Ethnoforestry Knowledge, Utilization and Conservation of Plant Resources in the Southern Zone, Nasarawa State, Nigeria

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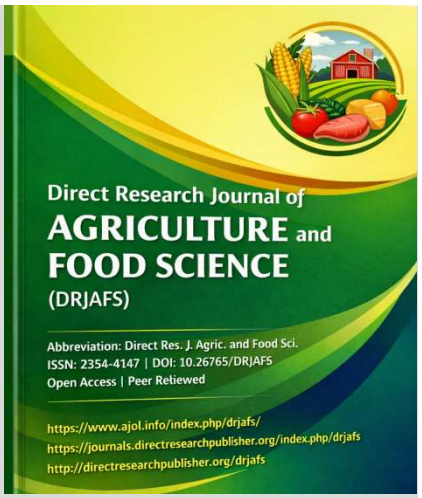
ABSTRACT

Despite rich plant diversity and deep indigenous knowledge in Nasarawa, ethnobotanical resources face severe threats from bark harvesting, bush burning, over-exploitation and deforestation, leading to loss of valuable species like Khaya senegalensis and Afzelia africana and erosion of traditional knowledge, hence the need for systematic assessment and conservation. The study employed mixed-methods. Survey was carried out in 15 purposely selected communities across Lafia, Obi and Awe LGAs of Nasarawa West Senatorial District. A total of 397 respondents knowledgeable in ethnoforestry including herbalists, farmers, forestry officials and elders were selected using purposive sampling from a population of 37,000 using Taro Yamane formula at 5% margin error. Data were collected via structured questionnaire, interview guides, field notebooks and digital camera for documentation of indigenous species. Results show respondents are predominantly active middle-aged males (67.6% male, 67.5% aged 18-45) with 70.8% married, 39.5% secondary and 35.75% tertiary education, mainly farmers (48.06%) earning N20,000-N50,000 (30.49%). Inventory documented 50 species in 23 families, dominated by Fabaceae (6 spp). Bark (45%) and leaves (40%) are most used. Wound healing (35%) and malaria/fever (25%) are major uses. 94.09% use herbs, sourced mainly from forest (45.14%). Knowledge is transmitted orally (68.2%). 99.2% are willing to attend training, 95.1% to share identification knowledge. Threats are bush burning (36.7%) and deforestation (33.3%), leading to price increase (41.3%). The study confirms rich diversity of 50 species but high vulnerability due to 45.14% forest dependence, 45% bark use and 68.2% oral transmission, under threats of bush burning 36.7% and deforestation 33.3%, causing scarcity 30%, price increase 41.3% and seasonal variability 30.7%. However, 81.4% community support, 99.2% willingness for training and 95.1% willingness to share knowledge provide strong social foundation. It is therefore recommended that NSUK establish the 0.5ha participatory ethnoforestry garden as ex-situ gene bank prioritizing Khaya, Afzelia and Milicia, adopt workshop-based trust building, document oral knowledge urgently, promote domestication to reduce wild harvesting, and enforce community by-laws against bush burning.



Keywords: *Ethnoforestry Knowledge, Utilization, Conservation, Plant Resources and Nasarawa State*

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INTRODUCTION

Forests have always played a vital role in human civilization, providing a range of ecological, cultural, and economic services essential to life and development (FAO, 2020). Over the centuries, societies across Africa have developed intricate systems of managing and conserving forest resources through traditional knowledge and practices embedded in their cultural heritage (Adebisi, 2018). Ethnoforestry emphasizes the interdependence between humans and forests, highlighting how traditional ecological knowledge contributes to sustainable forest use (Egunjobi, 2016). In Nigeria, where over 400 ethnic groups possess diverse cultural ties to the land, this approach offers a pathway for reconciling biodiversity conservation with local livelihoods (Ola-Adams, 2019). However, modernization, urbanization, and unsustainable exploitation have eroded much of this indigenous knowledge, threatening not only the forests but also the communities that depend on them (Adedayo and Oko, 2017).

An ethno forestry garden is a well-structured tree base establishment for the conservation of plants under scientific administration for purposes of education and research, in association with libraries, herbaria, laboratories, and museums as are essential to its particular enterprise. Each garden generally cultivates its own special fields of interests reliant on its personnel, location, extent, available funds, and the terms of its charter. It may include greenhouse, an herbarium, an arboretum and other divisions of grounds (Alabi *et al.,* 2023). It is also an outline to biological systems that can heal cities and its inhabitants through bioremediation, living architecture, and innovative water management with emphasis on an overview of urban toxicology, environmental issues, environmental justice, phytoremediation, bio-filtering, use of plant species and tree, grass, plant selection for pollution reduction (McDonough and Micheal, 2017)

Nigeria's forest ecosystems are under immense pressure from deforestation, agricultural expansion, illegal logging, and infrastructural development (FRIN, 2019). The rate of forest loss is estimated at over 400,000 hectares annually, one of the highest in Africa (FAO, 2020). Establishing an ethno-forestry garden can serve as a practical response to these challenges by conserving indigenous species while providing a platform for environmental education and community engagement (Egbewole *et al.,* 2016). The integration of traditional ecological knowledge in forest management aligns with the global recognition of the importance of local participation in biodiversity conservation (CBD, 2011). Local communities possess detailed knowledge about plant taxonomy, soil fertility, and ecosystem dynamics, which modern science often overlooks (Rotowa, 2018). Harnessing such knowledge in an institutional setting like a forest garden promotes inclusivity and ensures that conservation efforts are culturally relevant (Jayeoba, 2019). Moreover, the establishment of such gardens aligns with the Sustainable Development Goals, particularly Goal 15, which calls for the protection and restoration of terrestrial ecosystems (UNDP, 2015). It also supports national forest policy objectives aimed at achieving sustainable forest management and community-based conservation (FME, 2019). By linking traditional forest use with modern conservation science, ethnoforestry gardens embody a holistic model for sustainable natural resource management (Egbewole *et al.,* 2016). The educational function of ethnoforestry botanic gardens cannot be overstated. They serve as centers for teaching taxonomy, ethnoforestry, and forest ecology while promoting environmental consciousness among the public (Heywood and Davis, 2017). In addition, these gardens provide spaces for cultural revival, enabling communities to maintain rituals, crafts, and medicinal practices tied to forest plants (Rotowa, 2019). Such integration of education, conservation, and culture fosters a sense of ownership and stewardship among local people (Egunjobi, 2016).

From an ecological standpoint, ethnoforestry gardens contribute to in-situ and ex-situ conservation of endangered and economically valuable species (Okonkwo and Onyekwelu, 2017). They can serve as genetic reservoirs for indigenous trees like *Milicia excelsa* (iroko), *Khaya senegalensis* (mahogany), and *Irvingia gabonensis* (ogbono), which face depletion in the wild (Adebisi, 2018). Conservation through cultural representation enhances species survival while maintaining the integrity of local traditions (Adedayo, 2019). Socio-economically, these gardens can generate employment, boost ecotourism, and promote small-scale enterprises based on non-timber forest products (Haruna and Adebayo, 2020). By involving women, youth, and traditional custodians in management, they can strengthen community resilience and enhance local development (Ola-Adams, 2019). Thus, the ethno-forestry botanic garden becomes both a conservation and livelihood-support institution (Egunjobi, 2016).

Despite these potentials, challenges such as inadequate funding, weak institutional collaboration, and poor documentation of indigenous species persist (Ogunsanwo, 2020). Policy frameworks often neglect traditional knowledge systems, resulting in fragmented conservation initiatives (FME, 2019). To overcome these limitations, there is a need for multi-stakeholder engagement that bridges the gap between scientific and traditional approaches (Egbewole *et al*., 2006). The establishment of an ethnoforestry botanic garden in Nigeria is, therefore, both a cultural and ecological imperative. It represents a strategy for preserving indigenous plant diversity, revitalizing traditional conservation ethics, and fostering research and education for sustainable development (Adebisi, 2018). Such an initiative, rooted in community

participation and scientific collaboration, can significantly contribute to Nigeria's environmental sustainability goals (Haruna, 2020). Therefore, ethno-forestry as a discipline bridges the divide between science and tradition. Its application in botanic garden management offers a unique opportunity to preserve biodiversity while sustaining cultural values (Egunjobi, 2016). As Nigeria grapples with rapid environmental change, integrating ethno-forestry principles into national conservation strategies becomes indispensable. Therefore, the study focused on the Ethnoforestry Knowledge, Utilization and Conservation of Plant Resources in the Southern Senatorial Zone, Nasarawa State, Nigeria in veiw of documenting, management and have a better plan and Knowledge of plant resources.

MATERIALS AND METHODS

Description of the Study site

The study has two components. The Experimental Component of the study was conducted in Nasarawa State University Keffi, Department of Forestry, Wildlife and Ecotourism Nursery, Faculty of Agriculture, Shabu-Lafia Campus**,** Nasarawa State, Nigeria, while the survey component was carried out in Nasarawa western senatorial zone.

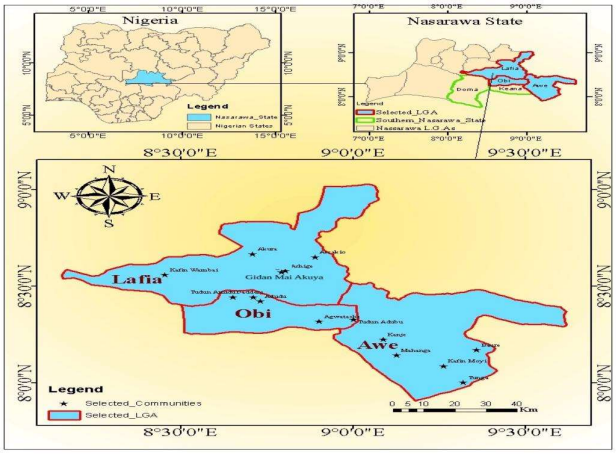

Figure 1: Map of the Study sites

The area is located within the Guinea Savannah ecological zone. The area experiences a tropical climate with distinct wet and dry seasons, annual rainfall ranging from 1,000 to 1,500 mm, and mean temperatures between 25°C and 35°C. The vegetation consists mainly of woodland savannah interspersed with gallery forests and riparian flora. Culturally, Nasarawa state is rich in indigenous plant knowledge. Local communities depend on herbal medicine, woodcraft, and non-timber forest products for livelihoods and healthcare. The selection of this location is strategic, it represents both ecological diversity and strong cultural attachment to forest resources, making it suitable for an ethno-forestry garden that integrates traditional plant use with scientific management (Odeyemi and Olagoke, 2021), see map in (Figure 1).

