Diversity and Abundance of Edible Wild Fruit and Leaf Plants in Parts of Forest and Savanna Eco-regions, Nigeria.

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ABSTRACT

Wild foods are important sources of nutrition for one out of six people worldwide and it remains an open access source of food and income, especially to vulnerable group such as the resource-poor and malnourished children. Different ecological zones in Nigeria are endowed with diverse edible fruits and leaves and hence their diversity and abundance differ. With the previous and current rate of deforestation particularly in the African continent and specifically in Nigeria, the diversity and abundance of these invaluable forests –derived foods across the forest and savanna ecozones in Nigeria are unknown. An inventory of forest-derived edible fruits and leaves was conducted using a systematic line transect in two (2) selected forest reserves in each ecological zone. Five line transects of 515 m in length, with a distance of at least 150 m between two parallel transects was used. Five sample plots of 25 m x25 m in size were laid in alternate position along each transect at 100 m interval. A total of 25 sample plots were laid in each of the selected forest reserves. In each sample plot, all edible fruits and leaves encountered were identified and their frequency recorded. The frequency of the species per ha was used to compute the relative species abundance and Shannon weiner diversity index. The species diversity across the ecological zones was compared using one-way analysis of variance. Shannon-weiner diversity index (3.49) for the rainforest edible wild fruits and leaves is significantly higher ($P \leq 0.05$) than in all the other ecological zones. This is followed by Guinea savanna (3.10), Derived savanna (3.02), Sudan savanna (2.91), and Sahel savanna (2.83) while the mangrove forest has the lowest diversity index (2.53). Assessing species diversity helps in understanding the resilience of forest ecosystems. This knowledge is crucial for fostering environments that can withstand and recover from adverse events. Policy makers rely on scientific studies to design regulations and conservation strategies. This research provided evidence-based insight necessary for informed decision-making to protect forest reserves

Key words: Edible; fruits; leaves; diversity; abundance

INTRODUCTION

The contribution of wild fruits, nuts, seeds, vegetables and other classes of edible product to the local diet in developing countries and their potential in overcoming or ameliorating prevailing food problems are enormous. Forest –derived edible non-forest resources particularly fruits and leaves are critical in the life of the rural dwellers and by extension to people in the peri-urban and urban communities in Nigeria. They are among the most widely used non-timber forest products (NTFPs) in the forest and savanna ecological zones (Mangrove forests, Rain forests, Derived savanna, Guinea savanna, Sudan savanna, and Sahel savanna) in Nigeria (Nwala et al: 2023). They are important sources of nutrition, medicine and income for the users (Agrawal et al; 2017). Malnutition in all its forms remains a global challenge particularly in the African sub-

region. In 2020, it was estimated that 22% (149, 2 million) of children fewer than 5 years of age were stunted, 45.4 million were wasted and 38.9 million were overweight (FAO, 2021). Wild foods are important sources of nutrition for one out of six people worldwide (Vira et al; 2015) and it remains an open access source of food and income, especially to vulnerable group such as the resource-poor and malnourished children (McGarry et al; 2009). The food resources in the forests are an important component of household subsistence (Arnold and Perez, 2001) and contribute immensely to household food nutrition and security (Shackleton and Shackleton, 2004). Different ecological zones in Nigeria are endowed with diverse edible fruits and leaves, and hence their diversity and abundance differ. Edible fruits and leaves are available either on emergency; seasonally or year-round to meet important dietary needs of the people in Nigeria. They add diversity and flavours to the diets. According to Talukdar et al (2021), more than three – quarters of the rural populations in most developing countries are dependent on non-timber forest resources for their nutrition and primary health. Moreover, the forest-derived foods provide safety nets against adverse effects of climate change, which often results in insecurity and thus accelerates the vulnerability in the agricultural sector (Talukdar et al; 2021). As a result of COVID -19, a pandemic of great proportion that has lead to many lockdowns and economic downturn across the globe since 2019, increasing number of people across Nigeria consume more of the edible fruits and leaves from the forests. This is because; it is evident and generally believed to have the potential to boost the immune system that provides resistance to COVID-19 and other infections. With the previous and current rate of deforestation particularly in the African continent and specifically in Nigeria, the diversity and abundance of these dependable forests –derived foods across the forest and savanna ecozones in Nigeria are unknown. Information regarding the diversity and status of abundance are critical for policy makers in the forestry sub-sector for a decision to undertake aggressive conservation and restoration of the edible forest-derived fruit and leaves species which no doubt may have already been threatened as far as their biodiversity and abundance are concerned.

