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Floristic Composition and Characterization of Legume Flora in Parklands of Aguié Department, Niger, West Africa

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

Due to the absence of a botanical assessment on legume flora in Aguié, so the study was conducted on parklands of Aguié Department to determine the floristic composition and characterize the flora. The characterization consists of determining the legume woody flora density, vertical structure, number of sapling, herbaceous legume biomass and importance socio-economic. Firstly, we used systematic sampling approach to collect legume flora. A total 51 plots each with a size of 50 m x 50m for all parklands species and within each major quadrat, five sub plots of 5mx5m and 1 m x 1 m were established for the woody regeneration and for herbaceous biomass. All plant species in each plot were recorded. The legume flora was extracted. Some dendrometric parameters such as height, diameter at breast height (1.30 m) and the crown cover were measured. Secondly, we used ethnobotanical questionnaire to collect the socio-economic data about the importance of legume flora to the rural communities. On the other hand, a total of 61 legume species representing 30 genera and the three botanical families namely Fabaceae,

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Mimosaceae and Caesalpiniaceae. Fabaceae is the floristically the highest family with 30 species representing 13 genera. Mimosaceae constitutes the second family with 16 species representing 7 genera. Caesalpiniaceae was presented with 15 species and 8 genera. The average density of legume woody species is 80 feet per hectare in the parklands. The structural analysis of the parklands revealed that there were two vertical structures namely tree and shrub strata. Ethnobotanical surveys within the parkland communities with 52 people show that legumes play a crucial role in meeting diverse domestic and environmental needs. Among the legumes recorded are cultivated, medicinal, pastoral, ornamental, gum, melliferous and spontaneous human food species. Consequently, based on the results, a further study that will examine the threat to the legume flora is recommended.

Keywords: Floristic composition; Legume Flora; characterization; parklands; Aguié.

1. INTRODUCTION

Niger (longitude 0°16' and 16° East and the latitude 11°1' and 23°17' North) is one of the vast sahelian countries in West Africa covering an area of 1,267,000 km^2. The population of Niger is 17.7 million of people and its population growth rate is 3.9% [1]. Nearly 80% of its population live in rural areas where Nigeriens derive various ecosystem services. Parklands provide enormous services to the rural dwellers in Niger. For instance, parklands constitute the source of firewood, traditional medicine for human and animal, timber, animal fodder and human food such as edible fruits and leaves in Niger [2-5]. More specifically, fuelwood such as firewood and charcoal remains the widely source of energy in rural areas of Niger. Further, in Aguié department parklands are the major source of fuelwood. Parklands are also a great source of income in the rural areas.

Botanical assessment of the flora of a region is of overwhelming importance especially to the management of the phytodiversity. Legume flora is of high importance to a given ecosystem. Legume species have played a very important role in ecosystem and human life [6]. In addition, many legume species have the ability to fix atmospheric nitrogen with the support of the bacteria such ability is of great importance in ecosystem functions [7]. Added to that some legume species are used or saved as green fertilizers in the parklands in Niger. Furthermore, legume plants are of great importance due to their role in nitrogen fixation. For instance, [8] concluded that legume plants sustain crop productivity and augment land fertility of the semi-arid environment.

In Aguié department the parklands consist of agricultural landscape, pastoral lands, forest reserve under contract of cultivation or taungya farming activities with scattered woody species. The parklands refer to the agroforestry systems or agroecosystems. Characterization of legume flora consists of determining the dendrometric characteristics, regeneration rate and legume herbaceous biomass in the parklands of Aguié department. Legume refers to the order of legumisosae that has three botanical families, namely Caesalpiniaceae, Fabaceae or Papilionaceae, and Mimosaceae.

2. MATERIALS AND METHODS

2.1 Study Area

Aguié is one among the departments of Maradi region in Niger. Aguié department lies between 13°51'21''N and 08°18'12''E (Fig. 1). The people of Aguié was estimated at 386.197 [1]. Agriculture is the main activity of the population of Aguié. The agricultural production consists of food and cash crops. Apart from that, the people of Aguié department are engaged in animal husbandry. Residential animal husbandry in Aguié consists of keeping animals in the houses during dry and rainy spell. But during dry season the parklands constitute the free range of the animals. In the rainy season, the forage is collected from the parklands to the houses. The climate of Aguié is south sahelian type with following characteristics [9]: Rainfall index = 400mm < RI < 600 mm; relative humidity = 18% (March) < RH < 70.5% (August); Temperature = 19°C (January) < T < 32°8 C (May). The relevés sites were at the following villages: Dodo, Bamo, Dan kéri, Gamji Saboua, Guidan Tanko, Guidan Nahantchi, Saja Manja, Bakabé, Mai Sanho, Dan Saga, Aguié commune, and Dan Kada, which were randomly selected.