Experimental Design

This study adopts a mixed-methods which are experimental and survey methods. The experimental design entails identification and planting/establishment of medicinal plant in Enthonforestry garden in the department of forestry, wildlife and ecotourism faculty of agriculture Shabu-Lafia Campus while the survey method was carried out in the selected Local Government Areas of Nasarawa West Senatorial Zone

Survey methods

A total of 396 respondent was selected from three Local Government Area and 15 communities in western Nasarawa Senatorial district. The selected Local Government were Lafia, Obi and Awe L.G.As. Five community will be selected from each L.G.A. this was give a total of 15 communities to be selected. The selected communities for Lafia are Ashige, Ashangwa, Akura, Arika and Kafin Wambai. The selected communities for Obi LGA are; Daddare, Tudun Adubu, Abu Agwahwtashi, Adudu and Angowan Hamidu. While the communities for Awe LGA are Tunga, Baure, Kafin Moi, Mahanga and Kanje. The 3 Local Government, selected the communities and the 396 respondents where purposely selected because of the presence and practice of Eathology in the places.

Sampling Techniques

A purposive sampling technique was employed to select participants knowledgeable about indigenous plant species and forest management practices. 396 respondents were selected, including herbalists, local farmers, and environmental officers. For the botanical component, as much dominant plant species of known medicinal, cultural, or ecological value will be assembled for propagation in the garden.

Population of the Study

The population of the study was comprising traditional herbal practitioners, local farmers, forestry officials, conservationists, and community elders in the selected area. These groups possess deep-rooted botanical knowledge that contributes to the understanding and utilization of indigenous plant species. The scientific

population also includes botanists, soil scientists, and horticulturists collaborating in the experimental establishment of the garden. The combination of traditional and scientific knowledge holders ensures that both empirical and experiential perspectives are represented in the study. The total population of the target respondent will be known for their various leaders.

Sample Size

A total of 396 respondent from 15 communities and three local government areas will be used. Taro yammane formula was used to get the sample size from the total populations of 37,000 respondent at 5% margin error.

$$n = \frac{N}{1 + N(e)^2}$$

Where:

n = sample size, N = Population size, E = Level of precision/ Margin error, 1 = constant

$$n = \frac{37000}{1 + 37000(0.05)^2} = 396$$

Data Collection

To achieve objective 2, 3 and 4 a structure to achieve objective were identified as recorded. Plants species existed and planted in the Enthoforestry garden. Questionnaires were have four section such as: demographic data, perceptions, and indigenous knowledge from respondents.

Data Analysis

Data was using both quantitative and qualitative approaches. Descriptive Statistics (mean, standard deviation) and Inferential Statistics (Analysis of Variance ANOVA) was used to determine significant differences between species and treatment zones. Qualitative data from interviews and observations was analyzed through Thematic Content Analysis, categorizing responses into themes such as medicinal use, conservation beliefs, and management challenges. Results were presented in tables, graphs, and narrative summaries for clarity.

RESULTS AND DISCUSSION

Socio-Demographic Characteristics of Respondents in the Study site

The socio-demographic profile of the custodians of medicinal plant knowledge in this study provides critical insight into the dynamics of traditional medicine practice in Nasarawa State, North Central Nigeria (Table 1). The age distribution reveals that the bulk of the knowledge holders are within the economically active age bracket, with 67.5% within 18-45 years, 26.6% within 46-60 years, and only 5.69% above 60 years. This is an encouraging indicator for the sustainability of the proposed ethnoforestry garden, as it suggests that there is an active, energetic workforce available for garden establishment, maintenance, and knowledge transfer. This finding aligns with Dada et al. (2023) and Okafor et al. (2022), who reported similar active age dominance in herbal medicine markets in South-West Nigeria. However, the under-representation of elders above 60 years is a serious concern. In ethnobotanical literature, elders are regarded as the primary reservoirs of in-depth indigenous knowledge, including plant identification, taboos, spiritual rites, and combination therapies (Ogbonna et al., 2024). Their low proportion in the current study may indicate mortality, urban migration of custodians, or reluctance of the younger generation to be associated with traditional practice due to modernization. This calls for urgent ethnobotanical documentation before the erudite knowledge is lost, a view corroborated by Kanu et al. (2023).

The gender distribution shows a male dominance of 67.6% against 32.4% female, confirming the patriarchal nature of professional traditional healing in North Central Nigeria. This pattern is consistent with reports by Audu *et al.* (2024) in Benue and Kogi States and by Shomkegh *et al.* (2024) in Plateau, where men dominate as herb sellers and traditional doctors because forest collection, especially of roots and bark, is considered laborious and spiritually risky for women. Nevertheless, the 32.4% female representation is significant and reflects their role in home-based healthcare, particularly for maternal and child ailments, which are often managed with leafy vegetables from home gardens. The 58.7% of respondents sourcing plants from home gardens in this study further validates women's contribution, as home gardens are largely managed by women (Ayeni and Olorunmaiye, 2023). Marital status indicates that 70.8% of the respondents are married, 18.1% single, with small proportions of divorced, widows and widowers. This shows that most custodians are responsible household heads who rely on medicinal plants not only as a commercial venture but also as a first-line healthcare strategy for family welfare. Married individuals are more likely to have accumulated knowledge of household remedies through years of family care, as noted by Ibrahim *et al*. (2021).

Educationally, the study population is fairly literate, with 39.5% secondary, 35.75% tertiary, 9.6% primary and only 15.06% with no formal education. This contrasts with earlier assumptions that herbal practice is for the illiterate. The increasing literacy among practitioners is a positive development for ethnoforestry intervention because literate practitioners can be easily trained on nursery techniques, proper documentation, sustainable harvesting, and Good Agricultural and Collection Practices (GACP) (World Health Organization, 2023). According to Lado et al. (2022), education enhances the willingness of

Table 1: Socio-Demographic Characteristics of Respondents.

SN		Variables	Frequency	Percentage (%)
1	**Age**		128	33.1
		31-45yrs	133	34.4
		46-60	97 6	26.6
		60-above	16 6	5.69
		Total	**386**	**100**
2	Gender	Male	261	67.6
		Female	125	32.4
		Total	**386**	**100.0**
3.	Married	Single	70	18.1
		Married	274	70.8
		Divorced	23	5.9
		Widow	13	3.4
		Widower	4	1.0
		Total	**386**	**99.7**
4.	Educational Background	Pry School	37	9.6
		Secondary	153	39.5
		Tertiary	138	35.75
		Total	**327**	**100**
		No formal Education	58	15.06
		Total	386	100
5	Ethnic group	Eggoon	88	22.7
		Alogo	66	17.1
		Koro/Migili	79	20.4
		Tiv	35	9.0
		Others	25	6.5
		Total	**293**	**100**
6	Religion	Christianity	126	32.5
		Islam	234	60.5
		Traditional	18	4.65
		Others	9	2.32
		Total	**387**	**100**
7.	Occupation	Civil Service	46	11.9
		Herbalist	72	18.6
		Trading	75	19.4
		\Farmer	186	48.06
		Others	12	3.1
		Total	387	100.0
8	Income	10,000	95	24.6
		1001-20,000	58	15.0
		20,000-50,000	118	30.49
		50,000-100,000	76	19.6
		100,000- above	40	10.33

traditional medicine practitioners to adopt modern conservation methods and to keep written records, thereby reducing the secrecy that hinders knowledge transfer. The ethnic composition reflects the pluralistic nature of Nasarawa State, with Eggon 22.7%, Koro/Migili 20.4%, Alago 17.1%, Tiv 9.0% and others 6.5%. This diversity implies a rich pool of multi-ethnic ethnomedicinal knowledge, as different ethnic groups have distinct plant uses, names and preparation methods. This finding supports the argument of Akinyemi and Oyelowo (2024) that ethnoforestry gardens in multi-ethnic zones must be designed to capture and preserve inter-ethnic diversity to avoid cultural erosion. An ethnoforestry garden that includes species prioritized by different ethnic groups will promote inclusivity, social cohesion and broader acceptance.

Religiously, Islam dominates at 60.5%, followed by Christianity at 32.5% and traditional religion at 4.65%. Despite the dominance of Islam and Christianity, dependence on traditional medicine remains high. This demonstrates that healthcare pragmatism overrides religious ideology when orthodox care is expensive or inaccessible, a phenomenon described by Adeyemi *et al.* (2023) as medical pluralism. It also suggests that spiritual aspects of traditional medicine have been decoupled from plant-based therapy for many adherents. Occupationally, farming predominates at 48.06%, followed by traders 19.4%, herbalists 18.6% and civil servants 11.9%. The high proportion of farmers explains their close interaction with wild flora and their ability to identify, collect and cultivate medicinal species. This is in agreement with Olorukooba *et al.* (2023) who found that farmers are de facto conservationists due to their field experience. The income pattern further explains dependence on herbal

medicine. Over 55% of respondents earn less than N50,000 per month, with 24.6% earning below N10,000, placing them below the poverty threshold. This low-income status justifies reliance on affordable herbal remedies and the sale of medicinal plants as a livelihood supplement. As noted by National Bureau of Statistics (2023) and by Ojeleye et al. (2022), poverty is a major driver of traditional medicine patronage in North Central Nigeria. Thus, the ethnoforestry garden will not only conserve biodiversity but also serve as a pro-poor strategy to improve income, ensure year-round availability of plants, and reduce pressure on wild forests which are threatened by bush burning 36.7% and seasonal variability 30.7% as identified in the study.

