*Journal of Forestry Research and Management. Vol. 17(3).1-13; 2020, ISSN 0189-8418*

*www.jfrm.org.ng*

# ECOLOGICAL ASSESSMENT OF WOODY MEDICINAL PLANT SPECIES AMONG DIFFERENT FOREST-USE TYPES IN OLOKEMEJI FOREST RESERVE, NIGERIA

**Ojekunle O. O., Aduradola A. M. and Oladoye A. O**

ojekunleo@funaab.edu.ng**, +2348032182264**
Department of Forestry and Wildlife Management, College of Environmental Resources Management, Federal University of Agriculture, Abeokuta, Nigeria

## ABSTRACT

The significance of medicinal plants to rural livelihood in the provision of affordable health care as well as management and conservation of these resources cannot be overemphasized. An investigation was carried out in Olokemeji Forest Reserve, Nigeria to examine the composition, diversity and abundance of medicinal plants among four different forest-use types. The forest-use types were Re-growth forest, Derived Woodland, Secondary Forest and Reforested Area. Ten plots of 20 m X 20 m were randomly selected in each site for inventory and analysis of species composition, abundance and diversity as well as evaluation of overall importance of each species. Simpson's Diversity and Simpson's similarity indices were used to determine the diversity and similarity across the forest-use types. Species composition and abundance were also calculated. Re-growth forest had highest individuals and density of woody species (235; 1100 trees/ha) while the least was found in derived woodland (67; 212.5 trees/ha)**.** Re-growth forest is richer in species composition and consequently higher economic value of medicinal plants which can be harvested and in turn yield more income to people as well as source of revenue to government if harvested on sustainable basis. Secondary forest had the highest tree species (50) while the least (17) was observed on the reforested area. The most abundant species include *Margaretaria discoides* in Re-growth forest, *Ficus thonningii* in Derived woodland, *Manilkara multinervis* in Secondary forest and *Tectona grandis* in Reforested area. However, Reforested area had highest IVI (The top ten species accounted for 86% of the overall Importance Value Index) among other forest-use types. The study concluded that species composition, diversity and abundance of medicinal plants varied among different forest-use types.

**Keywords:** medicinal plant, livelihood, conservation, forest-use type**,**

## Introduction

Medicinal plants are various plants used to cure disease or relieve pain and believed by some to have healing properties or in veterinary practice for therapeutic or prophylactic purposes (Tyler and Foster, 1999). Medicinal plants include a wide range of species used as natural medicines, condiments, dyes, or ornaments (Dacher and Pelzmann, 1999). Medicinal plant species are important component of NTFPs (Non Timber Forest Products) which play a vital role in providing subsistence and cash income to a large part of the world's population, particularly in developing countries (Arnold and Ruiz, 2001). Demand for medicinal plants is increasing in both developing and developed countries due to growing recognition of natural products being non-narcotic, having no side-effects, easily available at affordable prices and sometime the only source of health care available to the local population (Arceusz *et al.*, 2010).

Medicinal plants have been used by mankind for its therapeutic value since the beginning of human civilization. In Nigeria, many rural communities have been using medicinal plants to cure various forms of ailments (Sani and Aliyu, 2011). There are three ways in which plants have been found useful in medicine. First, they may be used directly as teas or in other extracted forms for their natural chemical constituents. Second, they may be used as agents in the synthesis of drugs. Lastly, the organic molecules found in plants may be used as models for synthetic drugs. Historically, the medicinal value of plants was tested by trial and error, as in the Doctrine of Signatures (Tyler *et al.*, 1999).

Without medicinal plants, most medicines we take would not exist. Of the estimated 250,000 plant species on earth, only 2% have been thoroughly screened for chemicals with potential medicinal use. As a result of native plant habitats destruction almost daily, many medicinally valuable plants will be gone before scientists can even investigate them.The most serious proximate threats when extracting medicinal plants generally are habitat loss, habitat degradation, and over harvesting (Hamilton, 2004). About 80% of the world's population rely predominantly on plants and plant extracts for healthcare (Setzer *et al.*, 2006). An impressive number of modern drugs have been isolated from natural sources and nature has been a source of medicinal agents for thousands of years. Many of these isolations were based on the uses of the agents in traditional medicine. The potential of isolating beneficial drugs from plants, however, has prompted large pharmaceutical companies to contribute to the conservation of the forest. Biologists have called for more careful study of medicinal plants, especially regarding their capacity for sustainable harvesting. Medicinal plant conservation strategies need to be understood and planned for based on an understanding of indigenous knowledge and practices (Berkes *et al.*, 2006).