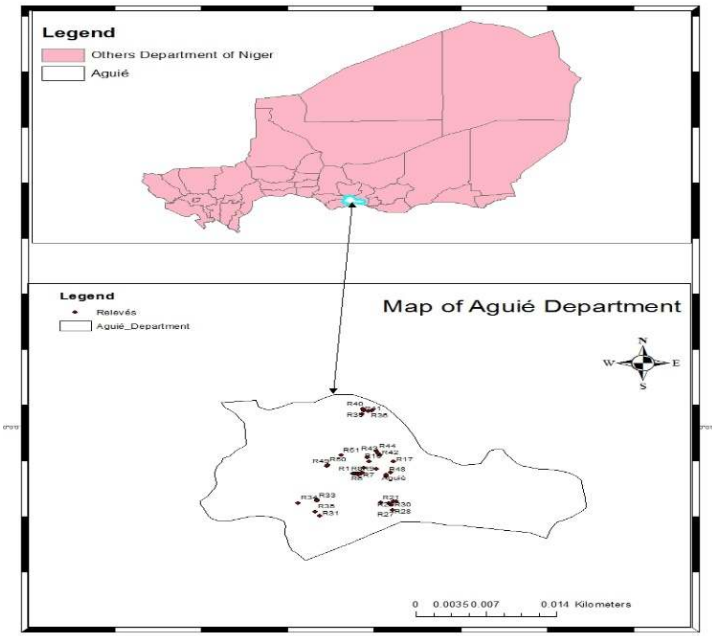

Fig. 1. Map of Aguié department

2.2 Data Collection

The inventory was carried out during August and September 2012, period corresponding of optimum vegetation development in sahelian milieu [9]. During such period the herbaceous vegetation is developed and easy to identify. Plot method or quadrat method was used to inventory the vegetation data in the parklands of Aguié by using systematic random sampling approach. The plots were distant from 500 m along a transect line. The size of the quadrat was 50 m x 50 m, which is the recommended dimensions for the agroforestry systems inventory [10]. We used tape meter and ringing pole for the construction of the plot. Within each plot, five sub plots of 5 m x 5 m and 1 m x 1 m were established for the woody regeneration and for herbaceous biomass, respectively. A total 51 plots were used and within each major quadrat, all plant species in each plot were recorded. The majority of species was identified by us during the terrain. Some specimens were collected of the unknown species which were identified by Doctor Karim Saley at the department of Biology, faculty of Science University Dan Dicko Dankoulodo of Maradi. For the herbaceous biomass, we cut only the herbaceous legume within the five sub plots in every plot. We weighted the herbaceous legume using the small spring balance in field and recorded the fresh weight. Secondly we dried at home and measured the dry weight. Some dendrometric parameters such as height, circumference at (1.30 m) and crown cover were measured. We used ringing pole for assessing the total woody legume species height, tape meter for crown cover measurement, and diameter tape for legume woody species diameter at 1. 30 m. We also measured the diameter South-North and West-East of the woody crown by using tape meter. Secondly, we used ethnobotanical questionnaire to collect the socio-economic data about the importance of legume flora to the rural communities. We took some pictures that explain the use of legume flora in Aguié.

Picture 1. Showing Soulé administrating the questionnaires

2.3 Data Analysis

All the vegetation data of the inventory were taped in Excel. After, the legume flora was extracted from the whole data. We analysed the data with Excel for following information about the legume flora of the parklands:

We used the formula circumference (C)= diameter x Pi = d.π, so you get a diameter = Circumference(C) divide by π. Where the value of π = 3.14

Density (N) of a specie or group of species is the number of individuals per unit of (nb/ha)

. N= $\frac{N}{A}$; Where n is the number of individuals and A is the area in hectares.