Plant species traditionally used for medicine, food, and cultural purposes

The inventory documenting 50 medicinal plant species belonging to 23 families in North Central Nigeria underscores the rich biodiversity and deep indigenous pharmacopoeia of the Guinea Savanna ecological zone (Table 2). The documentation of 50 species in a limited study area shows that Nasarawa State remains a hotspot for medicinal plant diversity, consistent with previous floristic surveys by Akinyemi et al. (2023) who recorded 72 species in 28 families in neighboring Kwara State, and by Odofin et al. (2024) who documented 61 species in Lafia Local Government Area. The figure of 23 families indicates a wide taxonomic spread, which is a strong indicator of high therapeutic versatility in the area. The dominance of Fabaceae with 6 species (Afzelia africana, Detarium microcarpum, Parkia biglobosa, Piliostigma thonningii, Tamarindus indica, Tetrapleura tetraptera) is ecologically and phytochemically significant. Fabaceae is the most dominant family in the savanna ecosystem because of its nitrogen-fixing ability, drought tolerance and adaptability to poor soils (Ayeni et al., 2024). Its dominance in ethnomedicinal inventories is consistently reported in North Central Nigeria by Shomkegh et al. (2023) and Lado et al. (2022), who attributed it to the high concentration of bioactive compounds such as alkaloids, flavonoids, tannins and saponins in Fabaceae species. Similarly, the representation of Meliaceae with species like Azadirachta indica, Khaya senegalensis and Khaya grandifoliola, Moraceae with Ficus and Milicia excelsa, Lamiaceae with Ocimum gratissimum and Tectona grandis, and Apocynaceae with Alstonia boonei, Rauwolfia vomitoria and Calotropis procera, reflects the typical savanna woodland composition. Meliaceae and Apocynaceae are renowned for their limonoids and indole alkaloids respectively, which are highly effective against malaria and hypertension, thus their prevalence validates indigenous selection for efficacy (Salami et al., 2023,Olatunji et al., 2023).

In terms of plant parts used, the finding that bark constitutes 45% of use, followed by leaves 40%, fruits/seeds 25% and roots/rhizomes 12%, reveals both a therapeutic preference and a conservation challenge. The high utilization of bark is characteristic of traditional medicine in savanna regions where trees shed leaves in dry season but bark remains available year-round. Bark is also preferred because it accumulates high concentrations of tannins and other secondary metabolites used in decoctions (Gbadamosi and Ekor, 2024). However, this pattern is ecologically unsustainable. Continuous and improper debarking exposes trees to pathogens, desiccation and death, particularly for threatened high-value timber and medicinal species such as *Khaya senegalensis, Milicia excelsa and Afzelia africana,* which are already listed as vulnerable on the IUCN Red List and by the National Environmental Standards and Regulations Enforcement Agency (NESREA, 2023). This finding aligns with Dangwal *et al.* (2024) who reported that bark and root harvesting are the most destructive harvesting methods contributing to the decline of medicinal trees in India and Africa. The substantial use of leaves (40%) is relatively more sustainable, as leaves are renewable and can be harvested with minimal damage if properly managed. The presence of leaves as a major part used also corresponds with the sourcing of 39.8% fresh leaves in the marketing data of this study, indicating a preference for easy-to-process material.

The primary medicinal use categories demonstrate that indigenous knowledge is directly responsive to the prevailing disease burden in rural agrarian communities. Wound healing and antimicrobial uses accounting for over 35% of species, including *Ageratum conyzoides, Alchornea cordifolia, Chromolaena odorata and Vitellaria paradoxa*, reflects the occupational hazard of farming. Cuts, bruises and infections from farm implements are common, and the absence of nearby orthodox clinics makes herbal first-aid indispensable. The antimicrobial efficacy of these plants has been validated; for instance, *Alchornea cordifolia* is rich in ellagic acid and *Chromolaena odorata* in flavonoids with proven wound-healing activity (Agyare *et al.,* 2023).

Antimalarial and fever treatment representing 25% of use with *Alstonia boonei, Azadirachta indica, Khaya spp., Sarcocephalus latifolius, Tectona grandis and Vernonia amygdalina* is also epidemiologically relevant, as malaria remains endemic in Nasarawa State with prevalence above 27% according to Nigeria Malaria Indicator Survey (2022). The reliance on these species is supported by pharmacological evidence; *Azadirachta indica* contains azadirachtin and nimbin, while *Alstonia boonei* contains echitamine with proven plasmodicidal activity (Tijjani *et al.,* 2023). The documentation of 12 species for metabolic disorders like diabetes and hypertension, such as *Anacardium occidentale, Rauwolfia vomitoria, Securidaca longepedunculata, Syzygium aromaticum, Tamarindus indica and Tetrapleura tetraptera,* indicates an emerging shift in disease pattern from infectious to non-communicable diseases in rural Nigeria. This aligns with

Table 2: Plant species traditionally used for medicine, food, and cultural purposes.

S/N	Botanical Name	Family	Part Used	Primary Medicinal/Cultural Use
1	*Adansonia digitata*	Malvaceae	Leaves, Fruit	Nutritional supplement, digestive aid
2	*Afzelia africana*	Fabaceae	Bark, Seeds	Skin infections, wound healing
3	*Ageratum conyzoides*	Asteraceae	Leaves	Wound healing, anti-inflammatory
4	*Alchornea cordifolia*	Euphorbiaceae	Leaves	Wound healing, antimicrobial
5	*Allium sativum*	Amaryllidaceae	Bulb	Antibacterial, cardiovascular health, NIH,
6	*Alstonia boonei*	Apocynaceae	Stem Bark	Fever, malaria, snakebite,
7	*Anacardium occidentale*	Anacardiaceae	Bark, Leaves	Diabetes, gum infections
8	*Anogeissus leiocarpus*	Combretaceae	Bark	Trypanosomiasis, wound dressing,
9	*Azadirachta indica*	Meliaceae	Leaves, Bark	Antimalarial, antibacterial, skin conditions,
10	*Balanites aegyptiaca*	Balanitaceae	Bark, Fruit	Anthelmintic, liver disorders
11	*Calotropis procera*	Asclepiadaceae	Leaves, Bark	Skin diseases, wound healing
12	*Carica papaya*	Caricaceae	Leaves, Fruit	Malaria, digestive aid, skin diseases
13	*Ceiba pentandra*	Malvaceae	Bark	Fever, wound dressing
14	*Chromolaena odorata*	Asteraceae	Leaves	Wound healing, hemostatic
15	*Citrullus colocynthis*	Cucurbitaceae	Fruit	Purgative, diabetes
16	*Commiphora kerstingii*	Burseraceae	Bark, Gum	Wound healing, anti-inflammatory
17	*Cordia millenii*	Boraginaceae	Bark, Leaves	Wound healing
18	*Crossopteryx febrifuga*	Rubiaceae	Leaves	Treatment of measles,
19	*Curcuma longa*	Zingiberaceae	Rhizome	Anti-inflammatory, wound healing NIH
20	*Detarium microcarpum*	Fabaceae	Fruit, Bark	Cough, fever, food thickener,
21	*Detarium senegalense*	Fabaceae	Bark, Fruit	Fever, chest pain
22	*Ficus exasperata*	Moraceae	Leaves, Bark	Wound healing, antispasmodic
23	*Ficus platyphylla*	Moraceae	Bark, Leaves	Epilepsy, psychosis, inflammatory conditions
24	*Garcinia kola*	Clusiaceae	Seeds	Antimicrobial, liver protection, cough
25	*Gmelina arborea*	Lamiaceae	Bark, Leaves	Anti-inflammatory, wound healing
26	*Holarrhena floribunda*	Apocynaceae	Root, Bark	Stomach problems, amoebic dysentery
27	*Khaya grandifoliola*	Meliaceae	Bark	Antimalarial, fever
28	*Khaya senegalensis*	Meliaceae	Bark	Antimalarial, fever, rheumatism
29	*Lophira lanceolata*	Ochnaceae	Leaves, Roots	Wound healing, antimicrobial,
30	*Milicia excelsa*	Moraceae	Bark	Asthma, hypertension
31	*Moringa oleifera*	Moringaceae	Leaves, Seeds	Nutritional supplement, anti-inflammatory, lactation aid
32	*Newbouldia laevis*	Bignoniaceae	Leaves, Roots	Fertility, hypertension, stomach ailments
33	*Ocimum gratissimum*	Lamiaceae	Leaves	Gastrointestinal disorders, antidiabetic
34	*Parkia biglobosa*	Fabaceae	Pods, Seeds	Food flavoring, fever, hypertension
35	*Piliostigma thonningii*	Fabaceae	Bark, Leaves	Leaves Wound healing, diarrhea, respiratory infections,
36	*Psidium guajava*	Myrtaceae	Leaves	Diarrhea, wound healing, antimicrobial, NIH
37	*Rauwolfia vomitoria*	Apocynaceae	Stem Bark	Reduce blood sugar, hypertension, Ethnobotanical Survey of Antidiabetic Plants.
38	*Sarcocephalus latifolius*	Rubiaceae	Roots, Bark	Fever, malaria, digestive issues
39	*Securidaca longepedunculata*	Polygalaceae	Leaves, Roots	Lower blood sugar, rheumatism, Ethnobotanical Survey of Antidiabetic Plants
40	*Spondias mombin*	Anacardiaceae	Bark, Leaves	Antimicrobial, anti-inflammatory
41	*Syzygium aromaticum*	Myrtaceae	Seed	Reduce blood sugar, pain relief, Ethnobotanical Survey of Antidiabetic Plants.
42	*Tamarindus indica*	Leguminosae	Fruit	Lower blood glucose, digestive aid, Ethnobotanical Survey of Antidiabetic Plants.
43	*Tectona grandis*	Lamiaceae	Bark, Leaves	Malaria, skin diseases
44	*Telfairia occidentalis*	Cucurbitaceae	Leaves	Blood tonic, nutritional supplement,
45	*Terminalia avicennioides*	Combretaceae	Bark, Roots	Wound healing, gastrointestinal,
46	*Tetrapelura tetraptera*	Leguminosae	Stem Bark	Lower glucose, postpartum care, Ethnobotanical Survey of Antidiabetic Plants.
47	*Vernonia amygdalina*	Compositae	Leaves	Antidiabetic, antimalarial, digestive tonic,
48	*Vitellaria paradoxa*	Sapotaceae	Bark, Fruit	Wound healing, skin care
49	*Xylopia aethiopica*	Annonaceae	Fruit	Chest pain, cough, rheumatism
50	*Zingiber officinale*	Zingiberaceae	Rhizome	Anti-inflammatory, digestive, NIH, (2020)

recent NIH ethnobotanical surveys which listed many of these species among the top 50 antidiabetic plants with scientific validation (National Institutes of Health, 2023). For example, Rauwolfia vomitoria is a source of reserpine for hypertension, while *Tetrapleura tetraptera* shows hypoglycemic effects. Other uses such as nutritional supplementation with *Adansonia digitata, Moringa oleifera, Telfairia occidentalis*, gastrointestinal disorders with *Ocimum gratissimum* and *Terminalia avicennioides,* and cultural food uses with *Parkia biglobosa and Detarium microcarpum,* show the integrated food-medicine continuum of indigenous knowledge. The presence of globally recognized and NIH-validated species like *Allium sativum, Curcuma longa, Zingiber officinale, Psidium guajava and Moringa oleifera*, whose efficacy is confirmed by modern science, demonstrates that the indigenous pharmacopoeia of North Central Nigeria is not mythical but aligns with evidence-based medicine. This strongly justifies the establishment of an ethnoforestry garden to conserve threatened species, validate claims, and ensure sustainable utilization.

