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Comparative Assessment of Medicinal Plant Diversity in Agroforestry Systems and Open Farmlands in Northern Katsina State, Nigeria

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ABSTRACT

This study assessed medicinal plant diversity in agroforestry and open farmland systems in northern Katsina State, Nigeria. A comparative field-based approach was employed across parklands, homegardens and open farmlands using standard quadrat sampling methods for vegetation assessment. A total of 82 medicinal plant species belonging to 37 families were recorded. Species diversity was measured using the Shannon–Wiener index (H'), with parklands ($H' \approx 1.75 \pm 0.30$) and homegardens ($H' \approx 1.61 \pm 0.44$) showing higher diversity than open farmlands ($H' \approx 0.91 \pm 0.48$). Welch's ANOVA indicated a significant difference in medicinal plant diversity among land-use types ($F(2, 105.58) = 69.65$, $p < 0.001$). Post-hoc comparisons (Games-Howell test) revealed that both parklands and homegardens had significantly higher medicinal plant diversity than open farmlands. Significant difference was observed between parklands and homegardens. The findings conclude that agroforestry systems play an important role in conserving medicinal plant diversity in semi-arid environments, highlighting their value for biodiversity conservation and sustainable land management.

Keywords: Agroforestry, Biodiversity conservation, Ethnobotany, Medicinal plant, Semi-arid Nigeria, Shannon–Wiener index

INTRODUCTION

Medicinal plants are a vital component of both traditional and modern healthcare systems (WHO, 2013; Sofowora *et al.*, 2013). They provide therapeutic compounds that underpin primary healthcare, especially in regions where formal medical services are limited and plant-based remedies are culturally embedded (WHO, 2013). Globally, an estimated 80% of people in some African and Asian countries rely primarily on medicinal plants for healthcare needs (WHO, 2013). In Nigeria, medicinal plants are widely used for the treatment of various ailments and form an important part of cultural heritage and local healthcare practices (Kankara *et al.*, 2018; Kankara *et al.*, 2020; Kankara *et al.*, 2022).

Despite their importance, medicinal plant resources are increasingly threatened by deforestation, overharvesting, agricultural expansion, fuelwood collection and overgrazing. These pressures have led to habitat loss and a decline in plant biodiversity, particularly in the Sudan and Sahel savanna regions of northern Nigeria. The continued loss of these resources poses serious challenges to both biodiversity and conservation and rural healthcare systems. (Bello *et al.*, 2019).

Agroforestry, which involves the deliberate integration of trees, shrubs, and crops within managed landscapes, has been recognized as a sustainable land-use practice capable of conserving biodiversity while supporting agricultural productivity. Agroforestry systems such as home gardens, parklands, shelterbelts and live fences enhance structural complexity, create diverse ecological niches and often support higher species richness than monoculture systems (Mbow *et al.*, 2014). In Katsina State, important medicinal species, including *Azadirachta indica* (neem), *Moringa oleifera* (drumstick), *Hyptis suaveolens* (bush mint) and *Telfairia occidentalis* (fluted pumpkin) are frequently conserved within agroforestry systems. These systems allow sustainable harvesting, reduce pressure on wild populations and promote the conservation of rare or threatened species while integrating indigenous knowledge with sustainable land management practices (Jose, 2009: Bello *et al*., 2019).

Katsina State located in northern Nigeria's semi-arid Sudan Savanna is characterized by distinct rainy and dry seasons, low and erratic rainfall and high temperatures. Rural communities in the region rely heavily on both cultivated and wild plant species for healthcare, nutrition and cultural practices. Medicinal plants play a central role in sustaining these communities while agroforestry systems help buffer environmental stresses by improving soil fertility, water retention, and microclimate regulation (Jose, 2009; Akinnifesi *et al.*, 2010). Socio-economically, medicinal plants provide non-timber forest products (NTFPs) that generate income, particularly for women that manage herbal medicines and contribute to climate resilience by mitigating drought and restoring degraded lands (Shanley and Luz, 2003; Mbow *et al.*, 2014).

Despite recognition of agroforestry's ecological and socio-economic benefits, significant knowledge gaps remain. Empirical evidence directly linking agroforestry to the conservation of medicinal plant diversity in northern Nigeria is limited. Most studies generalize agroforestry benefits without focusing on medicinal flora or integrating quantitative vegetation surveys with ethnobotanical documentation. Therefore, this study was conducted to identify and document medicinal plants found in agroforestry systems and to compare medicinal plant diversity between agroforestry and non-agroforestry system in northern Katsina State. The findings are expected to contribute to biodiversity conservation planning and sustainable land-use management in semi-arid regions.

MATERIALS AND METHODS

Study Area

The study was conducted in Katsina State, located in the northwestern geopolitical zone of Nigeria. It covers an area of 23,938 square kilometers, approximately between latitude 11°00'N and 13°20'N and longitude 6°45'E and 9°10'E. Katsina shares borders with the Republic of Niger to the north, Kano and Jigawa States to the east, Kaduna State to the south, and Zamfara State to the west. The region experiences a tropical continental (semi-arid) climate characterized by distinct wet and dry seasons with a mean annual rainfall ranging between 500mm - 800mm. Temperature ranges from about 21°C during the cool dry season to 42°C during the hottest dry period (Nigerian Meteorological Agency [NIMET], 2020). The vegetation transitions from Sudan Savanna in the south to Sahelian savanna in the north, featuring scrubland, grasses, and scattered woody plants. Katsina State is divided into 34 Local Government Areas (LGAs), grouped into three senatorial districts: Katsina North, Katsina Central and Katsina South. (Fig. 1). For the purpose of this study, Katsina North was purposively selected because the area is more vulnerable to desertification, making it a priority for biodiversity conservation and Agroforestry research.