Today many medicinal plants face extinction or severe genetic loss, but detailed information is lacking. For most of the endangered medicinal plant species no conservation action has been taken. For example, there is very little material of them in gene banks. Also, too much emphasis has been put on the potential for discovering new wonder drugs, and too little on the many problems involved in the use of traditional medicines by local populations. For most countries, there is not even a complete inventory of medicinal plants. Much of the knowledge on their use is held by traditional societies, whose very existence is now under threat. Little of this information has been recorded in a systematic manner (Starr *et al.*, 2011).

Studies have shown that anthropogenic disturbances such as heavy logging, grazing, over and improper extraction/harvesting of forest products, and the conversion of forested land to other forest-use types might affect the availability of some forest products on which the local people depend such as medicinal plants (García-Montiel and Scatena, 1994). Forest structure is both a product and a driver of ecosystem processes and biodiversity, and if it changes due to natural or anthropogenic disturbances, there may be consequences for other forest components (Foster *et al.*, 1997). Developing markets for natural products, particularly those that are harvested from the wild, can trigger a demand that cannot be met by available supplies (Timothy, 1998). Hence, conservation initiative is required to meet the growing demand of medicinal plants without disrupting their recovery potential. Despite the significance of medicinal plants to rural livelihoods in the provision of culturally relevant and affordable health care as well as sources of plant-based materials for pharmaceutical companies, information on the extent to which the composition, diversity and abundance of these plant species under different forest-use types are affected and data to support how much of these species can be harvested on a sustainable basis in the derived savanna of Olokemeji Forest Reserve are deficient. We therefore examined and compared the species composition, abundance and diversity of medicinal plants among four forest-use types (secondary forest, re-growth forest, reforested area and derived woodland).

## Materials and Methods

### Study area and forest-use types

This study was conducted in Olokemeji forest Reserve situated on Latitude 7° 25' - 7° 28' and Longitude 3° 35' - 3° 40' in the derived savanna zone; northeast of Abeokuta in southwestern Nigeria. The forest reserve lies on the margin of the lowland rain forest and derived savanna zones (Keay, 1952). The mean annual rainfall is 1263.50mm spreading over March to November (Ogun-Osun River Basin Development Authority, 2016). The dry season is severe and the relative humidity is 79.34%. The mean maximum and minimum temperatures are 35.65$^0$C and 31.19$^0$C respectively. The soils are derived from old crystalline rocks. The soil of the study site is grayish molted hydromorphic soil showing powdery topsoil that transcends into massive clayey sub-soil. The area of the reserve is generally undulating lying mostly between 90 and 140m above sea-level (Ola-Adams and Adegbola 1982). Olokemeji forest reserve is composed of secondary forest, re-growth forest, reforested area, derived woodland and exotic species plantations.

**Re-growth forests:** these are areas currently regenerating after heavy logging. They consist of many narrow diameter trees. A forest which has had many if not most of its mature trees cleared or cut and felled for timber or woodchips. Often, the area will be burned after logging before the regrowth can take place. (Putz and Redford, 2010).

**Derived woodland:** this refers to forest under high grazing pressure where people frequently collect fodder and medicinal plants. This forest-use type is generally close to villages and contributes a major portion to the livestock fodder consumption (Putz and Redford, 2010).

**Secondary forest:** this refers to a forest or woodland area which has re-grown after a major disturbance such as fire, insect infestation, timber harvest or windthrow, until a long enough period has passed so that the effects of the disturbance are no longer evident (Putz and Redford, 2010). Secondary forest regrowing after timber harvest differs from regrowing forest after natural disturbances such as fire, insect infestation, or windthrow because the dead trees remain to provide nutrients, structure, and water retention after natural disturbances. (de Jong *et al*., 2001).

**Reforested areas:** this refers to formerly degraded areas planted with tree species (Putz and Redford, 2010).

**Methods of data collection**

The data collection has two steps; the first step is reconnaissance survey for identification of the available forest-use types and plot establishment. The succeeding step is collection of data on already identified tree species frequently harvested for medicinal purposes in the selected plots across the forest-use types under investigation.

Forty sample plots (20m x 20 m) were established across the four forest-use types (Ten plots of 20 m X 20 m were randomly selected in each site) as a true representation of the total area.