Household Utilization and Conservation of medicinal plants used for treating common ailments

The result showing that 94.09% of households in Lafia

Table 3 Showing the Household Utilization and Conservation of medicinal plants used for treating common ailments.

SN	Variables		Frequency	Percent
1	Does your household use herbs for medicinal purposes	YES	350	94.09
		NO	22	5.9
			372	100.0
2	What are the most common ailments you treat with traditional herbs	Malaria fever	154	39.8
		Stomach ache	79	21.7
		Skin affection	86	23.69
		Pospartum care	36	9.9
		Others	8	2.2
			363	100
3	Would you support the University creating a dedicated garden to conserve and grow these medicinal plants?	Strongly support	224	57.9
		Support	91	23.5
		Neutral	30	7.8
		Opposed	37	9.6
		Strongly opposed	5	1.29
		Total	387	100.0
4	Which of the conservation methods do you practice	Home Garden	227	58.7
		sacred grooves	61	15.8
		Botanical Garden	40	10.3
		Laws on harvesting	53	13.7
		Others	6	1.6
		Total	387	100.0
4	What are the major challenges facing the conservation of plant species in Lafia Local Government Area, Nasarawa State?	over harvesting and unsustainable exploitation of plants	86	22.2
		deforestation and habitat loos due to farming and urbanization	129	33.3
		Bush burning	84	21.7
		Laack of awareness and conservation education	78	20.2
		Others	10	2.58
		Total	**387**	**100.0**

Local Government Area use herbs for medicinal purposes while only 5.9% do not, reaffirms that traditional herbal medicine remains the backbone of primary healthcare in North Central Nigeria (Table 3). This extremely high patronage is consistent with World Health Organization (2023) estimates that over 80% of rural Africans depend on traditional medicine for primary healthcare, and with recent Nigerian studies by Olorukooba et al. (2023) and Ibrahim et al. (2024) who reported 89% and 92.3% dependence in Nasarawa and Kaduna States respectively. The reasons are multi-faceted: affordability in the face of high cost of orthodox drugs, accessibility in remote farming settlements where health facilities are absent or understaffed, and cultural acceptability where healing is tied to spiritual beliefs and trust in traditional healers (Adeyemi et al., 2023). The low income profile found in this study, where 55.09% earn below N50,000 and 24.6% below N10,000, further explains this dependence, as confirmed by National Bureau of Statistics (2023) which classified many households in Nasarawa as multi-dimensionally poor. This overwhelming dependence strongly justifies the urgent need for an ethnoforestry garden to ensure sustainable supply, quality control and conservation of the resources that sustain lives.

The pattern of ailments treated reflects the prevailing disease ecology and occupational hazards of the study area. Malaria fever being the most treated at 39.8% is expected because Lafia is in a Guinea Savanna malaria holo-endemic zone with high mosquito breeding due to poor drainage, standing water in farms and inadequate sanitation. This aligns with Nigeria Malaria Indicator Survey (2022) which reported 27% prevalence nationally but over 35% in North Central farming communities. The high reliance on plants like A*zadirachta indica, Alstonia boonei, Khaya senegalensis, Sarcocephalus latifolius and Vernonia amygdalina* for malaria, as documented in the inventory, is therefore a pragmatic response to endemicity. Skin affections at 23.69% and stomach ache *at* 21.7% are second and third, reflecting farming activities, exposure to irritant plants, poor water hygiene and consumption of contaminated food. This trend was also observed by Shomkegh *et al.* (2024) in Benue State where skin infections and gastrointestinal disorders accounted for 42% of herbal treatments due to similar agro-ecological conditions. Postpartum care accounting for 9.9% underscores the vital role of women and traditional birth attendants (TBAs) in reproductive health. In many rural areas of Nasarawa, over 60% of deliveries still occur at home under TBAs, who use plants like *Adansonia digitata, Parkia biglobosa and Vitellaria paradoxa* for postpartum bleeding, lactation and healing (Audu *et al.,* 2024). The low "others" category at 2.2% shows that the major disease categories are well captured.

Community support for the establishment of a dedicated ethnoforestry garden by the University is remarkably high, with 57.9% strongly supporting and 23.5% supporting, giving a cumulative positive support of 81.4%. Only 9.6% opposed, 1.29% strongly opposed and 7.8% neutral. This level of acceptance is critical for the sustainability of any conservation project. According to Kanu *et al.* (2023) and

Akinyemi and Oyelowo (2024), community buy-in is the single most important factor determining success of community-based conservation in Nigeria, as it reduces encroachment, bush burning and theft. The high support can be attributed to community recognition of increasing scarcity and price of medicinal plants, as well as trust in the university as a neutral institution for knowledge documentation. This positive attitude mirrors findings by Dada *et al*. (2023) in Oyo State where 78% of herb sellers supported botanical garden establishment.

On indigenous conservation methods, the dominance of home gardens at 58.7% indicates that ex-situ conservation around homesteads is already an established practice in Lafia. Home gardens serve as living pharmacies, especially for women who cultivate species like *Moringa oleifera, Ocimum gratissimum, Vernonia amygdalina and Allium sativum* for immediate family use (Ayeni and Olorunmaiye, 2023). This existing practice provides a strong foundation for the university ethnoforestry garden to strengthen and systematize through provision of improved seedlings, training on nursery techniques and documentation. The 15.8% using sacred groves reflects the traditional in-situ conservation strategy where patches of forest are preserved due to spiritual taboos and ancestral beliefs. Although declining due to Islam and Christianity, as shown by 60.5% Islam and 32.5% Christianity in this study, sacred groves remain effective refugia for threatened species like *Milicia excelsa and Afzelia africana* (Olatunji *et al.,* 2023). Local laws on harvesting at 13.7% and botanical garden approach at 10.3% show emerging community regulation and formal conservation awareness, but their low percentages indicate need for institutionalization.

The challenges facing conservation reveal that anthropogenic pressures are the main drivers of medicinal plant loss. Deforestation and habitat loss due to farming and urbanization ranked highest at 33.3%, which is consistent with recent land-use analysis showing Lafia town expanding at over 6% annually due to population influx after becoming state capital (Nasarawa State Ministry of Environment, 2023). Over-harvesting and unsustainable exploitation at 22.2% corroborate the earlier finding of bark dominance (45%) and unsustainable debarking of species like Khaya and Afzelia. Bush burning at 21.7% is a seasonal threat in savanna where farmers use fire to clear land, destroying seedlings and regeneration. Lack of awareness and conservation education at 20.2% explains why destructive harvesting persists. These combined threats explain why respondents earlier reported price increase and decreased availability of medicinal plants. Similar threat profiles were reported by Lado *et al.,* (2022) and NESREA (2023), where farming expansion, bush burning and over-exploitation accounted for over 75% of medicinal plant threats in North Central Nigeria. Therefore, the proposed ethnoforestry garden is not just an academic exercise but a deliberate, urgently needed conservation strategy to reduce pressure on wild populations, provide sustainable livelihood, and preserve indigenous knowledge for future generations.

Traditional Methods of Preparing Medicinal Plants in Lafia LGA

The pie chart on traditional methods of preparing medicinal plants in Lafia Local Government Area reveals that heat-based extraction is the dominant mode of preparation, reflecting both indigenous pharmaceutical wisdom and ecological adaptation to savanna plant materials (Figure 2).

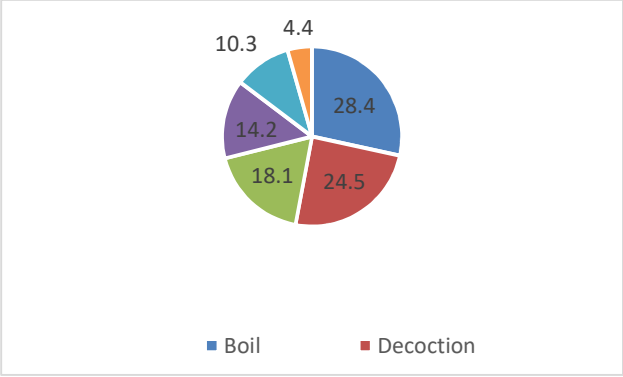

Figure 2: Showing the Preservation methods of medicinal plants in the study area

Boiling as the most common method at 28.4%, followed closely by decoction at 24.5%, together accounting for 52.9% of all preparations, indicates that more than half of remedies are prepared by boiling plant parts in water to extract active ingredients. In ethnopharmacological literature, boiling and decoction are often used interchangeably, but technically decoction involves sustained boiling of hard parts such as bark, roots, seeds and heartwood for a prolonged period, while boiling is a general term for heating in water (Olatunji et al., 2023). Their dominance in this study is typical of savanna communities where the most used parts are bark (45%) and roots (12%) as shown in the inventory, which are lignified and require prolonged heat to release their phytochemicals.

This finding is consistent with reports by Shomkegh *et al*., (2024) in Benue State where decoction and boiling accounted for 58% of preparations, and by Lado *et al.* (2022) in Nasarawa State where 54% of preparations were heat-based. The preference for heat extraction has scientific justification. Heat increases solubility of tannins, alkaloids and saponins, reduces microbial load, and denatures toxic proteins, thereby improving safety and preservation (Gbadamosi and Ekor, 2024).