Basal area (G) is the area of a given section of land that is occupied by the cross-section of woody specie trunks and stems at the base. The basal area is calculated on the basis of trunk diameter and expressed in m^2 per hectare. It is obtained by the following formula: $G = \pi D^2/4$, where D is diameter at breast height (1.3 m).

Crown Cover (R) is the area of vertical projection of the woody crown on soil. It is calculated by the following formula: Crown cover = (Average crown diameter) ² x (π) /4, where Average crown diameter is equal to the sum of the diameter South-North and West-East of the woody crown divide by two. The crown cover is expressed in percentage of plot area (%). Rate of regeneration (Rr) is defined as the ration of the total number of sapling/seedlings counted over the total plot area per hectare. Rr = Total number of seedlings/ Area(ha). Here we consider seedling or sapling any woody plant which is diameter is less than 2.5 cm (which the minimum diameter in semi area zone and the height less than 1.3 m.

3. RESULTS AND DISCUSSION

3.1 Legume Floristic Composition

The floristic analysis of the legume flora of Aguié parklands shows a total of 61 legume species were recoded, representing 30 genera and the three botanical families namely Fabaceae, Mimosaceae and Caesalpiniaceae (Table 1). Fabaceae is floristically the most abundant family with 30 species representing 13 genera. The best represented genera in the Fabaceae are *Indigofera* with 10 species, *Crotalaria* with 4 species, and *Tephrosia* with 3 species. This result is significantly lower than the number of species of this family found by [11] in the same compartment. The woody flora of Fabaceae in parklands of Aguié has two species which are: *Pterocarpus erinaceus* and *Dalbergia sissoo* which is an introduced legume. Only one *Pterocarpus erinaceus* individual was recorded during our survey. Mimosaceae constitutes the second most abundant family with 16 species representing 7 genera. But *Acacia* genus has 7 species, *Albizia* 2 species, and *Prosopis* 2 species. But *Prosopis juliflora* was exotic plants. The number of Acacia species (7) we obtained is less than the Acacia number (14) found by [11] in the same compartment (B). This can be explained by the fact that the study is carried out only in the Aguié department and only the few villages were randomly prospected for the study. We collected also an exotic specie, *Acacia holosericea*, which was not found in compartment B by [11]. Caesalpiniaceae was present with 15 species and 8 genera. The best represented genus is the Cassia genus with 9 species; This is consistent with the result found in compartment B by [11] by contrast a single species that was not harvested *Cassia senna* but found by [11] in the compartments D and E. Caesalpiniaceae of the parklands of Aguié has 9 woody species. *Parkinsonia aculeata* is also an exotic plant. Our results show the Fabaceae as most abundant family, second Mimosaceae and third Caesalpiniaceae. This confirms the result found by [6] in Taif district, Saudi Arabia in terms of order of numerical importance. However, in this study we found 61 species, while [6] found 26 species. The presence of introduced woody legume species indicates the afforestation activity within the parklands.

Table 1. Legume floristic composition

Botanical families	Number of Species	Number of Genera
Fabaceae	30	13
Mimosaceae	16	7
Caesalpiniaceae	15	8
Total	61	28

3.2 Characterization of Legume Flora

3.2.1 Legume woody species density

The average density of woody legume species is 80 specimen per hectare in the parklands of Aguié department. It varies from 36 individuals per hectare for *Piliostigma reticulatum*, 7 for

Faidherbia albida, 4 for *Acacia nilotica,* and 3 for *Prosopis africana* (Table 2). For these four species the department of Aguié has a spatial distribution which is somewhat continuous. The most numerically dominant species in the parklands of Aguié department is *Piliostigma reticulatum.* The average density of legume woody flora and for the three woody species greater than the (1.17 *Pterocarpus erinaceus* per hectare in Sahel) found by [12] found for *Pterocarpus erinaceus*. Further in this study we found only one *Pterocarpus erinaceus* specimen. This confirms the weak density of *Pterocarpus erinaceus* found by Segla et al. [12] in Sahel environment.

