



Assessment of Open Grown Trees Composition and Diversity in Selected Research Institutes in Peri-Urban Ibadan, Oyo state, Nigeria

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ABSTRACT: Urban green spaces are rapidly deteriorating in most parts of Nigeria. The study assessed open grown trees composition and diversity in selected Research Institutes within Ibadan Region with the aim of comparing the ecological diversity in the study locations. This was achieved through species identification and mensuration of all open grown trees species that were accessible in the study areas. Open grown trees with Diameter at breast height ≥ 10 cm were assessed for growth characteristics of total height and diameter at breast height. Basal area and volume were estimated from measured growth characteristics. Tree species were identified by a taxonomist at Federal Herbarium in Ibadan. Biodiversity indices of Shannon diversity index, species evenness and species dominance were computed to see variation in tree community of the areas. The Shannon diversity index calculated was higher in IITA with a value of 3.04 compared to that of CRIN with a value of 2.36. A dominance value of 0.15 and 0.05 was obtained for CRIN and IITA respectively. The study concludes that both institutes are repository of large diversity of tree species thereby, helping in the conservation of biodiversity while ameliorating weather. It is recommended that educational institutions from all levels located within the region as well as private organizations and individuals should plant trees within their domains in order to create conducive green environments that would promote sustainable environment in the region. This is possible when government provide adequate incentive and annual rewards for establishments with the best green environments.

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Trees are one of the most important components of urban green space and they play an important role in street aesthetics. As an integral component of urban green infrastructure, tree, especially trees selection is crucial to successfully shaping a better urban environment (Adeyemi and Adesoye, 2016). An open-grown tree is a tree that has grown virtually all its life without competition from other trees. It usually has a short, squalls fat trunk with a very large diameter, spreading limbs of which some grow out almost horizontally. They generally have a large dome-like crown compared with a forest from trees that is tall with a narrow trunk and a small crown (Browne, 2001). The importance and conservation of the open grown tree as a natural, cultural and literacy icons is now gaining recognition across the world (Nowak *et al.*, 2007). Trees in urban and Semi-urban areas provide numerous benefits such as public aesthetic appeal, the root of trees preventing erosion, tree covers and branches improving air quality as well as serving as wind break. Trees also serve as shelterbelts in dry

lands, protect water flow, sequester carbon, ameliorate harsh weather condition, as raw materials to the wooden industries, preserve water shed, serve as recreation centers for relaxation parks and garden. It also provides security for poor urban people through the provision of edible vegetable, fruits, nuts, planting of low care fruit bearing trees, etc. (Onyekwelu *et al.*, 2008). Urban forest provides numerous tangible environmental benefits that often go unrecognized as reported by (McPherson and Simpson, 1999). Early this century, there has been increased research on quantification of ecosystem services, the direct benefits that urban forest ecosystem provides to people (Millennium Ecosystem assessment, 2005). Urban trees are increasingly being fell due to anthropogenic activities and its attendant urban growth and thus, the disappearance and threatening of tree species (Babalola and Raji, 2016). Statistics show that urban green spaces are rapidly deteriorating in most part of Nigeria and little attention is given to their composition and diversity. Studies on grown

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characteristics and diversity of semi-urban green spaces have also not considered research institutes and spaces surrounding them.

Research and enumeration of urban forest composition and diversity can help create awareness of what is in an urban forest within an area. This helps to provide a basis for management of such tree resource. This can further help to know factors that influence urban environment ecology and how this can be managed properly during constructions within the built-up environment. Assessing the status and trends of tree species diversity population is essential for sustainable development, strategies and planning of urban centers in Nigeria (Adekunle *et al.*, 2013).

Therefore, the objective of this paper is to assess open grown trees composition and diversity in selected Research Institutes in Peri-Urban Ibadan, Oyo state, Nigeria.