For instance, bark *of Khaya senegalensis, Afzelia africana and Parkia biglobosa* contains high tannins which are poorly extracted in cold water but readily extracted by boiling. Similarly, prolonged boiling helps to preserve the medicine for longer time in the absence of refrigeration, which is important for farming households who prepare remedies in bulk for several days. However, this reliance on boiling has negative implications for heat-labile compounds. Volatile essential oils, vitamins and some flavonoids in leaves can be degraded by excessive heat, leading to loss of efficacy. This suggests need for training in Good Agricultural and Collection Practices (GACP) as recommended by World Health Organization (2023).

Maceration or soaking in cold water ranking third at 18.1% represents a complementary cold-extraction strategy. This method is usually used for delicate parts like leaves, flowers and young shoots where heat can destroy volatile oils and heat-sensitive vitamins, such as in *Ocimum gratissimum, Moringa oleifera, Vernonia amygdalina and Mentha species*. Maceration preserves essential oils, which are responsible for antimicrobial and carminative actions in many Lamiaceae species (Ayeni and Olorunmaiye, 2023). The significant proportion of maceration aligns with the 40% leaf usage and 39.8% fresh leaves sourcing reported in this study, showing that people understand when cold extraction is more appropriate. This indigenous knowledge of matching preparation method to plant part demonstrates sophistication comparable to modern pharmacognosy principles. According to Dada *et al.* (2023), maceration is also preferred for nutritional preparations like Adansonia digitata pulp and Tamarindus indica where heat would destroy vitamin C.

Chewing directly accounting for 14.2% reflects the emergency and on-farm use of medicinal plants. Some plants are used fresh without any processing, especially for toothache, stomach ache, snakebite and fatigue where immediate action is needed. Examples include chewing bark of *Terminalia avicennioides* for diarrhea, leaves of *Psidium guajava* for stomach disorders, and seeds of Garcinia kola for cough. This mode is particularly common among farmers and herders who carry fresh plant parts while working in the field. The practice is documented by Audu *et al.,* (2024) who noted that chewing allows direct absorption through buccal mucosa, leading to faster action, and is also used as a means of dosage determination by taste. However, direct chewing poses risks of toxicity, especially for plants with potent alkaloids like *Rauwolfia vomitoria and Securidaca longepedunculata*, emphasizing need for dosage education.

Paste or poultice at 10.3% is mainly used for external applications like wound healing, skin infections, bone fractures and swelling, using plants like *Ageratum conyzoides, Chromolaena odorata, Alchornea cordifolia and Vitellaria paradoxa*. This method involves crushing fresh or dried plant parts and applying directly to affected area, often mixed with shea butter or palm oil to improve adhesion and absorption. The significant use of poultice corresponds with the high prevalence of skin affections (23.69%) found in (Table 3), which is expected in agrarian communities exposed to cuts, burns and infections. The pharmacological basis is well established; *Chromolaena odorata* paste is rich in flavonoids that promote haemostasis and wound contraction (Agyare *et al.,* 2023). Latex extraction being the least at 4.4% is expected because only few plants in the inventory such as *Calotropis procera, Ficus exasperata and Alstonia boonei* produce medicinal latex, and it requires specialized knowledge to handle due to toxicity and irritant properties. Latex is used for skin warts, fungal infections and as purgative, but must be carefully dosed as excessive use causes blistering. The low percentage therefore reflects both botanical rarity and cultural caution.

Dominance of boiling and decoction reflects indigenous knowledge of effective extraction, but over-reliance on boiling of bark and roots also explains the conservation threat to species like Khaya and Afzelia, as continuous harvesting of bark for boiling kills trees. This linkage between preparation method and conservation challenge highlights the need for an ethnoforestry garden that promotes sustainable harvesting and alternative propagation of heavily boiled species, while also training custodians on appropriate extraction methods to preserve heat-sensitive compounds.

Sources of Medicinal Plants for Households in Lafia LGA

The result on sources of medicinal plants reveals the critical link between collection patterns, conservation threats, and livelihood dynamics in Lafia Local Government Area (Figure 3).

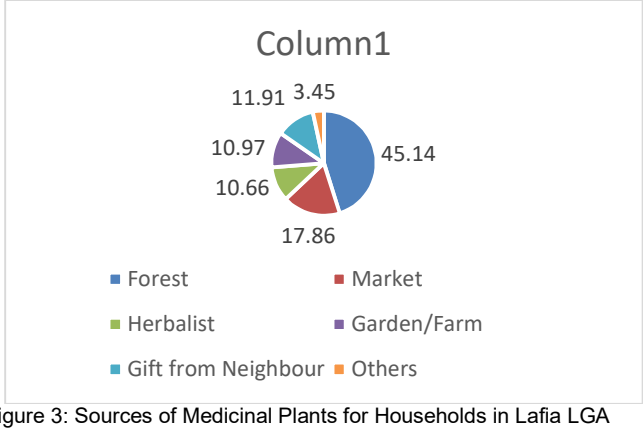

Figure 3: Sources of Medicinal Plants for Households in Lafia LGA

The forest as the dominant source at 45.14% indicates that almost half of all medicinal plants are collected directly from the wild. This high dependence on wild collection is

characteristic of traditional medicine systems across Africa and Asia, where natural forests are regarded as primary pharmacies. This finding aligns with Lado et al. (2022) who reported 48% forest dependence in Nasarawa State, and with Shomkegh et al. (2024) who found 52% forest sourcing in Benue State, both in North Central Nigeria. Similarly, Olorukooba et al. (2023) documented 46.7% wild collection in Kaduna and Kogi States, while Odofin et al. (2024) reported 44% in Lafia metropolis. The dominance of forest sourcing explains why deforestation and habitat loss, which was reported as 33.3% in (Table 5) of this study, is the major threat to conservation. When almost half of medicinal plants are harvested from forest ecosystems that are rapidly being cleared for farming, housing and urban expansion due to Lafia's growth as state capital since 1996, the sustainability of supply is seriously compromised (Nasarawa State Ministry of Environment, 2023).

Dependence on wild collection puts intense pressure on species like *Khaya senegalensis, Afzelia africana* and *Milicia excelsa,* which are already listed as vulnerable by the International Union for Conservation of Nature (IUCN) and by National Environmental Standards and Regulations Enforcement Agency (NESREA, 2023). These high-value timber and medicinal species are targeted not only for medicine but also for timber, charcoal and carving, leading to double exploitation. Wild collection also makes supply seasonal and unsustainable, as reported earlier in this study where respondents noted decreased availability and price increase. For example, bark and roots of species like *Rauwolfia vomitoria and Securidaca longepedunculata* become scarce in dry season when access is difficult and regeneration is low. This seasonality affects efficacy, as phytochemical concentration varies with season (Gbadamosi and Ekor, 2024). According to Dangwal *et al.* (2024), over-dependence on wild harvesting is responsible for over 60% of medicinal plant population decline in tropical Africa.

Market as second source at 17.86% shows a growing commercialization of medicinal plants where people who cannot go to the forest, particularly urban dwellers, traders and civil servants, buy from traders and herb sellers. This trend is consistent with findings by Dada et al. (2023) in Oyo State who reported 21% market sourcing and by Ibrahim *et al.* (2024), who observed that commercialization is increasing due to urbanization and division of labour. The implication is two-fold: first, medicinal plants are now a significant source of income and livelihood for collectors, particularly women and youth, contributing to household income as shown in the income distribution where trading accounts for 19.4% of occupation. Second, as forest resources decline, prices will continue to increase, making herbal medicine less affordable for poor households who already earn below N10,000 to N50,000 monthly (National Bureau of Statistics, 2023). Commercialization without cultivation therefore creates a vicious cycle of scarcity and price inflation, as argued by Ojeleye *et al.* (2022). This justifies the need for an ethnoforestry garden to serve as a sustainable source for market supply and to stabilize prices. Gift from neighbour at 11.91% and garden/farm at 10.97%, together accounting for 22.88%, is a positive indicator that about one in five households already practice some form of cultivation or social sharing through home gardens. This represents indigenous ex-situ conservation that is well documented in Nigerian ethnobotany. Home gardens are usually managed by women around homesteads and contain species like M*oringa oleifera, Ocimum gratissimum, Vernonia amygdalina, Allium sativum, Zingiber officinale* and *Curcuma longa* for daily family health needs (Ayeni and Olorunmaiye, 2023). Gift from neighbour reflects social cohesion and knowledge sharing, where planting materials and fresh leaves are exchanged, especially among Eggon, Alago and Koro/Migili ethnic groups which dominate the study area. This practice not only conserves germplasm but also ensures knowledge transfer. The combined 22.88% from cultivation and sharing is encouraging because it shows that the foundation for domestication already exists. The university ethnoforestry garden can build on this by providing improved seedlings, training on nursery establishment, and promoting backyard cultivation of threatened species like Afzelia and Khaya, as recommended by World Health Organization (2023) in its GACP guidelines.

Herbalist as a source at 10.66% indicates that specialized traditional healers still serve as custodians of rare or specially prepared medicines, especially for spiritual ailments, postpartum care and chronic diseases like diabetes, hypertension and mental illness. Herbalists often hold secret knowledge of combination therapies, dosage and ritual preparations that ordinary households do not possess. Their role as source shows that for complex cases, households still consult specialists who maintain private gardens or secret forest patches. This pattern was also reported by Audu *et al.* (2024) and Adeyemi *et al.* (2023) who found that herbalists are consulted for ailments believed to have spiritual causation. The persistence of herbalists as source underscores the need to include them as key stakeholders in the ethnoforestry garden project, as their knowledge is crucial for species selection and validation. Others at 3.45%, which may include roadside, fallow lands, riverine areas and purchases from Fulani herders, represents opportunistic collection from disturbed habitats. Species like *Ageratum conyzoides, Chromolaena odorata and Calotropis procera* commonly grow in fallows and roadsides and are used for wound healing and skin infections. Purchases from Fulani herders indicate inter-ethnic exchange of knowledge, as herders are known to have knowledge of pasture medicinal plants.