3.2.2 Basal area and crown cover

The total basal area of legumes in the parklands of Aguié is the sum of all the land areas of legume species on the inventoried area. It is 14.34 m^2 / ha in the parklands of Aguié. The basal area for the woody flora is greater than (0.30 m^2/ha) what [12] found for only for *Pterocarpus erinaceus in* Sahel area. The basal area plays a great role in parklands management and parklands ecology. The crown cover of woody legume plants is 4.71% for the department of Aguié. This figure is lower than the one reported by [13] in parklands of Maradi region. Crown cover in the parklands of Aguié varies according to the land use and land cover types. It is higher in the forest reserves (Table3). This could be due to the artificial plantations of legumes and to the protection of the forest reserve. Meanwhile it is lower in the croplands. This is justified by the fact that the trees in the croplands are very poorly pruned for aerial grazing and cut during the cropping period in order to reduce the shading effect on the crops. In the fallows, this could be explained by the aerial cuts made by the breeders and wood harvesting by the woodcutters.

3.2.3 Vertical structure of Legume Woody Flora

Based on the legume vertical distribution diagram by height class (Fig. 2), the parklands of Aguié has two structures, the shrub stratum whose representatives are the majority, and the tree stratum whose individuals of this stratum are poorly represented. Shrub stratum constitutes the major vertical structure of legume flora in the parklands of Aguié. The dominance of such a structure can be explained the impact of human activities on woody plant in the parklands. Our findings, the two vertical structure, and even the dominance of the shrub stratum confirm the result of [13] in the parklands of Maradi region.

Table 2. Relative density of woody legume plants

Legume woody species	Relative density(ha)
Piliostigma reticulatum	36
Faidherbia albida	7
Acacia nilotica	4
Prosopis africana	3

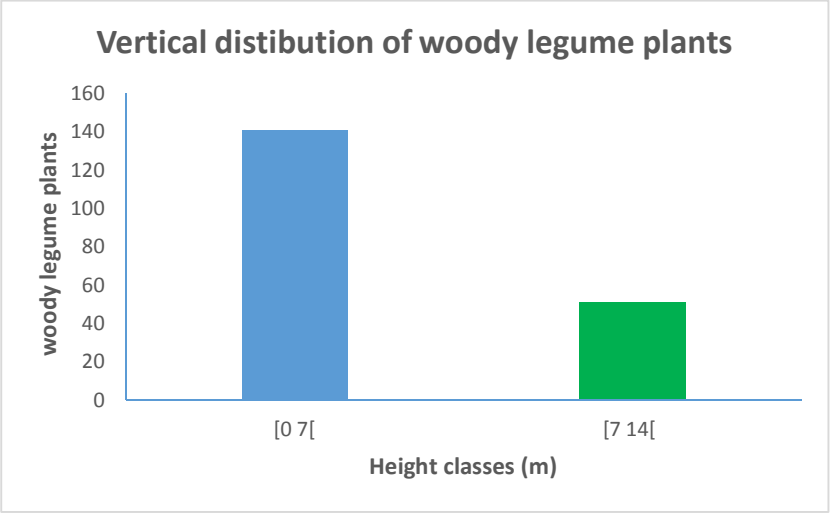

Fig. 2. Distribution of woody legumes by height class

Table 3. Crown cover in the different land use land cover types

Crown cover	Croplands	Fallow lands	Forest reserves
%	4.70	4 .90	14

3.2.4 Natural regeneration and herbaceous Legume biomass

In the parklands of Aguié department, we recorded 28 legume seedlings per hectare which is smaller than the regeneration rate of the mixed woody flora found by [13] in their study sites. The number of seedling per hectare represents a rate of regeneration, which is a good indicator of appreciating the regeneration capacity. Herbaceous legume biomass is 0.40 tons of dry matter per hectare in the parklands of Aguié department.

3.2.5 Socio-economic importance

The ethno-botanical survey in the parklands communities in Aguié department shows that the legume flora plays a major role in satisfying the socio-economic needs of people. The inventoried legumes include cultivated species; medicinal species; pastoral species; gum species; ornamental species; melliferous species; and other wild spontaneous human food species. Some legume species have economic value such as *Parkia biglobosa.* For instance, the wild legume *Cassia obtusifolia* or *tora* has been domesticated. From the interviewers, the seeds are sold in the markets.