The aim of this article therefore is to assess the diversity and abundance of edible forest-derived fruits and leaves plant species in parts of Mangrove forests, Rain forests, Derived savanna, Guinea savanna, Sudan savanna and Sahel savanna ecozones of Nigeria. This is with a view to recommending appropriate conservation measures for their sustainability. Research problems

Wild edible plants have narrow distribution ranges and are prone to genetic depletion or extinction following habitat modification. With the previous and current rate of deforestation particularly in the African continent and specifically in Nigeria, the diversity and abundance of edible wild plants across the major ecozones are unknown

Research objectives

The specific objectives of the research are to: (1) identify major edible wild fruits and leaves in selected forest reserves across major ecological zones in Nigeria; (2) determine the diversity and abundance of the edible wild fruits and leaves in the study area and (3) compare the diversity and abundance of the edible wild fruits and leaves.

Research questions

1. What are the species of edible wild fruit and leaves that are native to each of the major ecological zones in Nigeria?
2. How diverse and abundant are the edible wild fruits and leaves that are native to major ecological zones in Nigeria?
3. Which of the ecological zones in Nigeria have more diverse and abundant edible wild fruits and leaves than the other?

Justification for the Research

The importance of edible wild fruits and leaves as food safety nets cannot be overstressed. They are available for the rural dwellers either on emergency, seasonally or all year round to meet important dietary needs.

Information regarding the diversity and abundance of edible wild fruits are critical for policy making and for a decision to undertake aggressive conservation and restoration that will ensure their sustainability.

MATERIALS AND METHODS

Study Area

Nigeria is located on the West coast of Africa between latitudes 3^0 15^1 to 13^0 N and longitudes 2^0 59^1 to 15^0 00 E. The ecological zones consist of Mangrove swamp and Coastal vegetation, Freshwater swamp Forest, Lowland Rain Forest, Derived Savanna, Guinea Savanna, Sudan Savanna and Sahel Savanna. Mangrove forest is found along the coastal and delta areas of Nigeria where the water is brackish. The lowland rain forest is located north of the freshwater swamp forest and south of the derived savanna ecological zone to the north. The derived savanna constitutes an east-west band between the lowland rain forest and Guinea savanna ecological zones, and is characterized by dense populations. The Guinea savanna is the most extensive vegetation in the middle belt of Nigeria, and consists of a mixture of trees and grass. It contains parkland savanna, gallery forests and derived savanna. The Sudan savanna belt is found to the Northern parts of Nigeria, and stretches from the Sokoto plains through the Northern section of the high plains of Nigeria to the Chad basin. The Sahel savanna is found to the extreme Northwest and Northeast of Nigeria, where the annual rainfall is less than 600 mm and with dry seasons exceeding 8 months. Typically the vegetation consist of grasses, open thorn shrub savanna with scattered trees, 4 -9 m in height, most of which are thorny, and extensive grasses (see Fig. 1)