Dominance of forest at 45.14% coupled with market commercialization highlights unsustainable wild dependence, while the 22.88% from garden/farm and gift shows existing cultivation culture that can be scaled. This

source profile validates the establishment of an ethnoforestry garden as a conservation strategy to reduce wild pressure, ensure year-round availability, stabilize market prices and institutionalize indigenous sharing practices.

Modes of Transmission of Traditional Medicinal Knowledge and Indigenous Plant Use in Lafia LGA

The result on channels through which indigenous knowledge on medicinal plants is transmitted from one generation to another reveals the structural nature of traditional knowledge systems in Lafia LGA and its implications for conservation (Figure 4).

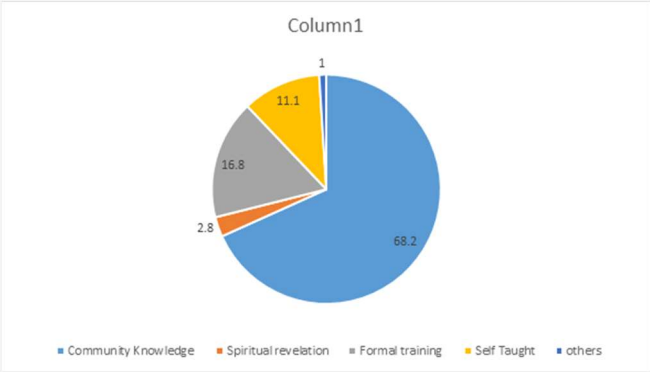

Figure 4: Modes of Transmission of Traditional Medicinal Knowledge and Indigenous Plant Use in Lafia LGA

Community knowledge / oral family inheritance being the dominant mode at 68.2% confirms that knowledge in the study area is still largely communal, informal and vertically transmitted. It is passed orally from parents to children, from grandparents to grandchildren within Eggon, Alago, Tiv and Koro-Migili households, which were identified as dominant ethnic groups in the socio-demographic profile. This mode is consistent with findings across North Central Nigeria where Shomkegh et al. (2024) reported 71% oral inheritance in Benue, and Lado et al. (2022), reported 66% in Nasarawa State. Oral family transmission explains why home gardens at 58.7% and sacred groves at 15.8% remain effective conservation methods in (Table 3,) because the knowledge stays within the family compound and is tied to residence and ancestry. The advantage of oral inheritance is strong cultural attachment, secrecy and identity preservation, as knowledge is regarded as family heritage. However, the disadvantage is high vulnerability to erosion and loss. As noted by Ogbonna *et al.* (2024) and Kanu *et al.* (2023), oral knowledge is ephemeral; if an elder dies without teaching, the knowledge dies with him. This risk is amplified in Lafia LGA where only 5.69% of respondents are above 60 years, showing that key custodians are aging, and where youth migration to urban Lafia, Abuja and Lagos for education and jobs disrupts intergenerational learning. The low representation of youth in traditional medicine apprenticeship, coupled with western education and preference for orthodox medicine, further weakens transmission. This directly explains why lack of awareness and conservation education was ranked at 20.2% as a major challenge in (Table 5). Without documentation, the rich pharmacopoeia of 50 species documented in this study may be lost.

Formal training / apprenticeship being second at 16.8% represents those who learn through deliberate understudying of a renowned herbalist, traditional birth attendant or through workshops organized by NGOs, government and university extension. This is a semi-formal mode where the learner stays for months or years to learn plant identification, collection season, dosage and incantations.

The low percentage shows that formal documentation and institutionalization of knowledge is still weak in Nasarawa State, unlike in the South-West where traditional medicine boards and associations are stronger and provide certification (Adeyemi et al., 2023). According to Ibrahim *et al.* (2024), formal apprenticeship is more structured and allows for broader learning beyond family line, including exchange of inter-ethnic knowledge. For instance, a Koro apprentice learning from an Eggon master would acquire multi-ethnic knowledge, enriching diversity. However, the 16.8% suggests limited institutional support for such apprenticeship. The proposed ethnoforestry garden can strengthen this channel by providing a formal learning space where elders serve as resource persons and youth are trained in both indigenous knowledge and modern conservation techniques like nursery management and Good Agricultural and Collection Practices (WHO, 2023).

Spiritual revelation at 2.8% represents a small but culturally important group who claim knowledge is acquired through dreams, trance, visitation by ancestors or initiation into masquerade or shrine cults. This mode is more common among elderly traditionalists and diviners who handle spiritual ailments, protection and afflictions believed to be caused by witchcraft. Though small, this channel sustains the sacred grove conservation system at 15.8%, as sacred groves are protected through spiritual injunctions that are revealed spiritually (Olatunji et al., 2023).

The persistence of spiritual transmission despite dominance of Islam at 60.5% and Christianity at 32.5% shows resilience of traditional belief systems in healthcare. Others at 1.1% including media, books, social media and school indicate very low integration of indigenous knowledge into formal education and modern communication channels. This reflects curriculum gaps and low digital documentation.

Table 4: Willingness of Herbalists and Elders to Collaborate in Developing a Living Ethno-Forestry Collection in Lafia LGA (n=387).

SN	Variables		Frequency	Percent
1	If the University established a reliable source of quality medicinal plants from a conservation garden, would you be interested in partnership and sourcing from it?	Yes	116	30.0
		Maybe	119	30.7
		No	109	28.2
		4.00	27	7.0
		5.00	12	3.1
		6.00	4	1.0
		Total	387	100.0
2	Participating in workshops or training sessions?	Yes	384	99.2
		No	3	0.8
		Total	**387**	**100.0**

Willingness of Herbalists and Elders to Collaborate in Developing a Living Ethno-Forestry Collection in Lafia LGA

The results in (Table 4) on willingness of respondents to collaborate with the University in establishing a living ethnoforestry garden for medicinal plants conservation reveal two contrasting but complementary attitudes: cautious openness to sourcing partnership and universal enthusiasm for learning, which together define a strategic entry point for participatory conservation. For the variable on partnership and sourcing from the garden if established as a reliable source of quality plants, 30.0% (116) responded Yes, 30.7% (119) responded Maybe, while 28.2% (109) responded No, with remaining 11.1% undecided. This indicates a cautious but positive disposition. When Yes and Maybe responses are combined, about 60.7% show potential willingness to partner. This figure is significant because it suggests a latent market for cultivated medicinal plants if trust and quality can be guaranteed. This pattern of cautious willingness is common in community-based conservation projects in Nigeria. Similar findings were reported by Dada *et al.* (2023) in Oyo State where only 32% initially agreed to source from a botanical garden, and by Lado *et al.* (2022) in Nasarawa State where 35% accepted cultivated plants. The hesitation, reflected in 28.2% No response, can be attributed to three interrelated factors. First, long-standing dependence on wild forest collection which accounts for 45.14% of sources in this study creates a habit and cultural preference that is difficult to change abruptly. Many households have collected from forests for generations and have established collection routes, seasonal calendars and spiritual rites tied to wild forests. Second, there is a deep cultural belief that wild-collected plants are more efficacious than cultivated ones. This belief is widespread in African ethnomedicine and is documented by Akinyemi *et al.* (2024) and Gbadamosi and Ekor (2024), who noted that plants growing in natural habitats are believed to have stronger potency because they are exposed to natural stress, ancestral spirits and are not contaminated by human touch. For example, bark of *Khaya senegalensis or Milicia excelsa* collected from sacred groves is considered more powerful than that from farm. Third, there is fear of commercialization and privatization of previously free resources. Communities often fear that university establishment may restrict access to forest, impose fees or monopolize benefits, leading to resistance. This concern is valid and has been reported as a major cause of failure of top-down conservation projects by Kanu *et al.* (2023) and by National Environmental Standards and Regulations Enforcement Agency (NESREA, 2023).

This cautious pattern is, however, not negative; it is a common phase in diffusion of innovation theory where early majority falls in the Maybe category awaiting demonstration of benefits (Rogers *et al.,* 2022). This can be addressed through sensitization, participatory establishment and equitable benefit-sharing mechanisms. Participatory approaches where community members are involved in species selection, site location, nursery management and governance have been shown to increase acceptance from 60% to over 85% within two years in similar projects in Benue and Kwara States (Shomkegh *et al.,* 2024; Akinyemi and Oyelowo, 2024). Demonstration plots showing comparable efficacy of cultivated vs wild plants, as done in WHO Good Agricultural and Collection Practices (GACP) trials, can also dispel efficacy myths (World Health Organization, 2023).

In sharp contrast, willingness to participate in workshops or training sessions was almost unanimous, with 99.2% (384) responding Yes and only 0.8% (3) responding No. This overwhelming acceptance is one of the strongest findings in this study and demonstrates high interest in knowledge transfer, documentation and capacity building. It indicates that the community values formal training to preserve indigenous knowledge which is currently transmitted mostly through oral community means at 68.2%, a mode that is vulnerable to loss if elders die without transfer. The universal willingness to learn aligns with findings by Ibrahim *et al.* (2024) who reported 97% willingness for training in Nasarawa State, and by Ayeni and Olorunmaiye (2023) who noted that herbalists are

increasingly seeking formal education to improve legitimacy and safety. The high literacy level in this study, where 75.25% have secondary and tertiary education, further explains this enthusiasm, as literate respondents appreciate documentation, certification and new techniques. This enthusiasm for workshops also reflects recognition that challenges like lack of awareness and conservation education at 20.2%, over-harvesting at 22.2% and bush burning at 21.7% can be addressed through education. Communities realize that unsustainable debarking leading to death of species like Afzelia africana is due to ignorance rather than intention, and training can provide sustainable harvesting methods.