MATERIALS AND METHODS

Study Area: The study was conducted in Ibadan Region and specifically at the two research institutes located towards the Southern and Northern parts of the Region. The two Research Institutes are the Cocoa Research Institute of Nigeria (CRIN) and International

Institute of Tropical Agriculture (IITA). Cocoa Research Institute of Nigeria (CRIN), Ibadan at Idi-Ayunre in Oluyole Local Government of Oyo State. It lies on latitude $03^{\circ}50'$ East of the Greenwich Meridian and longitude $07^{\circ}20'$ North of the Equator lying on an altitude 122 meter above sea level (Ajewole and Iyanda, 2010). The area is characterized by wet season of about 6 months and a pronounced dry season of another 6 months. The mean annual rainfall may reach about 1200 mm. Annual mean temperature is about 25°C with high relative humidity of about 76% (Ajewole and Iyanda, 2010). International Institute of Tropical Agriculture (IITA) is located along old Oyo road in the Akinyele Local Government Area, Moniya, Ibadan, Oyo State. It lies on Longitude $07^{\circ}30'8''\text{N}$ and latitude $03^{\circ}54'37''\text{E}$ and altitude 243 meter above sea level (Tenkouano and Baiyeri, 2007). The area is characterized by two distinct seasons; the wet season which lasts for about 8 months and the dry season which is for about 4 months. Rainfall pattern is bimodal, with mean annual rainfall range of 1300-1500 mm most of which fall between May and September. The Average daily temperature ranges between 21°C and 23°C while the maximum is between 28°C and 34°C . The average relative humidity range is to 64% to 83% (Tenkouano and Baiyeri, 2007).

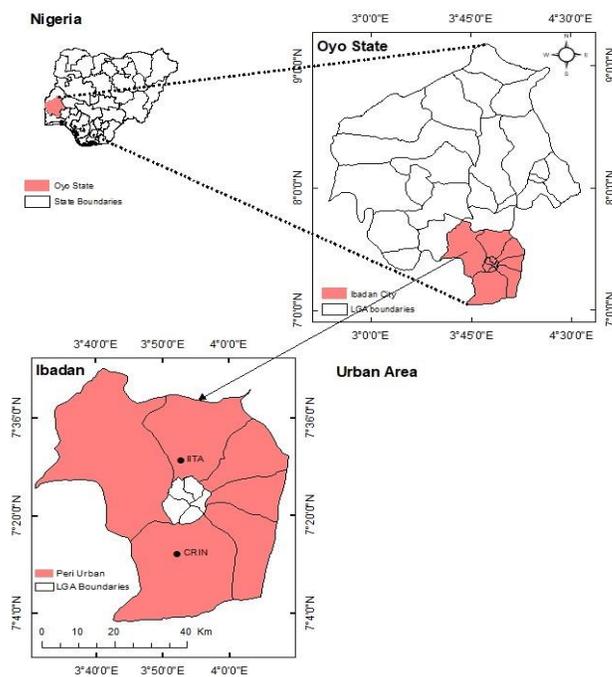


Fig 1: Map of study area

Data Collection: Growth variables such as total height (m) and diameter at breast height (dbh) were measured. Basal area and volume were estimated from measured growth characteristics of height and basal

area. The species were identified by a taxonomist from the Federal Herbarium, Ibadan.

Data from the quantitative measurements were subjected to ecological analysis using indices such as relative dominance, species diversity and evenness.

Measurement of Growth Variable: Total Height: This is the distance between the ground level and the apex of the tree species. It was obtained by taking the reading at the top (RT) and reading at the base (RB) which is usually negative and positive. It was measured with the Spiegel Relaskope.

Diameter at Breast Height (DBH): The Diameter at breast height is the measurement of a point on the standing tree which is 1.30m above the ground level. The tree parameter was taken for trees species within the temporary sample plots. It was measured with the support of diameter tape (Valladares and Niinemets, 2008).

Estimations Used

Basal Area: Basal area is used to describe the average amount of an area occupied by the tree stems. It is defined as the total cross-sectional area of all stems in a stand measured at breast height. It was calculated using the formula

$$BA = \frac{D^2}{4} \dots\dots\dots (1)$$

Where: BA= basal Area; D=Diameter at Breast Height; $\pi = 3.14$

Volume: The volume of trees in the study areas were estimated using the Newton's formula (Hush *et al.*, 2003). The formula is given by:

$$V = BA \times H \dots\dots\dots (2)$$

Where: BA= basal Area; H= Height

Ecological Analyses: The number of qualitative and quantitative indices of species diversity have been proposed by several workers (Simpson, 1949; Margalef, 1972; Shannon and Wiener, 1963; Pielou, 1975; Whittaker, 1972) which provided information on compositional change at different analytical levels that include species diversity in relation to size of area, relationship between local and regional species diversity and diversity along gradient across space or environmental factors (Busing and White, 1997; Gaston, 2000).