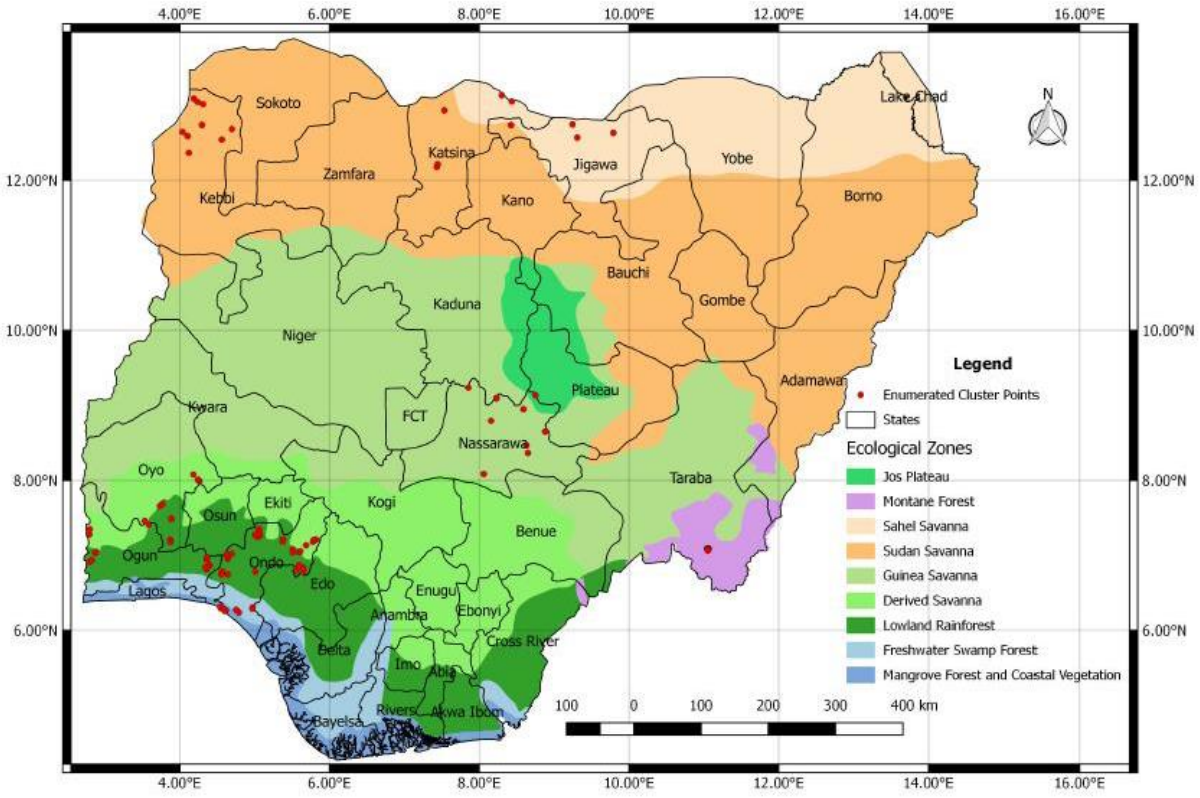

Fig 1 Ecological zones in Nigeria

Source: FORMECU, Federal Department of Forestry, Nigeria

Sampling and Field inventory

A two stage sampling technique was employed to sample and identify forest-derived fruits and leaves in major ecological zones in Nigeria. In the first stage, one state was purposively selected in each ecological zone. The second stage involved a purposive selection of two forest reserves from each of the selected state. Therefore, a

total number of 12 forest reserves were selected for the study. The selection of the study sites was restricted to forest reserves because government regulations largely prevent illegal felling in these reserves. An inventory of forest-derived edible fruits and leaves was conducted using a systematic line transect in the two (2) selected forest reserves in each ecological zone. Five line transects of 515 m in length, with a distance of at least 150 m (depending on the size of forest reserve) between two parallel transects was used. Five sample plots of 25 m x25 m in size was laid in alternate position along each transect at 100 m interval. A total of 25 sample plots were laid in each of the selected forest reserves. In each sample plot, all edible fruits and leaves encountered were identified and their frequency recorded.

Research hypothesis

Null Hypothesis (Ho): There is no significant difference in the abundance and diversity of edible wild fruits and leaves between eco-regions in Nigeria

Alternative Hypothesis (H_A): There are significant differences in the abundance and diversity of edible wild fruits and leaves between eco-regions in Nigeria.

Data computation

The relative density of all the edible wild fruits and leaves encountered was determined. Species relative density (number of a given species expressed as percentage of all species present), it is expressed as:

$$RD = \frac{n_i}{N} \times 100$$

Where: RD (%) = species relative density; ni = number of individuals of species i; N = total number of all species in the entire community

Species diversity index was used to estimate the diversity of the edible wild fruits and leaves. The index takes into account the number of species in a habitat (richness) and their relative abundance (evenness). It is expressed as:

$$H' = -\sum_{i=1}^{S} p_i \ln(p_i).$$

Where: H' = Shannon-Wiener diversity index; P_i = proportion of S made up of the i^{th} species, ln = natural logarithm

Statistical analysis of data

Diversity and abundance of forest-derived fruits and leaves between the ecological zones were compared using one way analysis of variance (ANOVA). Where significant difference exists, mean separation was carried out by Least Significance Difference (LSD)

RESULTS AND DISCUSSION

Table 1 Edible wild fruits and leaves in selected forest reserves across major ecological zones in Nigeria

Mangrove Forest	Rain Forest	Derived savanna	Guninea savanna	Sudan savanna	Sahel savanna
Bruguira gynorhiza	Chrysophyllum albidum	Persea americana	Ficus sycomorus	Adansonia digitata	Dentarium senegalensis
Nypa fruticans				Balanite	
Avicennia	Dennettia	Parkia	Nauclea	aegyptiaca	Adansonia