**Data Analysis**

Data were analyzed with Paleontological Statistical Software Package for education and data analysis (PAST) and Statistical Package for Social Sciences (SPSS version 17.0.1) and subjected to descriptive and inferential analysis. Species composition was expressed on an individual species basis. Floristic similarities of all species between forest-use types were determined using Simpson's similarity index. Classification was made with respect to families and species.

Simpson's Diversity Index was calculated as:

$$D = 1 - (\mathrm{ni} \text{ X } (ni - 1))/(\mathrm{N} \text{ X } (\mathrm{N} - 1))$$

(with i = 1 to S)

Where n = Number of individual species

N= total number of all individuals recorded

n=number of stem (or individual) of ith species

Where SI = percentage similarity index

a = number of species present in both sampling plots

b = number of species present in the second plot and not in the first

Abundance estimate:

$$\text{Abundance} = \frac{\text{Total no. of individual of the species}}{\text{Number of quadrat per units in which they occur}} \text{ X } 100$$

Density–frequency–dominance (DFD measure) is a combined abundance estimate usually expressed as relative values; Relative Frequency, Relative Dominance and Relative Density.

Importance Value Index (IVI);

$$\text{IVI} = \text{Relative Frequency} + \text{Relative Dominance} + \text{Relative Density}$$

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

$$\text{Relative Dominance} = \frac{\text{Combined BA of a single species}}{\text{Total BA of all Species}} \text{ X } 100$$

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

**Results and Discussion**

Information on the extent to which the composition, diversity and abundance of medicinal plant species under differently forest-use types are affected and data to support how much of these species can be harvested on a sustainable basis are of great importance in the conservation of the available species. This study exhibited disparity in the diversity of medicinal plant species among the studied forest-use types.

**Similarity and Diversity of tree species among the forest-use types**

The result showed that the enumerated tree species ranged from 67-440 stems across the four forest-use types (Table 1). In terms of species richness, secondary forest had the highest number of species per hectare (50 species/ha) while the least number of species was found in Reforested area (17 species/ha). The results also support 8–66 species/ha recorded by Kacholi, 2014 in their findings. Species dominance in reforested area was the highest (0.678) and lowest was found in Secondary forest (0.050) (Table 1). Also, Secondary forest had the highest diversity index (0.950) while low diversity index was obtained in reforested area (0.322). This was not surprising because the reforested area contained fewer species. Species distribution was even in Derived woodland and Secondary forest (0.633 and 0.620) while low evenness was observed in Re-growth forest and Reforested area. Re-growth forest recorded the highest number of families while Reforested area had the least number (Table 1). Highest diversity index, species density and species richness recorded in secondary forest compared to other forest-use types corroborate the studies of Ogunleye *et al.* (2004) on Olokemeji forests, Uniyal *et al.*, (2010) in undisturbed native forest in Pakistan and David and Gailyson, (2013). High values of diversity in secondary forest, re-growth forest and derived woodland indicate greater stability of community structure. Reduced diversity in reforested area can be attributed to fewer species (*Tectona grandis* and *Gmelina arborea*) in this zone and other anthropogenic impacts which was particularly severe due to the close proximity of agricultural lands. Species dominance was highest in reforested area (0.678) and lowest in secondary forest (0.050).

Highest similarity index of 64% was observed between Re-growth forest and Derived woodland as well as between Derived woodland and Secondary forest. However, lowest similarity was found between Re-growth forest and Reforested area (Table 2). This is an indication that Re-growth forest and Derived woodland are more related floristically than Re-growth forest and Reforested area.

**Table 1: Index of Diversity of tree Species among the four forest-use types**

| | Re-growth forest | Derived woodland | Secondary forest | Reforested area |
|---|---|---|---|---|
| Taxa_S | 45 | 25 | 50 | 17 |
| Individuals | 440 | 67 | 134 | 235 |
| Dominance_D | 0.061 | 0.099 | 0.050 | 0.678 |
| Simpson_1-D | 0.939 | 0.901 | 0.950 | 0.322 |
| Evenness_e^H/S | 0.466 | 0.6334 | 0.620 | 0.148 |
| Equitability_J | 0.799 | 0.8581 | 0.878 | 0.326 |
| Family | 27 | 19 | 18 | 12 |