Information on floristic composition, diversity is absolutely essential in understanding the forest ecosystem dynamic (Gentry, 1990). The following analyses were carried out for all the enumerated trees;

Species Diversity Index: Species diversity index was computed using the Shannon-Wiener diversity index after Kent and Coker (1992).

$$H = \sum_{i=1}^s P_i \ln(P_i) \quad (3)$$

Where: H' = Shannon-Wiener diversity index; s= total number of species in the study area; P_i = proportion of 's' made up of the i^{th} species; \ln = natural logarithm.

Species Relative Dominance: Species relative dominance (RD) usually in percentage (%) was used in assessing relative space occupancy. It was estimated using after (Aidar *et al.*, 2001).

$$RD = \sum Bai/Ban \times 100 \dots\dots (4)$$

Where: Bai = basal area of all trees belonging to a particular species I; Ban = basal area of all trees in a city.

RESULTS AND DISCUSSION

Floristic Composition and Structure of Tree Species: A total of 166 trees belonging to different species and families were identified and enumerated in the two study locations (CRIN and IITA). Fabaceae had the highest individuals of 52 among the identified and enumerated trees species. This was closely followed by the Annonaceae having 29 individuals in CRIN study only site (Table 1).

Species and family of trees encountered in study sites: 114 individuals' trees of 20 species belonging to 12 families were identified and enumerated in CRIN. Annonaceae family had the highest individual of 29.

This was followed by the Fabaceae family with 27 individuals. Next to the Family is the Combretaceae family with 12 individuals. Burnham and Johnson (2004) reported that Fabaceae is the most commonly reported family in Tropical Rain Forest and even in dry forest in Africa.

This is because of its invasiveness that aids in its spread (Table 2a): 52 individual's trees of 24 species belonging to 8 families were identified and enumerated.

The number of individuals in each family were almost evenly spread as number of individuals in each family range from 1-5 with the highest being 5 individuals. This implies that no individual species dominant in IITA as all identified species are almost equally spread board. Most of them had individuals from between 1 and 2 (Table 2b).

Table 1: Floristic Composition and Structure of Tree Species

Family	Frequency	CRIN	IITA
Anacardeaceae	6	1	5
Arecaceae	3	3	-
Annonaceae	29	29	-
Bignoniaceae	1	1	-
Combretaceae	18	12	6
Dipterocarpaceae	2	2	-
Fabaceae	52	37	15
Malvaceae	24	12	12
Moraceae	12	8	4
Myraceae	4	-	4
Rubiaceae	8	8	-
Sapindaceae	2	1	1
Sterculaceae	1	1	-

Tree species Distribution and Diversity of study sites:

Table 2a show *Polyalthia longifolia* had the highest frequency of 30 among the identified tree species while *Peltophorum pterocarpium* had 24. *Terminalia superba* had frequency of 9 while the threatened *Triplochiton scleroxylon* was encountered 12 times. Total DBH ranged from 17.8cm – 188.9cm while the total height of the trees enumerated ranged from 181.1cm- 6.7cm². The basal area range from 0.02cm² – 17.07cm². Total volume ranged from 0.51-52.86m³. *Cola gigantea* had the highest mean dbh while *Roystonea regia* recorded the least dbh. *Shorea roxburghii* had the highest mean height of 181.1cm while *Ficus exasperate* had the least mean height value of 6.7cm. (Table 3a). Table 2b show *Albizia ferruginea* had the highest frequency of 5 among the identified tree species with *Eucalyptus camaldulensis*, *Spondia mombian* and *Talbabua rosia* having frequency of 4 respectively. Total dbh ranged from 37.7 cm – 729.1cm while total height ranges from 71.2cm – 4.5cm. Basal area ranges from 0.01 – 1.1m². Total volume is from 0.06-21.98m³. Basal area ranged from 0.95 to 0.01 m² with *Milicia excelsa* having the least value while the highest was number of 12.00 m² in *Terminalia cattapa*, *Terminalia superba*; *Talbabua rosia* *Eucalyptus camaldulensis* had the highest mean height value. *Milicia excelsa* had the highest mean dbh of 345cm while *Millettia griffoniana* recorded the least dbh of 28.6cm. *Talbabua rosia* had the highest mean height of 17.80 cm while *Millettia griffoniana* had the least mean height value of 4.5.cm. (Table 3b).