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marina Phizophora sp Sonneratia caseolaris Acrostichum aureum Artocarpus altilis Aframomum sp Piper nigrum Tetrapleura tetraptera Irvingia wombulu *Murraya koenigii *Occimum gratissimum *Veronia amygdalina *Talinum triangulare Amaranthus viridis *Solanecio biafrae *Corchorus olitorius	tripetala Dialium guineense Lecaniodiscus cupanioides Polyphia sapida Thaumatococcus danielli Cola milleni Sphenocentrum jollyanu Cola hispida Icacina trichantha Irvingia gabonensis Sterculia tragacantha Dacryodes edulis Spondia mombin Capsicum annuum Xylopia aethiopica Irvingia wombulu Plukenetia conophora Garcinia kola Monodora myristica Treculia Africana Brachystegia eurycoma Afzelia africana	biglobosa Blighia sapida Treculia africana Cola millenii Cola nitida Xylopia aethiopica Spondia mombin Capsicum annuum Cola hispida Artocarpus altilis Pentaclethra macrophylla Afzelia africana *Gnetum africanum *Piper guineense *Pterocarpus mildbraedii *Gongronema latifolium *Afzelia africana *Peperomia pellucida *Asystasia gangetica	latifolia Annona senegalensis Parkia biglobosa Gardenia aqualla Fiscus sur Vitex simplicifolia Prosopis africana Vitellaria paradoxa Afzelia africana Vitex doniana Lophira lanceolata Oncoba spinosa Borassus aethiopum Combretum glutinosum Ficus carica Flueggea virosa Rhus virens Livistona chinensis *Vitex simplicifolia *Afzelia africana	Ziziphus mauritiana Ricinodendron africana Parkia biglobosa Tamarindus indica Vitex doniana Phoenix dactylifera Hyphaene thebaica Ziziphus spina-christi Borassus aethiopum Sclerocarya birrea Diospyros mespiliformis Acacia seyal Bauhinia thoningii Crateva religiosa Cucumis prophetarum Ceratotheca sesamoides Mitracarpus verticillatus Senna occidentalis	digitata Parkia biglobosa Tamarindus indica Balanite aegyptiaca Cucumis prophetarium Ceratotheca sesamoides Mitracarpus verticillatus Senna occidentalis Annona senegalensis Momordica balsamina Ficus platyphylla Lagenaria siceraria Cenchrus biflorus Ziziphus spina-christi *Adansonia digitata *Leptadenia hastate *Momordica balsamina *Vigna unguiculata *Ziziphus spina-christi

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	Artocarpus altilis Elaeis guineensis *Macaranga barteri *Hyptis suaveolens *Vernonia amygdalina *Talinum triangulare *Ocimum gratissimum *Ocimum basilicum *Amaranthus viridis *Solanecio biafrae *Corchorus olitorius *Solanum nigrium *Gongronema latifolium *Emilia coccinea *Crassocephalum rubens *Piper guineense *Pterocarpus mildbraedii *Sesamum radiatum *Lactuca virosa	*Vernonia amygdalina *Corchorus olitorius *Talinum triangulare * Amaranthus viridis *Emilia coccinea *Lactuca virosa *Sesamum radiatum *Solanum nigrum	*Combretum glutinosum *Machaerium nyctitans *Adansonia digitata *Ceiba pentandra *Ceiba speciosa *Ficus sur *Cissus populnea *Piliostigma thoningii *Pterocarpus santalinoides *Celosia argentea *Daniellia oliveri *Emilia coccinea *Milicia excelsa	*Adansonia digitata *Vitex doniana *Ziziphus spina-christi *Vigna unguiculata *Momordica balsamina *Balanites aegyptiaca *Leptadenia hastata *Hibiscus sabdariffa	

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	*Triplochiton scleroxylon *Peperomia pellucida *Asystasia gangetica *Gnetum africanum *Baphia nitida				
N = 18	N= 46	N= 28	N= 34	N= 28	N= 20

*Edible wild leaves

Table 2 Relative Abundance (%) of edible wild fruits and leaves in selected forest reserves across major ecological zones in Nigeria

Ecological zone	Wild fruits/leaves	Frequency of occurrence /ha	Relative abundance (%)
Mangrove Forest	Nypa fruitaus	32	13.0
	Sonneratia caseolavis	25	11.6
	Tetrapleora tetrapter	16	7.4
	Bruguira gynorhiza	15	7.0
	*Murvaya keonigis	21	9.5
	*Veronia amygdalina	11	5.1
Rain Forest	Irvingia gabonensis	12	3.8
	Thaumatococcus danielli	10	3.2
	Poliphia sapida	8	2.5
	Cola milleni	8	2.5
	Icacina trichantha	8	2.5
	*Talinum triangulare	25	8.0
	*Amaranthus viridis	13	4.1
	*Corchorus olitorius	12	3.8
	*Occimum		