Picture 2. Showing the cropland of *Cassia obtusifolia* and the farmer using it for food

Table 4. Legume floristic list

Species	Families
Bauhinia rufescens Lam.	Caesalpiniaceae
Cassia absus L.	Caesalpiniaceae
*Cassia italica (*Mill.) Lam. Ex Fw. Andr	Caesalpiniaceae
Cassia mimosoides L.	Caesalpiniaceae
Cassia nigricans Vahl.	Caesalpiniaceae
Cassia obtusifolia L.	Caesalpiniaceae
Cassia occidentalis L.	Caesalpiniaceae
Senna siamea L.	Caesalpiniaceae
Cassia sieberiana DC.	Caesalpiniaceae
Cassia singueana Del.	Caesalpiniaceae
Delonix regia (Hook.) Raf.	Caesalpiniaceae
Detarium microcarpum Guill. Et Perr.	Caesalpiniaceae
Parkinsonia aculeata L.	Caesalpiniaceae
Piliostigma reticulatum (Dc.) Hochst	Caesalpiniaceae
Tamarindus indica L.	Caesalpiniaceae
Aeschynomene indica L.	Fabaceae
Alysicarpus ovalifolius (Schum. Et Thonn.)	Fabaceae
Arachis hypogaea L.	Fabaceae
Canavalia rosea (L.) DC.	Fabaceae

Species	Families
Crotalaria goreensis Guill. Et Perr.	Fabaceae
Crotalaria podocarpa DC.	Fabaceae
Crotalaria retusa L.	Fabaceae
Crotalaria senegalensis (Pers.) Bak. Ex.DC.	Fabaceae
Dalbergia sissoo DC.	Fabaceae
Indigofera astragalina Dc.	Fabaceae
Indigofera berhautiana Gillet	Fabaceae
Indigofera bracteolata DC.	Fabaceae
Indigofera dendroides Jacq.	Fabaceae
Indigofera diphylla Vent.	Fabaceae
Indigofera hirsuta Var.hirsuta	Fabaceae
Indigofera nummulariifolia (L.) Liv. Ex Alston	Fabaceae
Indigofera pilosa Poir.	Fabaceae
Indigofera stenophylla Guill. Et Perr.	Fabaceae
Indigofera tinctoria L.	Fabaceae
Pterocarpus erinaceus Poir.	Fabaceae
Sesbania pachycarpa Dc.	Fabaceae
Stylosanthes erecta P. Beauv.	Fabaceae
Tephrosia bracteolata Guill. Et Perr.	Fabaceae
Tephrosia linearis (Willd.) Pers.	Fabaceae
Tephrosia lupunifolia DC.	Fabaceae
Tephrosia obcordata (Lam.ex Poir.)	Fabaceae
Tephrosia purpurea (L.) Pers.ssp.	Fabaceae
Vigna subtereranea (Thouars (L.)) Verdec.	Fabaceae
Vigna unguiculata (L.) Walp.	Fabaceae
Zornia glochidiata Reichb.ex Dc.	Fabaceae
Acacia ataxacantha Dc.	Mimosaceae
Acacia holosericea A.Cunn.ex G.Don	Mimosaceae
Acacia nilotica (L.) Willd. Ex Del.subsp.*nilotica*	Mimosaceae
Acacia polyacantha Subsp.*Campylacantha*	Mimosaceae
Acacia senegal (L.) Willd.	Mimosaceae
Acacia seyal Del.	Mimosaceae
Acacia sieberiana DC.	Mimosaceae
Acacia tortilis Subsp.*raddiana*	Mimosaceae
Albizia chevalieri Harms.	Mimosaceae
Albizia lebbeck (L.) Benth.	Mimosaceae
Dichrostachys cinerea (L.) Wight et Arn.	Mimosaceae
Entada africana	Mimosaceae
Faidherbia albida Del.	Mimosaceae
Parkia biglobosa (Jacq.) Benth	Mimosaceae
Prosopis africana (Guill. Et Perr.) Taub.	Mimosaceae
Prosopis juliflora (SW) DC.	Mimosaceae

4. CONCLUSION

The parklands of Aguié department are rich in legume biodiversity. The floristic composition is diverse in terms of species, genera and families. The legume flora of the Aguié department is characterized by dominance of legume woody species namely *Piliostigma reticulatum* and *Faidherbia albida.* The structural analysis of the parklands revealed that there were two vertical structure, namely tree and shrub strata. The current study augments our knowledge of wild legume vegetation in parklands of Aguié department. Based on the results, a further study that will examine the threat to the legume flora is recommended.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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