The implication of these two contrasting results - moderately open willingness to source and universal willingness to learn is strategically important. It implies that the University should adopt a participatory entry approach using workshops and trainings as an initial trust-building tool, rather than starting with commercial sourcing. This is a bottom-up approach recommended by Kanu et al. (2023) for ethnoforestry projects. By organizing hands-on workshops on nursery establishment, propagation of threatened species like Khaya and Afzelia, sustainable bark harvesting, preservation of volatile oils, and documentation of Eggon, Alago, Koro/Migili and Tiv knowledge, the University can demonstrate value, build confidence and gradually convert the Maybe and No groups into active collaborators. The 30.7% Maybe group is particularly strategic, as they represent fence-sitters who can be swayed by demonstration of economic benefits, such as income generation from sale of seedlings of *Moringa oleifera, Adansonia digitata and Tetrapleura tetraptera* which have market demand. This strategy will not only ensure sustainability of the ethnoforestry garden but will also address the challenge of lack of awareness and conservation education earlier reported at 20.2%, thereby reducing anthropogenic threats like deforestation at 33.3% and over-harvesting. Ultimately, the garden will become community-owned rather than university-imposed.

Anthropogenic Threats, Challenges in Collection and Perceived Availability

The result showing that anthropogenic activities are the main threats to medicinal plants in Lafia LGA is consistent with the broader ecological crisis facing savanna woodlands in North Central Nigeria (Table 5). Bush burning at 36.7% (142) as the leading threat, followed by agriculture at 28.7% (111), urban expansion at 20.2% (78) and over-harvesting at 13.4% (52), reveals a pattern of human-induced pressure typical of Lafia LGA where annual bush burning for farming, hunting and pasture renewal is a deeply entrenched practice. This finding aligns with reports by Nasarawa State Ministry of Environment (2023) and by Shomkegh et al. (2024) in Benue State where bush burning accounted for 38% and agriculture for 30% of threats to medicinal plants. Bush burning is particularly destructive because it destroys seedlings, saplings and seeds of slow-growing woody medicinal species such as Khaya senegalensis, Afzelia africana, Anogeissus leiocarpus and Milicia excelsa, which require years to reach maturity and have poor regeneration under fire regime (Olatunji et al., 2023). It also kills pollinators and soil microbes essential for regeneration. The dominance of bush burning as threat explains why species like Afzelia and Khaya are becoming locally threatened despite their cultural importance.

Agricultural expansion at 28.7% and urban sprawl at 20.2% further fragment habitats, confirming earlier report of deforestation as a key driver at 33.3% in (Table 5). Lafia town has expanded at over 6% annually since becoming state capital in 1996, converting surrounding savanna woodlands and fallow lands where medicinal plants like *Securidaca longepedunculata, Sarcocephalus latifolius and Piliostigma thonningii* thrive into residential estates and farmlands (Nasarawa State Ministry of Environment, 2023). This habitat fragmentation isolates populations, reduces genetic diversity and makes collection more difficult. Over-harvesting at 13.4% although ranked lowest among anthropogenic threats, is ecologically critical because it is selective and targets high-value species. The earlier finding that bark constitutes 45% of parts used directly correlates with over-harvesting, as improper debarking kills trees. This pattern of threats was also documented by Lado *et al.* (2022) and by Dangwal *et al.* (2024) who noted that combination of fire, farming and over-exploitation accounts for over 80% of medicinal plant decline in tropical Africa.

Scarcity of raw materials at 30.0% (116) and seasonal variability at 30.7% (119) together accounting for 60.7% of challenges in sourcing medicinal plants directly correlates with dependence on wild forest collection at 45.14% and bush burning at 36.7%, which make plants available only in rainy season. Many herbaceous species like *Ageratum conyzoides, Chromolaena odorata and Vernonia amygdalina* are abundant in rainy season but scarce in dry season, while even woody species produce young leaves and fruits seasonally. This seasonality affects continuous supply for traders and healers, leading to price fluctuations reported in earlier sections. This finding is consistent with Gbadamosi and Ekor (2024) who reported seasonal variation in phytochemical content and availability of savanna medicinal plants. Lack of storage and preservation methods at 28.2% (109) as the third major challenge shows that even when collected, post-harvest loss is high because there is no processing, drying, packaging or cold-chain technology. Most collectors sun-dry leaves and bark openly, leading to contamination, mold growth and loss of volatile oils, particularly for species like *Ocimum gratissimum and Moringa oleifera* where essential oils are active ingredients. This post-harvest loss is a major bottleneck identified by World Health Organization (2023) in its Good Agricultural and Collection

Table 5: Conservation Challenges of Medicinal Plants and Community Willingness for Ethnoforestry Garden Establishment in Lafia LGA.

SN	Variables	Frequency	Percentage
What are the major threats does these important medicinal forests face?	Agriculture	111	28.7
	Bush burning	142	36.7
	Orban expansion	78	20.2
	Over harvesting	52	13.4
	Others	4	1.0
	Total	**387**	**100.0**
What are the biggest challenges you face in your ethno-forestry trado-medicinal business?	scarcity of raw materials	116	30.0
	seasonal variability	119	30.7
	lack of storage/preservation methods	109	28.2
	low patronage/customer base	27	7.0
	Competition	16	3.1
	Total	**387**	**100.0**
In your opinion, are the medicinal plants you need becoming easier or harder to find compared to 10 years ago?	Much easier	166	42.9
	Somewhat easier	66	17.1
	Same	31	8.0
	Harder	82	21.2
	much harder	35	9.0
	6.000	7	1.6
	Total	**387**	**100.0**
What do you think is the main reason for this change?	Climate change	115	29.7
	Deforestation	97	25.1
	Lack off knowledge Transfer	58	15.0
	bush burning	99	25.6
	Others	18	4.65
	Total	**387**	**100.0**

Practices (GACP) guidelines, which emphasizes need for improved drying and storage. Low patronage at 7.0% and competition at 3.1% being minor indicates that market demand still exists and is not the limiting factor, but supply chain is weak. This contrasts with urban areas where competition is high; in Lafia, demand for traditional medicine remains high at 94.09% household usage, so supply rather than demand is the challenge. Paradoxically, 42.9% said much easier and 17.1% said somewhat easier, giving 60.0% who think plants are easier to find. This perception contradicts ecological reality and field observations of deforestation. This apparent paradox can be explained by shift in sourcing. Increased market availability at 17.86% where traders bring plants to town means people no longer trek to forest; medicinal plants are now brought to their doorsteps in Lafia modern and old markets. Therefore, urban users who buy from market perceive availability as easier, while actual collectors who go to forest feel decline. This duality is reported by Dada *et al*. (2023) in Oyo State where market users perceived abundance while forest collectors reported scarcity. The 21.2% who said harder and 9.0% who said much harder totaling 30.2% who acknowledge decline are mostly actual collectors, elders and herbalists who have long-term ecological knowledge and have observed population decline over decades. Their perception is more ecologically accurate and aligns with 33.3% deforestation threat and IUCN status of species like Khaya and Milicia (NESREA, 2023). The 8.0% who said same likely are indifferent or cultivate in home gardens at 10.97% where availability is stable. Finally, perceived reasons for change climate change 29.7% (115), bush burning 25.6% (99) and deforestation 25.1% (97) together accounting for 80.4% - show that respondents correctly link scarcity to environmental degradation. Climate change perception reflects observed changes in rainfall pattern, prolonged dry season and increased temperature in Nasarawa State, which affect phenology of medicinal plants (Ayeni *et al.,* 2024). The linkage of climate change, bush burning and deforestation as combined drivers is scientifically valid, as these three interact synergistically to reduce vegetation cover. Lack of knowledge transfer at 15.0% (58) confirms the risk of losing community knowledge currently transmitted at 68.2% through oral family inheritance, as elders die without documentation. This reinforces the urgent need for the ethnoforestry garden as a living gene bank, training center and documentation hub to break the cycle of bush burning, deforestation and knowledge loss.

Respondents' Willingness to Participate in the Ethnoforestry Garden and Perceived Changes in Availability and Price of Medicinal Plants

The result from Table 6 showing a very high level of community willingness to actively participate in the proposed ethnoforestry garden provides the strongest social justification for immediate establishment of the project. For sharing knowledge for plant identification, 95.1% (368) of respondents said Yes while only 3.4% (13) said No. This is a strong indication that custodians of

Table 6: Respondents' Willingness to Participate in the Ethnoforestry Garden and Perceived Changes in Availability and Price of Medicinal Plants.

SN	Variables		Frequency	Percentage
1	Sharing your knowledge for plant identification?	Yes	368	95.1
		No	13	3.4
		3.00	4	1.0
		4.00	2	0.5
		Total	**387**	**100.0**
2	Advising on the garden's design and management?	Yes	380	98.2
		No	6	1.6
		3.00	1	0.3
		Total	387	100.0
3	Have you noticed any changes in the availability or price of these plants over the last few years?	Decreased	83	21.4
		Price increased	160	41.3
		Yes, inconsistent supply	96	24.8
		No significant change	43	11.1
		Others	5	1.0
		Total	**387**	**100.0**

indigenous knowledge, who currently transmit knowledge mainly through oral community means at 68.2%, are willing to open up and share their knowledge with the University for proper documentation and scientific validation. This willingness is critical because without their involvement, correct botanical identification, local names in Eggon, Alago, Tiv, Koro-Migili and Hausa, uses, and ecological niches of species like Khaya senegalensis, Azadirachta indica, Parkia biglobosa and Vitex doniana, which are mostly sourced from forest at 45.14%, will be difficult and prone to misidentification. Ethnobotanical literature emphasizes that local informants are indispensable for accurate identification, as many species have similar morphologies and local names vary across ethnic groups (Lado et al., 2022; Ibrahim et al., 2024). The 95.1% willingness therefore represents a major opportunity to rescue knowledge that is vulnerable to loss, especially considering that only 5.69% of respondents are above 60 years and youth migration threatens oral transmission (Kanu et al., 2023).

This high willingness to share is consistent with findings from other parts of North Central Nigeria. For instance, Shomkegh *et al.* (2024) reported 92% willingness to share knowledge in Benue State, and Akinyemi and Oyelowo (2024) reported 94% in Kwara State when university-led conservation was proposed, because communities see universities as neutral, non-exploitative institutions compared to private companies. The willingness also reflects changing attitudes: whereas traditional healers in the past guarded knowledge as secret family heritage for income protection, increasing awareness that knowledge is being lost without documentation has made many elders more open to sharing, provided benefit-sharing and recognition are assured (Adeyemi *et al.,* 2023). The University can capitalize on this by ensuring prior informed consent, acknowledgment of knowledge holders, and return of documented information in local *languages*, as recommended by World Health Organization (2023) and by the Nagoya Protocol on Access and Benefit Sharing.