Species diversity indices for the study sites: Biodiversity indices are computed to show the level of diversity and abundance of species in different locations. Shannon's diversity typical values are generally between 1.5 and 3.5 in most ecological studies and the index is rarely greater than 4 (Magurran, 2004). It measures species abundance and richness so as to quantify the diversity of woody species (Magurran, 2004). The value of the Shannon's maximum diversity (H') obtained for CRIN is 2.36. This implies that the species diversity of the area is

moderate. This implies that diversity index in CRIN is moderate as revealed by the H' value (Table 4a). The Shannon diversity value for IITA is 3.04. It indicates that the species diversity in IITA is very high which is close to the upper limit value of 3.5 (Table 4). This corroborates the findings of Oladoye (2012). The high diversity of plant in IITA could be attributed to favorable climatic condition of high annual rainfall amount received in the area just like in most Southern part of Nigeria (Ayodele and Lameed, 1999) and protection over many years of good management. Species diversity indices affect the dominance and evenness. Therefore, as the richness increases, evenness is also affected.

Table 2a: Species and family of trees encountered in CRIN

Plant Species	Family	Number
<i>Milicia excelsa</i>	Moraceae	2
<i>Triplochiton scleroxylon</i>	Malvaceae	8
<i>Cola gigantea</i>	Malvaceae	2
<i>Cola nitida</i>	Sterculaceae	1
<i>Delonix regia</i>	Fabaceae	12
<i>Terminalia superba</i>	Combretaceae	12
<i>Sterculia tragachanta</i>		2
<i>Peltophorum pterocarpium</i>	Fabaceae	23
<i>Hildegardia barteri</i>	Malvaceae	2
<i>Roystonea regia</i>	Arecaceae	3
<i>Ficus thonningii</i>	Moraceae	3
<i>Newbouldia laevis</i>	Bignoniaceae	1
<i>Shorea roxburghii</i>	Dipterocarpaceae	2
<i>Anacardium occidentale</i>	Anacardaceae	1
<i>Polyalthia longifolia</i>	Annonaceae	29
<i>Blighia sapida</i>	Sapindaceae	1
<i>Terminalia randii</i>	Rubiaceae	7
<i>Ficus exasperate</i>	Moraceae	3
<i>Albizia zygia</i>	Fabaceae	1
<i>Acacia ferdherbia</i>	Fabaceae	1
<i>Morinda lucida</i>	Rubiaceae	1

Table 2b: Species and family of trees encountered in IITA

Plant Species	Family	Number
<i>Cola gigantea</i>	Malvaceae	3
<i>Blighia sapida</i>	Sapindaceae	1
<i>Albizia adantifolia</i>	Fabaceae	4
<i>Pterocarpus spp</i>	Fabaceae	1
<i>Albizia zygia</i>	Fabaceae	1
<i>Spondia monbin</i>	Anacardiaceae	5
<i>Erythrophleum suaveolens</i>	Fabaceae	3
<i>Millettia griffoniana</i>	Fabaceae	1
<i>Triplochiton scleroxylon</i>	Malvaceae	1
<i>Anthrocephalus cadamba</i>	Fabaceae	1
<i>Anogeissus leiocarpum</i>	Combretaceae	2
<i>Acacia spp</i>	Fabaceae	2
<i>Terminalia superba</i>	Combretaceae	2
<i>Ceiba pentandra</i>	Malvaceae	4
<i>Coco nucifera</i>	Arecaceae	2
<i>Hildegardia barteri</i>	Malvaceae	2
<i>Milicia excelsa</i>	Moraceae	1
<i>Terculia Africana</i>	Moraceae	3
<i>Eucalyptus camadulence</i>	Myraceae	4
<i>Terminalia cattapa</i>	Combretaceae	2
<i>Albizia lebbeck</i>	Fabaceae	1
<i>Cacia fistulia</i>	Fabaceae	2
<i>Talbabua rosia</i>	Fabaceae	4
<i>Delonix regia</i>	Fabaceae	1