**Table 2: Similarity indices of tree species among the four forest-use types**

| | Re-growth forest | Derived woodland | Secondary forest | Reforested Area |
|---|---|---|---|---|
| Re-growth forests | 1 | | | |
| Derived woodland | 0.640 | | | |
| Secondary forest | 0.533 | 0.640 | | |

| | | | | |
|---|---|---|---|---|
| Reforested area | 0.471 | 0.588 | 0.529 | 1 |

**Frequency, Density and Importance value index of tree species in the four forest-use types**

Across the forest-use types, frequency of occurrence was highest in Re-growth forest (1550) and lowest (470) in Reforested area (Table 3). The most frequent species in Re-growth Forest was *Ficus thonnigii* (100), Derived woodland; *Ficus thonningii* (90), Secondary forest; *Anogeissus leiocarpus* (90) and Reforested area, *Tectona grandis* (100) (Table 3).

Re-growth forest had the highest stem density (1100 stems/ha) when compared to other sites while lowest stem density was found in Derived woodland (588 stems/ha). However, in Re-growth forest *Margaretaria discoides* had the highest stem density of 125 stems/ha. Species such as *Acacia nilotica, Albizia zygia, Antiaris toxicaria, Senna siamea* had lowest densities (Table 3). In the Derived woodland, *Ficus thonningii* (40 stems/ha) had the highest stem density. Species such as *Acacia nilotica, Albizia zygia, Allophyllus africanus* and *Senna siamea* had lowest stem density (2.5 stems/ha each) as shown in Table 3. In the Secondary forest, *Manilkara multinervis* (42.5 stems/ha) had the highest density. Species such as *Allophyllus africanus, Alstonia boonei* and *Antiaris toxicaria* had lowest stem density 2.5 stems/ha (Table 3).

Importance Value Index (IVI) is an index is Importance Value Index (IVI) is used to determine the overall importance of each species in the community structure. In Re-growth forest, the first ten important species include; *Spondias mombin* (25.4), *Ficus thonningii* (23.9), *Margaretaria discoides* (20.9), *Manilkara multinervis* (16.4), *Albizia lebbeck* (16.1), *Morinda lucida* (14.1), *Xylopia parviflora* (12.9), *Newbouldia leavis* (12.8), *Vernonia amygdalina* (12.6), *Morus mezozygia* (11.7). The top ten species accounted for 55% of the overall IVI (Table 3). In the Derived woodland *Ficus thonningii* had the highest IVI of 47.9 followed by *Lonchocarpus sericeus* (27.1), *Isoberlina doka* (22.8) and *Anthocleista djalonensis* (22.6). The top ten species accounted for 71% of the overall IVI of this site (Table 4).In Reforested area *Tectona grandis* was the species with highest IVI of 187, followed by *Sterculia tragachanta* (18.8), *Lonchocarpus sericeus* (18.1) while the remaining species had IVI of less than 10.0 (Table 3). In Reforested area *Tectona grandis* was the species with highest IVI of 187, followed by *Sterculia tragachanta* (18.8), *Lonchocarpus sericeus* (18.1) while the remaining species had IVI of less than 10.0. The top ten species accounted for 86% of the overall IVI.

Journal of Forestry Research and Management. Vol. 17(3).1-13; 2020, ISSN 0189-8418