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	gratissium	12	3.2
Derived Savanna	Parkia biglobosa	22	7.8
	Capsicum annum	10	3.5
	Bliphia sapida	6	2.1
	Spondia mombin	6	2.1
	*Corchorus olitorius	40	14.2
	*Amarathus viridis	20	7.1
	*Emilea coccinea	15	5.3
Guinea savanna	, Nauclea latifolia	58	9.3
	Annona senegalensis	46	7.4
	Parkia biglobosa	42	6.7
	Gardenia aqualla	38	6.1
	Ficus sycomorus	31	5.4
	*Afzelia africana	33	3.8
	*Daniella oliveri	8	1.3
	*Emilia coccinea	10	1.6
Sudan savanna	Adamsonia digitata	33	10.8
	Balamite aegyptiaca	30	9.8
	Tamarindus indica	12	3.9
	Vitex doniana	11	3.5
	Ziziphus spina-christi	12	3.9
	*Balamite aegyptiaca	30	9.8
	*Leptadenia hastate	10	3.2
	*Adamsonia digitata	33	10.8
	*Vitex doniana	11	3.5
Sahel savanna	Adamsonia digitata	11	7.3
	Tamarindus indica	14	9.3

	Balamites aegyptiaca	9	6.0
	Senna occidentalis	10	6.7
	*Adamsonia digitata	11	7.3
	*Momordica balsamina	6	4.0
	*Ziziphus spina-christi	8	5.3

*Edible leaves

Table 3 Shannon wiener diversity index of edible wild fruits and leaves in selected forest reserves across major ecological zones in Nigeria

Ecological zone	Diversity index
Rain forest	3.49[a]
Guinea savanna	3.10[b]
Derived savanna	3.02[c]
Sudan savanna	2.91[d]
Sahel savanna	2.83[e]
Mangrove forest	2.53[f]

Means with dissimilar superscript in a column are significantly different (P≤ 0.05)

The edible fruits and leaves encountered in selected forest reserves across major ecological zones in Nigeria are presented in Table 1.

As indicated, mangrove forest, rainforest, derived savanna, Guinea savanna, Sudan savanna and Sahel savanna are represented by 18, 46, 28, 34, 28 and 20 respectively. As shown in Table 2, in the Mangrove, Nypa fruiticans(13%), Sonneratia caseolaris (11.6%), Tetrapleora tetrapter (7.4%) and Bruguira gynorhiza (7.0%) were more abundant edible fruits while Murvaya keonigis (9.5%), Occimum gratisimum (4.6%) and veronica amygdalina (5.1) were more abundant edible leaves .

In the rain forest, Irvingia gabonensis (3.8%), Thaumatococcus danielli (3.2%), Polyphia sapida (2.5%), Cola milleni (2.5%) and Icacina trichanta (2.5%) were the more abundant forest – derived edible fruits while Talinum triangulare (8.0%), Amarathus viridis (4.1%), Corchorus olitorius (3.8%) and Occimum gratissium (3.2%) were more abundant forest - derived edible leaves.

In the Derived savanna, Parkia biglobosa (7.8%), Capsicum annum (3.5%), Persea Americana (2.14%), Bliphia sapida (2.14%) and Spondia mombin (2.14%) were more abundant forest - derived edible fruits while Corchorus olitorius (14.28%), Talinum triangulare (8.9%), Amarathus viridis (7.14%) and Emilea coccinea (5.3%) were more abundant forest - derived edible leaves.

In the Guinea savanna, Nuclea latifolia (9.3%), Annona senegalensis (7.4%), Parkia biglobosa (6.76%), Gardenia aqualla (6.1%) and Ficus sycomorus (5.47%) were more abundant forest – derived edible fruits while Afzelia africana (3.86%), Daniella oliveri (1.28%) and Emilia coccinea (1.61%) were more abundant forest - derived edible leaves.