Table 3a: Tree species Distribution and Diversity in CRIN

Species	Frequency	Total DBH(cm)	Mean DBH	Total Height(cm)	Mean Height	Total B.A.	Mean B.A	Total Vol	Mean Vol
Acacia ferdherbia	1	97.1	97.1	14.5	14.5	0.08	0.08	1.09	1.09
Albizia zygia	1	146	146	17.8	17.8	0.17	0.17	3.02	3.02
Anacardium occidentale	1	160.9	160.9	11.6	11.6	0.21	0.21	2.39	2.39
Blighia sapida	1	156.7	156.7	17.5	17.5	0.20	0.20	3.42	3.42
Cola gigantean	3	566.7	188.9	62.2	20.74	0.85	0.28	17.86	5.95
Cola nitida	2	203.1	101.55	26.9	13.45	0.20	0.10	3.52	1.76
Delonix regia	6	720.5	120.09	86.9	14.44	0.80	0.13	11.99	2.00
Ficus exasperate	1	17.8	17.8	23.1	23.1	0.00	0.00	0.06	0.06
ficus exasperate	1	55.1	55.1	6.7	6.7	0.02	0.02	0.16	0.16
Ficus thonningii	2	196.5	98.25	33.6	16.8	0.15	0.08	2.58	1.29
Hildegardia barteri	1	142.3	142.3	8.1	8.1	0.16	0.16	1.31	1.31
Milicia excelsa	1	205.1	205.1	22.1	22.1	0.33	0.33	7.40	7.40
Morinda lucida	1	101.8	101.8	13.5	13.5	0.08	0.08	1.11	1.11
Newbouldia laevis	1	72.6	72.6	11.1	11.1	0.04	0.04	0.47	0.47
Peltophorum pterocarpium	24	3593.5	149.73	254.5	10.60	4.84	0.20	52.86	2.20
Polyalthia longifolia	30	1556.14	51.88	294.9	9.83	0.80	0.03	9.96	0.33
Roystonea regia	1	165.5	165.5	16.5	16.5	0.22	0.22	3.60	3.60
Shorea roxburghii	1	179.4	179.4	181.1	181.1	0.26	0.26	46.38	46.38
Sterculia setigera	1	184.7	184.7	20.5	20.5	0.27	0.27	5.56	5.56
Sterculia tragacantha	1	76.5	76.5	10.9	10.9	0.05	0.05	0.51	0.51
Terminalia randii	11	1173.1	106.65	185.2	16.84	1.73	0.16	42.69	3.88
Terminalia superb	1	126.1	126.1	10.1	10.1	0.13	0.13	1.28	1.28
Terminalia superb	9	1530.7	170.09	128.4	14.27	2.66	0.30	39.82	4.42
Triplochiton scleroxylon	12	1743.5	145.29	244.8	20.4	2.84	0.24	68.27	5.69
TOTAL	114	13171.34	115.54	1702.5	14.94	17.07	0.15	327.29	2.87