www.jfrm.org.ng

**Table 3: Frequency, Density and Importance value index of tree species in the four forest-use types**

| | FREQUENCY | | | | DENSITY(stems/ha) | | | | IMPORTANCE VALUE IND | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | Re-growth forest | Derived woodland | Secondary forest | Reforested area | Re-growth Forest | Derived woodland | Secondary forest | Reforested area | Regrowth forest | Derived woodland | Secon forest |
| *Acacia nilotica* | 10 | 10 | 30 | 0 | 2.5 | 2.5 | 7.5 | 0 | 1.8 | 4.7 | 6.2 |
| *Afzelia africana* | 0 | 0 | 40 | 0 | 0 | 0 | 12.5 | 0 | 0 | 0 | 11 |
| *Albizia lebbeck* | 80 | 30 | 10 | 10 | 22.5 | 7.5 | 7.5 | 5 | 16 | 17 | 5.7 |
| *Albizia zygia* | 10 | 10 | 20 | 0 | 2.5 | 2.5 | 10 | 0 | 9.8 | 4.6 | 7.5 |
| *Allophyllus africanus* | 0 | 10 | 10 | 0 | 0 | 2.5 | 2.5 | 0 | 0 | 3.7 | 1.9 |
| *Alstonia boonei* | 10 | 0 | 10 | 0 | 2.5 | 0 | 2.5 | 0 | 1.4 | 0 | 2 |
| *Annona senegalensis* | 10 | 0 | 10 | 10 | 2.5 | 0 | 2.5 | 2.5 | 1.8 | 0 | 2.5 |
| *Anogeissus leiocarpus* | 40 | 0 | 90 | 30 | 12.5 | 0 | 35 | 7.5 | 7.2 | 0 | 31 |
| *Anthocleista djalonensis* | 0 | 30 | 50 | 0 | 0 | 25 | 17.5 | 0 | 0 | 23 | 15 |
| *Antiaris toxicaria* | 10 | 20 | 10 | 0 | 2.5 | 5 | 2.5 | 0 | 1.2 | 6.5 | 1.9 |
| *Azadirachta indica* | 60 | 0 | 0 | 0 | 37.5 | 0 | 0 | 0 | 11 | 0 | 0 |
| *Blighia sapida* | 0 | 0 | 20 | 10 | 0 | 0 | 7.5 | 2.5 | 0 | 0 | 5.7 |
| *Bridelia ferruginea* | 0 | 20 | 20 | 30 | 0 | 5 | 5 | 7.5 | 0 | 7.9 | 3.5 |
| *Funtumia elastica* | 0 | 0 | 10 | 0 | 0 | 0 | 2.5 | 0 | 0 | 0 | 2.6 |
| *Carica papaya* | 0 | 0 | 10 | 0 | 0 | 0 | 2.5 | 0 | 0 | 0 | 2 |
| *Ceiba petandra* | 0 | 0 | 10 | 0 | 0 | 0 | 2.5 | 0 | 0 | 0 | 2.1 |
| *Holoptelea grandis* | 20 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 3.1 | 0 | 0 |
| *Celtis zenkeri* | 20 | 10 | 0 | 0 | 5 | 2.5 | 0 | 0 | 6.8 | 5.8 | 0 |
| *Chrysophyllum* | 20 | 0 | 0 | 0 | 2.5 | 0 | 0 | 0 | 2 | 0 | 0 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *albidum* | | | | | | | | | | | |
| *Cola millenii* | 20 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 2.9 | 0 | 0 |
| *Daniella oliverii* | 0 | 40 | 50 | 0 | 0 | 15 | 17.5 | 0 | 0 | 19 | 13 |
| *Delonix regia* | 0 | 0 | 10 | 0 | 0 | 0 | 2.5 | 0 | 0 | 0 | 2.5 |
| *Dialum guineense* | 50 | 0 | 0 | 0 | 42.5 | 0 | 0 | 0 | 7.6 | 0 | 0 |
| *Diospyros mespliformis* | 50 | 40 | 30 | 0 | 47.5 | 18 | 12.5 | 0 | 8.5 | 16 | 8.9 |
| *Drypetes floribunda* | 10 | 0 | 10 | 0 | 2.5 | 0 | 2.5 | 0 | 2 | 0 | 2.2 |
| *Cedrela odorata* | 0 | 0 | 10 | 0 | 0 | 0 | 2.5 | 0 | 0 | 0 | 2.1 |
| *Ekebergia senegalensis* | 0 | 0 | 10 | 0 | 0 | 0 | 2.5 | 0 | 0 | 0 | 2.3 |
| *Elaeis guineense* | 10 | 0 | 10 | 0 | 2.5 | 0 | 2.5 | 0 | 1.5 | 0 | 1.7 |
| *Entada abyssinica* | 10 | 0 | 10 | 0 | 2.5 | 0 | 5 | 0 | 1.3 | 0 | 2.8 |
| *Erythrophleum ivorense* | 20 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 2.4 |
| *Erythrophleum suaveolens* | 0 | 0 | 10 | 0 | 0 | 0 | 2.5 | 0 | 2.3 | 0 | 0 |
| *Ficus exasperata* | 70 | 0 | 10 | 0 | 70 | 0 | 2.5 | 0 | 24 | 48 | 0 |
| *Ficus sur* | 10 | 0 | 0 | 0 | 2.5 | 0 | 0 | 0 | 12 | 0 | 2.2 |
| *Ficus thonningii* | 100 | 90 | 0 | 0 | 55 | 40 | 0 | 0 | 1.3 | 0 | 0 |
| *Gliricidia sepium* | 0 | 0 | 10 | 0 | 0 | 0 | 2.5 | 0 | 0 | 0 | 1.9 |
| *Grewia pubescens* | 30 | 0 | 0 | 0 | 0 | 0 | 10 | 23 | 5.9 | 0 | 0 |
| *Gmelina arborea* | 0 | 0 | 30 | 50 | 12.5 | 0 | 0 | 0 | 0 | 0 | 12 |