In the Sudan savanna, Adamsonia digitata (10.7%), Balamite aegyptiaca (9.8%), Tamarindus indica (3.92%), and Vitex doniana (3.5%), Ziziphus spina-christi (3.9%), Balamite aegyptiaca (9.80%) and Leptadenia hastate (3.2%) were the more abundance wild edible leaves

In Sahel savanna, Adamsonia digitata (7.3%), Tamarindus indica (9.3%), Balamites aegyptiaca (6.04%) and Senna occidentalis (6.7%) were the more abundant forest- derived edible fruits while Adamsonia digitata (7.3%), Momordica balsamina (4.02%) and Ziziphus spina-christi (5.3%) were the abundant forest- derived edible leaves.

As shown in Table 3, the Shannon-weiner diversity index (3.49) for the rainforest edible wild fruits and leaves is significantly higher ($P \leq 0.05$) than in all the other ecological zones. This is followed by Guinea savanna (3.10), Derived savanna (3.02), Sudan savanna (2.91), and Sahel savanna (2.83) while the mangrove forest has the lowest diversity index (2.53). The range of Shannon weiner diversity index (H^1) obtained in the study is consistent with the previous studies (Onyekwelu et al 2001), which reported that H^1 index mostly ranges from 1.5 - 3.5. Greater species richness and diversity makes an habitat more sustainable and stable. More diverse the ecosystem is the capacity to withstand anthropogenic and environmental stress like drought or invasive infestations. Species abundance makes an environment capable of responding to any catastrophe (Cebrian 2009). The findings in this study therefore implied that the rainforest will be more sustainable, stable, resilient and capable of responding positively to disturbances than other ecological zones while the mangrove forest will be more fragile and more vulnerable than other ecological zones like the Derived savanna, Guinea savanna, Sudan and Sahel savanna which are more diverse. In species rich community, every species can use a distinct part of the resources available as per their requirement. For example, plants with small roots can take in water and nutrients from shallow soil, and plants with deeper roots can tap with deeper soil. Rich species diversity is crucial for the survival of mankind. Humans get plenty of products from nature like fruits, cereals, meat, wood, fibre, resins, dyes, medicine, antibiotics, etc. Pollinators, symbiotic relationships, decomposers, every species carry out completely unique functions that are irreplaceable (Cesarz, 2017). Changes in structural attributes of forest have been attributed to disturbance gradients involving mostly a single factor that is limited in extent e.g selective logging. Similarly, it has also been argued that species richness and diversity are invariably affected by frequent and fluctuating disturbances of low-intensity e.g grazing and browsing , firewood and fodder extraction suggesting the importance of combined effects of multiple low-intensity factors (Zhu et al; 2007).

Disturbance can have positive and negative impact on forest by altering the environmental condition. Disturbance has a positive influence on diversity as an intermediate level of disturbance, which increases forest diversity (Sapkota et al; 2009). However, too much disturbance leads to the loss of late succession species, where as too little leads to exclusion of species adapted to colonize ecosystems immediately after disturbance (Sheil and Burslem; 2003). Connell (1978) indicated that in tropical rain forests, higher tree diversity occurs either at intermediate stage after large disturbances or with smaller disturbances that are neither frequent nor infrequent. Overall, an intermediate disturbances supports community co-existence (Molino and Sabatier; 2001). It is a common knowledge and observation that many of the natural forest in the sub-Saharan Africa and in particular Nigeria have suffered and currently victims of multiple disturbances.

CONCLUSION

Forest reserves are key to preserving global biodiversity. Understanding the species diversity is fundamental to developing strategies that protect endangered species and maintain ecosystem balance. Forests provide essential services, including carbon storage water filtration, and soil stabilization, edible fruits, leaves, medicine, dyes, resins bush meat etc. Disturbances that alter species composition can affect these services, with wide-range consequences for both local and global communities.

Assessing species diversity helps in understanding the resilience of forest ecosystems. This knowledge is crucial for fostering environments that can withstand and recover from adverse events. Policy makers rely on scientific studies to design regulations and conservation strategies. This research provided evidence-based insight necessary for informed decision-making to protect forest reserves.

Conservation of ecosystem and genetic resources of target species of edible wild fruits and leaves is particularly important in the tropics where the forests are being subjected to destruction and excessive exploitation. This is more so because of the narrow distribution ranges and often low densities of the edible wild plants, which, because of these characteristics are prone to genetic depletion or extinction following habitat modification. It is therefore recommended that both in-situ and ex-situ conservation of the edible wild plants should be intensified across major ecological zones in Nigeria. Also agroforestry practice using the edible wild plants can contribute to the conservation of biodiversity if local people are encouraged to use edible wild plants in agroforestry practice.

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