Table 3b Tree Species Distribution and Diversity in IITA

IITA Species	Frequency	Total DBH(cm)	Mean DBH	Total Height(cm)	Mean Height	Total B.A.	Mean B.A	Total Vol	Mean Vol
Acacia spp	2	104.4	52.20	17.95	8.98	0.04	0.02	0.40	0.20
Albizia ferruginea	5	217.5	43.50	31.3	6.26	0.09	0.02	0.59	0.12
Albizia lebeck	1	106.8	106.80	13.3	13.30	0.09	0.09	1.21	1.21
ALbizia zygia	1	37.7	37.70	5.2	5.20	0.01	0.01	0.06	0.06
Anogeissus leiocarpus	2	176.1	88.05	22.8	11.40	0.12	0.06	1.41	0.70
Anthrocephalus cadamba	1	59.3	59.30	10.1	10.10	0.03	0.03	0.28	0.28
Blighia sapida	1	35.5	35.50	5.5	5.50	0.01	0.01	0.06	0.06
Cacia fistula	2	249.1	124.55	31.9	15.95	0.25	0.12	3.97	1.98
Ceiba pentandra	3	187.9	62.63	24	8.00	0.12	0.04	0.99	0.33
Cici nucifera	2	161.3	80.65	25.9	12.95	0.10	0.05	1.34	0.67
Cola gigantean	3	134	44.67	21.2	7.07	0.06	0.02	0.46	0.15
Delonix regia	1	356	356.00	21.8	21.80	1.01	1.01	21.98	21.98
Erythrophleum suaveolens	3	235	78.33	33.1	11.03	0.16	0.05	1.82	0.61
Eucalyptus camaldulensis	4	491.1	122.78	65.3	16.33	0.54	0.13	9.38	2.34
Hildegardia barteri	2	93.9	46.95	10	5.00	0.04	0.02	0.18	0.09
Milicia excelsa	1	345	345.00	4.9	4.90	0.95	0.95	4.64	4.64
Milletia griffoniana	1	28.6	28.60	4.5	4.50	0.01	0.01	0.03	0.03
Pterocarpus spp	1	107.5	107.50	8.1	8.10	0.09	0.09	0.74	0.74
Spondia mombian	4	225.5	56.38	29.5	7.38	0.12	0.03	1.04	0.26
Talabua rosia	4	729.1	182.28	71.2	17.80	1.12	0.28	20.63	5.16
Terminal superb	2	127.9	63.95	18.7	9.35	0.07	0.03	0.62	0.31
Terminalia cattapa	2	230.1	115.05	24	12.00	0.23	0.11	3.01	1.50
Treculia Africana	3	94.1	31.37	19.7	6.57	0.03	0.01	0.18	0.06
Triplochiton scleroxylon	1	61.8	61.80	11.6	11.60	0.03	0.03	0.35	0.35
TOTAL	52	4595.2	88.37	531.55	10.22	5.29	0.10	75.35	1.45

The species dominance value of 0.15 and 0.05 respectively indicates a low dominance of any particular species in the two study sites. This means that no particular species dominates the area. Evenness index values usually ranges from 0 to 1. It is equal to 1 when all the species have the same abundance and tends to zero when the near total flora is mainly consisted of a species. The evenness index calculated

for both sites differs. The evenness value for IITA was 0.87 while that of CRIN was 0.44.

The value from IITA tends towards 1 than that from CRIN. This implies that almost all the species encountered in IITA are almost equally represented as reflected in recurrent frequency of 1 and 2 (table 1b). This is not so in CRIN where a species is having a

frequency of 30 and thus, the low evenness value tending more towards zero.

Table 4a: Species diversity indices for CRIN

Indices	Values
CRIN	
Individuals	114
Dominance	0.15
Shannon	2.36
Evenness	0.44
Equitability	0.74

Table 4b: Species Diversity Indices IITA

Indices	Values
IITA	
Individuals	52
Dominance	0.05
Shannon	3.04
Evenness	0.87
Equitability	0.96

Comparison of ecological Analysis of the study sites:

A total number of 166 individual trees were enumerated in the two study sites; 114 individuals in CRIN and 52 individuals in IITA. The 52 individuals in IITA belonged to 24 species and are of varied families (8) compared to CRIN and where 114 individuals belonged to only 20 species of just 12 families. This finding contradicts the findings of Oladoye (2012) who reported that the species richness depends on the number of species per units' area. The 52 individuals enumerated in IITA belonged to different species indicating a high abundance of diverse species. The 114 individuals enumerated in CRIN belonged to 20 species only. This implies that diversity in the individual trees was low and many of the trees were of the same species. The high species richness of IITA could be due to geological location and most importantly protection over a long period of time as one of the limitations in working in IITA was the constrain of not being allowed to cross lawn and having access to their protected trees.

Conclusion: This study yields a list of tree species used in beautification and ameliorating harsh weather condition along the streets and walk ways. Thus, revealing good and efficient management of tree resource within the institutes and subsequently, helped in tree biodiversity conservation. The continuous involvement of individuals, institutions, private organizations and non-governmental organization should be adequately rewarded to encourage them to do more in terms of tree planting in and around their buildings and the city.

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