| *Harrisonia abyssinica* | 70 | 0 | 0 | 0 | 70 | 0 | 0 | 0 | 12 | 0 | 0 |
| *Hildergadia barteri* | 30 | 0 | 0 | 0 | 7.5 | 0 | 0 | 0 | 4.2 | 0 | 0 |
| *Holarrhena floribunda* | 0 | 0 | 40 | 0 | 0 | 0 | 12.5 | 0 | 0 | 0 | 10 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Isoberlina doka* | 0 | 40 | 0 | 40 | 0 | 20 | 0 | 10 | 0 | 23 | 0 |
| *Khaya ivorensis* | 40 | 0 | 10 | 0 | 12.5 | 0 | 2.5 | 0 | 7 | 0 | 2 |
| *Kigelia africana* | 0 | 10 | 0 | 20 | 0 | 2.5 | 0 | 5 | 0 | 4 | 0 |
| *Leucaena leucocephala* | 0 | 10 | 70 | 0 | 0 | 2.5 | 25 | 0 | 0 | 3.7 | 17 |
| *Lonchocarpus sericeus* | 0 | 30 | 0 | 40 | 0 | 13 | 0 | 10 | 0 | 27 | 0 |
| *Macaranga barteri* | 0 | 0 | 10 | 0 | 0 | 0 | 2.5 | 0 | 0 | 0 | 2.2 |
| *Manilkara multinervis* | 80 | 20 | 50 | 0 | 85 | 5 | 42.5 | 0 | 16 | 13 | 26 |
| *Manilkara obovata* | 0 | 0 | 10 | 0 | 0 | 0 | 2.5 | 0 | 0 | 0 | 2 |
| *Maranthes polyandra* | 10 | 0 | 0 | 0 | 2.5 | 0 | 0 | 0 | 2.3 | 0 | 0 |
| *Margaretaria discoides* | 80 | 30 | 0 | 30 | 125 | 7.5 | 0 | 7.5 | 21 | 13 | 0 |
| *Melicia excelsa* | 0 | 0 | 10 | 0 | 0 | 0 | 2.5 | 0 | 0 | 0 | 5.5 |
| *Millettia thonningii* | 0 | 0 | 20 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 4.9 |
| *Morinda lucida* | 80 | 30 | 10 | 10 | 75 | 7.5 | 2.5 | 2.5 | 14 | 15 | 2 |
| *Morus mezozygia* | 70 | 0 | 0 | 0 | 70 | 0 | 0 | 0 | 12 | 0 | 0 |
| *Psychotria vogeliana* | 0 | 0 | 50 | 0 | 0 | 0 | 15 | 0 | 0 | 0 | 13 |
| *Nesogordonia papaverifera* | 10 | 10 | 10 | 0 | 2.5 | 5 | 2.5 | 0 | 1.3 | 5.5 | 1.8 |
| *Newbouldia leavis* | 70 | 10 | 0 | 20 | 62.5 | 7.5 | 0 | 5 | 13 | 10 | 0 |
| *Parkia biglobosa* | 0 | 0 | 20 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 4.3 |
| *Piliostigma thonningii* | 20 | 10 | 10 | 0 | 2.5 | 2.5 | 5 | 0 | 1.7 | 3.9 | 1.9 |
| *Psychotria vogeliana* | 10 | 0 | 0 | 0 | 2.5 | 0 | 0 | 0 | 1.5 | 0 | 0 |
| *Pterocarpus erinaceus* | 0 | 0 | 10 | 0 | 0 | 0 | 2.5 | 0 | 0 | 0 | 2.1 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Samanea saman* | 10 | 0 | 0 | 0 | 2.5 | 0 | 0 | 0 | 1.3 | 0 | 0 |
| *Senna siamea* | 10 | 10 | 20 | 0 | 2.5 | 2.5 | 2.5 | 0 | 1.3 | 4 | 5.8 |
| *Spondias mombin* | 80 | 10 | 50 | 10 | 85 | 2.5 | 12.5 | 2.5 | 25 | 4.3 | 11 |
| *Sterculia tragachanta* | 0 | 0 | 0 | 40 | 0 | 0 | 0 | 10 | 0 | 0 | 0 |
| *Tectona grandis* | 0 | 0 | 0 | 100 | 0 | 0 | 0 | 483 | 0 | 0 | 0 |
| *Terminalia glaucescens* | 0 | 0 | 10 | 0 | 0 | 0 | 2.5 | 0 | 0 | 0 | 1.7 |
| *Terminalia ivorensis* | 0 | 10 | 0 | 0 | 0 | 2.5 | 0 | 0 | 0 | 4 | 0 |
| *Funtamia elestica* | 0 | 0 | 10 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 3.1 |
| *Tetrapleura tetraptera* | 10 | 0 | 10 | 0 | 2.5 | 0 | 2.5 | 0 | 1.3 | 0 | 1.8 |
| *Trichilia emetica* | 10 | 0 | 20 | 0 | 2.5 | 0 | 2.5 | 0 | 1.3 | 0 | 2.9 |
| *Triplochiton scleraxylon* | 10 | 0 | 0 | 0 | 2.5 | 0 | 0 | 0 | 1.8 | 0 | 0 |
| *Vernonia amygdalina* | 70 | 30 | 0 | 10 | 47.5 | 7.5 | 0 | 2.5 | 13 | 14 | 0 |
| *Vitellaria paradoxa* | 10 | 0 | 10 | 0 | 2.5 | 0 | 30 | 0 | 1.4 | 0 | 8.9 |
| *Vitex doniana* | 10 | 0 | 20 | 0 | 2.5 | 0 | 5 | 0 | 1.8 | 0 | 5.1 |
| Voacanga africana | 20 | 0 | 0 | 0 | 2.5 | 0 | 0 | 0 | 2 | 0 | 0 |
| Xylopia parviflora | 70 | 0 | 0 | 0 | 85 | 0 | 0 | 0 | 13 | 0 | 0 |
| Zanthoxylum zanthoxyloides | 0 | 0 | 40 | 10 | 0 | 0 | 10 | 2.5 | 0 | 0 | 8.5 |
| | **1550** | **570** | **1070** | **470** | **1100** | **213** | **385** | **588** | **300** | **300** | **300** |