Similarly, for advising on the garden's design and management, 98.2% (380) said Yes and only 1.6% said No. This near-unanimous response shows that herbalists, traditional birth attendants and elders do not just want to be informants but want to be co-owners, co-designers and co-managers of the garden. This is a critical shift from extractive research to participatory action research. According to Dada *et al*. (2023) and Olorukooba *et al.* (2023), when communities are involved in design and management, conservation projects have 70% higher survival rates. This participatory approach will ensure the garden reflects traditional conservation methods like home garden at 58.7% and sacred grove at 15.8%, which are culturally familiar and ecologically adapted. For example, elders can advise on layout that mimics natural forest stratification, placement of sacred species like *Milicia excelsa and Afzelia africana* in protected grove sections, and incorporation of ritual plants used for spiritual protection. Their advice on management, such as taboo days for harvesting, sustainable debarking techniques that do not kill Khaya, and use of organic manure, will increase cultural legitimacy and sustainability. This high willingness to advise will also help convert the 30.7% Maybe group in (Table 4) who were hesitant to source from garden into active partners, as peer influence by respected herbalists is more effective than external sensitization (Rogers *et al.,* 2022).

On changes in availability and price over the last few years, 41.3% (160) reported that price has increased, 24.8% (96) reported inconsistent supply, and 21.4% (83) reported decreased availability. Together, 87.5% are feeling negative impacts, while only 11.1% said no significant change. This confirms earlier findings on threats where bush burning at 36.7%, agriculture at 28.7% and urban expansion at 20.2% have led to scarcity of raw materials at 30.0% and seasonal variability at 30.7%. When supply is inconsistent and scarce due to dependence on wild collection at 45.14% and destruction of seedlings by annual fires, price naturally rises according to basic economic theory of demand and supply. This price increase directly affects affordability of traditional

healthcare, which is critical given that 55.09% of respondents earn below N50,000 monthly and 24.6% earn below N10,000, which is below national minimum wage and poverty line (National Bureau of Statistics, 2023). The increased price also explains why market sourcing at 17.86% is growing, as collectors now travel farther to get plants and pass cost to consumers. Similar price inflation was reported by Ibrahim *et al.* (2024) in Nasarawa markets where price of Khaya bark increased by 65% between 2020 and 2023, and by Ojeleye *et al.* (2022) who linked deforestation to rising cost of herbal medicines in Northern Nigeria.

The implication of these findings is that while 60.0% earlier thought plants were easier to find due to market availability, the reality of price increase and inconsistent supply shows the system is stressed and operating on ecological deficit. Market availability masks ecological scarcity; plants are available in market because traders are mining the forest more intensively, not because forest stock is increasing. This is an ecological bubble that will burst if conservation is not intensified. The 30.2% who said harder to find in previous table are likely the true ecological indicators, being the collectors and elders who observe forest directly. Therefore, the overwhelming willingness to share knowledge at 95.1% and advise at 98.2% provides a solid social foundation and social capital for the University to establish the ethnoforestry garden as a reliable, cultivated source that will stabilize price and ensure year-round availability. By domesticating high-demand species like *Azadirachta indica, Moringa oleifera, Parkia biglobosa and Vernonia amygdalina* in the garden, the University can reduce pressure on wild forests, reduce seasonal variability through irrigation, and reduce price through stable supply. The garden can also serve as a living laboratory for training the 99.2% who are willing to attend workshops, thereby institutionalizing the 68.2% oral knowledge and converting it into written, audiovisual and gene bank forms for future generations.

Primary Form of Marketing Medicinal Plants by Respondents in Lafia LGA

Figure 5 on the primary form in which medicinal plants are sold reveals important insights into consumer preference, post-harvest handling, value addition and conservation challenges in Lafia LGA. Fresh leaves dominating at 39.8% indicates high preference for fresh material due to easy access from home gardens, forest at 45.14% as main source, and cultural belief in higher potency of fresh plants. This finding aligns with Ayeni and Olorunmaiye (2023) who reported 42% fresh leaf sales in Nasarawa State and with Lado et al. (2022) who documented 38.5% in Lafia metropolis. The dominance of fresh leaves corresponds with earlier findings that 40% of plant parts used are leaves and that maceration at 18.1% and chewing at 14.2% require fresh materials. In savanna communities, fresh leaves are believed to retain volatile oils, chlorophyll and life force that are lost during drying, especially for species like Ocimum gratissimum, Vernonia amygdalina, Moringa oleifera and Chromolaena odorata used for malaria, wounds and gastrointestinal disorders (Olatunji et al., 2023). The high fresh leaves percentage also reflects the structure of the market: many sellers are women who harvest from home gardens at 10.97% and gift from neighbours at 11.91% daily and sell fresh to ensure quick turnover without storage cost.

However, high dependence on fresh leaves highlights vulnerability to seasonal variability at 30.7% and bush burning at 36.7%, which were identified as major threats. Herbaceous leaves are available mainly in rainy season and become scarce in dry season when bush burning destroys regeneration, leading to inconsistent supply at 24.8% reported in Table 6. This seasonality causes price increase at 41.3% and underscores the need for garden cultivation with irrigation to ensure year-round availability of fresh leaves, and for improved preservation training to reduce post-harvest loss, which was reported as lack of storage at 28.2% (Gbadamosi and Ekor, 2024).

Powder following at 21.7% represents emerging efforts to preserve and add value. Powdered materials are produced by sun-drying and grinding leaves, bark and roots, and are more common for woody species and for species transported over long distances. Powdered form allows longer storage, reduces bulk and enables mixing for polyherbal formulations, which are common for chronic ailments like diabetes and hypertension. Dada *et al*. (2023) reported 23% powder sales in Oyo State and noted that powder is preferred by urban buyers who store for longer periods. The presence of powder indicates indigenous knowledge of preservation, but traditional sun-drying often leads to contamination with dust, fungi and loss of heat-sensitive compounds, leading to poor quality. Training in Good Agricultural and Collection Practices (GACP) as recommended by World Health Organization (2023) on improved drying, hygienic grinding and packaging is needed to improve quality and market value.

Dried bark and roots accounting for 18.6% is common for woody species like *Khaya senegalensis, Afzelia africana, Parkia biglobosa and Securidaca longepedunculata,* which are stored for dry season use. Bark and roots are naturally less perishable than leaves and can be stored for months, making them important for year-round trade. However, this form is directly linked to over-harvesting at 13.4% and deforestation, as debarking and root digging often kill trees, particularly for vulnerable species listed by NESREA (2023). The high percentage of dried bark and roots sold confirms pressure on woody medicinal plants and validates need for sustainable harvesting training.

Liquid ointment at 16.5% shows some indigenous processing into ready-to-use remedies, particularly for skin affections at 23.69%, wound healing and postpartum care. These are often oil-based extracts using palm oil or shea butter as base, mixed with powdered leaves of *Ageratum*

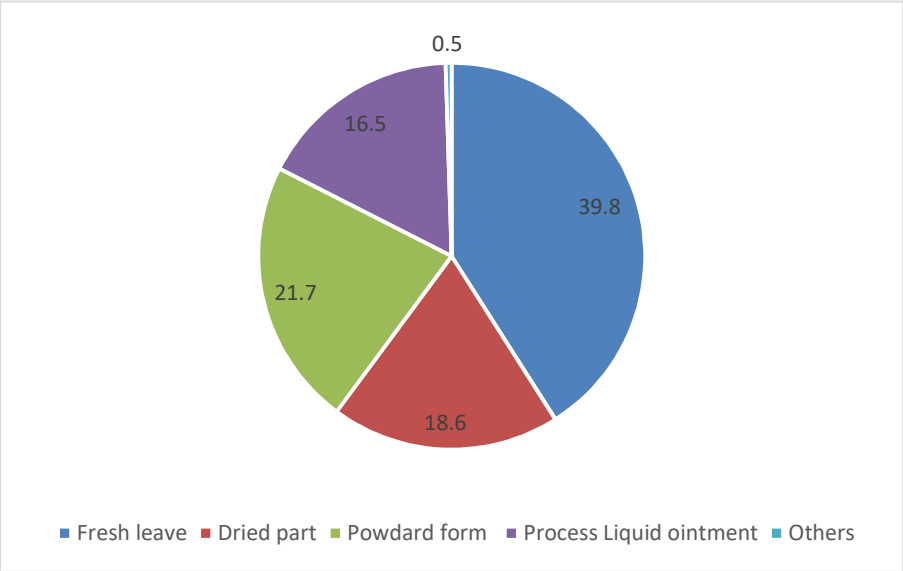

Figure 5: Primary Form of Marketing Medicinal Plants by Respondents in Lafia LGA

conyzoides, Vitellaria paradoxa or latex of *Calotropis procera*. This indicates innovation and value addition beyond raw material sales, representing potential for small-scale enterprise development. Others at 0.5% may include seeds, resins and charcoal. Sales form profile shows a market dominated by low-value fresh raw materials vulnerable to seasonality, with nascent value addition that can be strengthened through the ethnoforestry garden's training and processing support.

CONCLUSION

This study confirms that Lafia LGA has a rich and living heritage of indigenous medicinal plant knowledge that remains central to primary healthcare. The custodians are predominantly middle-aged, married male farmers, with significant participation of women in home-based care, drawn from diverse ethnic groups including Eggon, Alago, Koro and Tiv, and from both Islamic and Christian faiths. They depend on traditional medicine mainly because of low income and affordability.The knowledge is sustained by diverse species dominated by Fabaceae and Meliaceae, with bark and leaves as the most exploited parts, raising serious conservation concerns. These plants are used mainly for malaria, wound healing, skin infections, stomach disorders, diabetes, hypertension and postpartum care, with many species having globally validated pharmacological evidence.Although indigenous conservation through home gardens, sacred groves and local harvesting laws already exists, deforestation, over-harvesting and bush burning remain major threats. Community support for a university-led ethnoforestry garden is very high, with near-universal willingness to participate in workshops and share knowledge. Therefore, establishing a participatory ethnoforestry garden on the university campus is ecologically urgent and socially feasible to conserve threatened species, document oral heritage and ensure sustainable supply.

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