellative density %	Relative frequency %	Importance value index %
1	*Urena lobata* L.	62.0	68.94	65.47
2	*Sida spinosa* L.	88.57	8.40	48.49
3	*Waltheria indica*. L.	10.0	1.42	5.71
4	*Truimfetta rhomboidae* (Jacq).	64.3	8.33	36.32
5	*Corchorus olitorius* L.	5.00	0.85	2.93
6	*Pennisetum polystachion* L.	61.57	22.2	41.9
7	*Dactyloctenium aegyptiaca* (L). Willd	27.14	3.58	15.36
8	*Eragrostis ciliaris* (L). R. BR	69.3	9.18	39.24
9	*Mimosa spp* L.	28.36	27.88	28.12
10	*Senna obtusifolia* (L) H. S. Irwin	90.0	10.16	50.08
11	*Centrosema molle*. Mart. ex benth	19.3	2.10	10.70
12	*Cassia mimosoideae*.	25.0	3.68	14.34
13	*Cassia rotundifolia* L.	5.00	0.85	2.93
14	*Mitracarpus villosus* (SW.) DC	78.57	9.57	44.07
15	*Oldenlandia corymbosa* L.	58.6	16.56	37.58
16	*Euphorbia heterophylla* L.	24.93	26.68	137.9
17	*Linderia spp* (L.) PENNEL	33.57	3.34	18.46
18	*Justicia insularis* L.	26.4	2.84	14.62
19	*Palisota hirsuta* (Thunb) K. SCHUM	5.00	0.85	2.93
20	*Amorphophallus abyssinicus* (A. Rich)	5.00	0.85	2.93
	TOTAL NUMBER	1825.2	228.26	620.08

Table 5. Diversity indices of herbaceous species in Galumji and Lede, Wawa-Zange, forest reserve.

S/No	Index	Value
1	Simpson's Diversity Index (D)	0.15
2	Simpson's Index of Diversity = $(1 - D)$	0.80
3	Simpson's Reciprocal Index $(1/D)$	5.00
4	Shannon-Wiener Index	3.21

the area to produce seed to disperse and spread as expected. The herbs species in the present study with the highest Importance Value Index (IVI) in the whole forest reserve was *Urena lobata* L. (344.5%) while *Palisota hirsuta* (Thunb) K. SCHUM, *Cassia rotundifolia* L., *Amorphophallus abyssinicus* (A. Rich), and *Corchorus olitorius* L. (2.93%) had the lowest Importance Value Index in the reserve. The importance value indices of the herbaceous species were generally low in the study area this could be probably due to different species with few individuals represented in each herbaceous species. The Importance Value Index is imperative at comparing the ecological significance of species and it indicates the extent of dominance of a species in the structure of a vegetation stand [20]. Importance Value Index is also a reasonable measure to assess the overall significance of a species since it takes into account several properties of the species in the vegetation, this is consistent with the works of Abdullahi [20]. All these species were characteristic of Sudan Savanna vegetation types. The grasses were shorter than in the Guinea Savanna zones, and they had different characters. Most of the grasses were annuals because of drought-stress in the long dry period. The result of Simpson's diversity index (D) in this present study was (0.15%).

Simpson's index of diversity $(1 - D)$ was (0.80%) and Simpson's reciprocal index was $(1/D)$ was 5.00. A similar study was carried out by Abdullahi [20] where she reported Simpson's index of diversity for herbs species in Kanawa Forest Reserve as (0.998%). George [18] reported Simpson's index of diversity as (0.98%) in University of Lagos, George [18] also 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 in Wawa-Zange Forest Reserve this is probably because of the topography of the study area, limited soil moisture and the soil type, while Shannon-Weiner index (H') for the study area was (3.21) for the herbs species in the present study. A similar study was carried out by George [18] who reported Shannon-Wiener index (H') for herbs species in University of Lagos as (3.96) [3], where she reported Shannon-Wiener index (H') for herbs species in Kanawa Forest Reserve as (4.57%), George [18] also reported Shannon-Wiener index as (4.27) for the Miombo woodland of Bereku Forest Reserve, in Tanzania. These values were higher than those of the present study in Wawa-Zange Forest Reserve this is probably be-

cause of the different geographical location and the environmental factors of the study area [21].

5. Conclusion

The study area was predominated by *Urena lobata*, having the highest importance value indices among the herbaceous species, respectively. *Palisota hirsuta*, *Cassia rotundifolia*, *Amorphophallus abyssinicus* and *Corchorus olitorius*, were the least dominant among the herbaceous species, hence the need to foster the conservation of these plants. This study also generated baseline data on the herbaceous species diversity in Lede and Galumji, Wawa-Zange Forest Reserve Gombe State, Nigeria. This would serve as a guide to the systematists, ethnobotanists, amongst several other researchers who are interested in identifying herbaceous plants within this area. This study therefore recommended that in order to protect the forest reserve from further encroachment from human actives such as harvesting the herbs for medicinal purposes, and animals foraging on the grasses, the reserve needs to be fenced and additional guards obtained by the Government agency.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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