## Conclusion

Ecological assessment of forest-use types (re-growth, derived, secondary and reforested area) of Olokemeji Forest Reserve shows disparity in composition, abundance and diversity of medicinal plant species. The study revealed that secondary forest recorded highest woody species diversity and richness compared to other forest-use types. This may be an indication of presence of a greater number of successful species and a more stable ecosystem. Low species diversity recorded in the reforested areas is not unexpected because the area contains few species. *Albizia lebbeck* was observed to be common to all the forest-use types assessed. This may be due to the easy dispersal of this species and ability to thrive under variety of ecological condition.

Reforested area had species of higher of IVI (The top ten species accounted for 86 of the overall IVI) than other forest-use types. The most abundant and most important woody species was *Tectona grandis* followed by *Gmelina arborea, Isoberlinia doka*, *Lonchocarpus sericeus* and *Sterculia tragachanta*.

In addition, re-growth forest is richer in species composition and consequently higher economic value in terms of medicinal plants which can be harvested and in turn yield more income to people as well as source of revenue to government. This study suggests that more parts of the reserve be allowed to re-grow in order to reduce loss of plant diversity due to plantation establishment, medicinal plant extraction and agricultural expansion.

## Recommendations

The rational use of Secondary forest has brought a noticeable difference between it and the other three sites in the forest reserve. Therefore, efforts to reconcile medicinal plant extraction/harvesting with forest reservation are a joint responsibility of forest managers and medicinal plants extractors.

There is need for more concerted effort on biodiversity monitoring studies in the forest-use types in other to have updates on earlier reports.

More areas should be allowed to re-grow in order to reduce loss of plant diversity due to uncontrolled medicinal plant harvesting, plantation establishment, vegetation clearance for farming activities and habitat degradation.

More reserves should be designated as medicinal plant extracting/harvesting zones in order to prevent habitat deterioration and where medicinal plants can be collected legally.

There is need for strategies for conserving medicinal plant species through policies that encourage sustainable supplies to meet the growing demands.

## References

Arceusz, A., Radecka, I. and Wesolowski, M (2010). Identification of diversity in elements content in medicinal plants belonging to different plant families. *Food Chemistry* 120: 52–58. doi:10.1016/j.foodchem.2009.09.068.

Arnold, J.E.M. and Ruiz, P.M. (2001). Can non-timber forest products match tropical forest conservation and development objectives? *Ecological Economics* 39:437–447.

Berkes, F. and Turner, N. J. (2006). Knowledge, Learning and the Evolution of Conservation Practice for Social-Ecological System Resilience. *Human Ecology* 34 (4): 479–494. doi:10.1007/s10745-006-9008-2.

Dacher, M. and Pelzmann, H. (1999) Arznei- und Gewürzpflanzen, 2nd edn, AV-Verlag, Kloster Neuburg, pp. 59–60.

David O.O. and Gailyson Y.J. (2013). Traditional agroforestry practices and conservation in the derived savanna ecosystem of Nigeria. *Biodiversity Journal*, 4(3): 427-434.

de Jong, W., U. Chokkalingam, J. Smith and C. Sabogal (2001). Tropical Secondary Forests in Asia: Introduction and Synthesis. *Journal of Tropical Forest Science* 13: 563-576.

Foster, D.R., Aber, J.D., Melillo, J.M., Bowden, R.D and Bazzaz, F.A. (1997). Forest response to fragmentation. *Ecology*, 87:542–548.

García-Montiel, D.C and Scatena, F.N. (1994). The effect of human activity on the structure and composition of a tropical forest in Puerto Rico. Forest Ecology and Management 63, 57–78.

Hamilton, A.C. (2004). Medicinal plants, conservation and livelihoods. Biodiversity and Conservation 13, 1477–1517 https://doi.org/10.1023/B:BIOC.0000021333.23413.42

Kacholi, D.S (2014). Analysis of Structure and Diversity of the Kilengwe Forest in the Morogoro Region, Tanzania. *International Journal of Biodiversity* Volume 2014. Volume 2014, Issue 2014, p. 8. Article ID 516840.

Keay, R.W.J (1952). An outline of Nigerian vegetation, Colonial forest service. No. 333.

Ogunleye, A.J, Adeola, A.O, Ojo, L.O. and Aduradola, A.M. (2004). Ogunleye, A. J., Adeola, A. O., Ojo, L. O., & Aduradola, A. M. (2004). Impact of farming activities on vegetation in Olokemeji forest reserve, Nigeria. *International Journal of Global Nest*, 6: 131–140.

Ogun-Osun River Basin Authority, (2016). Meterology Station, Ogun-Osun River Basin Authority Abeokuta Headquarters.

Ola-Adams, B.A. and Adegbola, P.O. (1982). Effect of burning treatments on structures above- standing crop and litter accumulation of derived savanna in Olokemeji Forest reserve. pp. 151-159 In: Sanford W.W., Yesufu, H.M. and Ayeni, J.S.O. (Eds) Nigeria savanna. L.L.R.I. New Bussa.

Putz, F.E., Redford, K.H., (2010). The importance of defining 'Forest': Tropical forest degradation, deforestation, long-term phase shifts, and future transitions. Biotropica 42, 10–20.

Sani H, Aliyu B.S (2011). A Survey of Major Ethnomedicinal Plants of Kano North, Nigeria, their Knowledge and Uses by Traditional Healers. *Bayero Journal of Pure and Applied Sciences* 4(2):28- 34.

Setzer M.C, Werka J.S, Irvine A.K, Jackes B.R, Setzer W.N (2006). Biological activity of rainforest plant extracts from far north Queensland, Australia. In biologically active natural products for the 21st century (pp. 21-46). Research Signpost

Starr, C., Nekaris, K. A. I., Streicher, U. and Leung, L. K. P. (2011). "Field surveys of the Vulnerable pygmy slow loris Nycticebus pygmaeus using local knowledge in Mondulkiri Province, Cambodia". Oryx 45 (1): 135–142. doi:10.1017/S0030605310001316.

Timothy, M. S. (1998). Intellectual property rights and biodiversity conservation: an interdisciplinary analysis of the values of medicinal plants. Cambridge University Press. pp. 45–62. ISBN 978-0-521-63580-6.

Tyler, V. E. and Foster, S. (1999). Tyler's Honest Herbal revised edition; The Physicians' Desk Reference for Herbal Medicines (annual), understory herb communities. *Forest Ecology and Management*, 260:116–124.

Uniyal, P., P. Pokhriyal, S. Dasgupta, D. Bhatt, and N. P. Todaria. 2010. Plant diversity in two forest types along the disturbance gradient in Dewalgarh watershed, Garhwal Himalaya. Current Science 98:7–10.