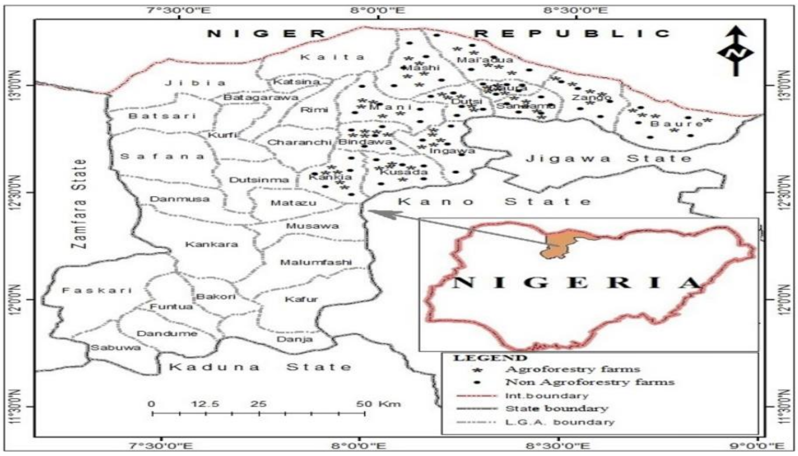

Figure 1: Map of Katsina state showing study locations and distribution of agroforestry farms (Parklands) and non-agroforestry (Open farmlands)

Sample Size and Sampling Design

This study adopted a comparative field research design, integrating both quantitative and qualitative methods. A total of 180 sampling units were surveyed across 12 Local Government Areas (LGAs) in northern Katsina State. These comprised 60 parklands, 60 homegardens and 60 open farmlands, representing the dominant land-use systems in the region. Within each LGA, five sampling units per land-use type were selected to ensure balanced spatial representation.

In parklands and open farmlands, three plots (15m × 15m) were established within each sampling unit for the assessment of tree and shrub medicinal species. Within each plot, nested quadrats (5m × 5m) were used to sample herbaceous medicinal plants, following standard vegetation sampling procedures (Kent, 2012). In homegardens, the entire garden area was surveyed due to their small size and heterogeneous structure, a commonly adopted approach in homegarden biodiversity studies (Kumar and Nair, 2004).

Data Collection

Field surveys were conducted between July and December 2025. Within each sampling plot, all medicinal plant species were identified and enumerated. Species identification was based on standard floras and taxonomic keys, supplemented by indigenous knowledge from local farmers, in line with established ethnobotanical methodologies (Martin, 1995). Voucher specimens were collected, processed and deposited at the Umaru Musa Yar'adua University Katsina Herbarium (UMYUK) to ensure taxonomic verification.

The geographic coordinates of parklands and open farmlands sites were recorded using smartphone-based GPS applications for spatial referencing. GPS coordinates were not recorded for home gardens; instead, each garden was assigned a unique identification code for data management and analysis.

Data Analysis

Medicinal plant diversity across parklands, homegardens and open farmlands was analyzed using the Shannon–Wiener Diversity Index (H′), which accounts for both species richness and evenness (Magurran, 2004). The index was calculated as:

$H' = -\Sigma\ (p_i \ln p_i)$

Where: H′ = Shannon–Wiener diversity index, $-\Sigma$= negative summation, p_i = proportion of individuals of species i (n_i/N) n_i = number of individuals of species, N = total number of individuals of all species.

Differences in medicinal plant diversity among land-use systems were analyzed using Welch's ANOVA, followed by Games-Howell post-hoc test for pairwise comparisons. All analyses were performed using Microsoft Excel (version 2016) and IBM SPSS Statistics (version 26.0).

Ethical Considerations

Ethical approval for the study was obtained from the Ministry of Environment Katsina State, prior to fieldwork. Consent was also sought and obtained from farmers before engaging with them or accessing their land. Fieldwork was conducted in strict adherence to local customs, cultural norms, and traditional knowledge systems, following the ethical guidelines of ethno botanical research (ISE, 2006).

RESULTS AND DISCUSSION

Results

Medicinal Plants identified in Agroforestry Systems (Parklands and Homegardens)

A total of 82 medicinal plant species were recorded across agroforestry systems in northern Katsina State, representing 35 botanical families. The most abundant families were Fabaceae (19 species, 23.17%), Poaceae (4 species, 4.88%), Anacardiaceae (4 species, 4.88%), Lamiaceae (4 species, 4.88%), Combretaceae (4 species, 4.88%), Malvaceae (3 species, 3.66%), Apocynaceae (3 species, 3.66%), Arecaceae (3 species, 3.66%), Asteraceae (3 species, 3.66%) and Moraceae (3 species, 3.66%), Amaryllidaceae (2 species, 2.44%), Cucurbitaceae (2 species, 2.44%), Euphorbiaceae (2 species, 2.44%), Lythraceae (2 species, 2.44%), Meliaceae (2 species, 2.44%), Myrtaceae (2 species, 2.44%), Rubiaceae (2 species, 2.44%) while each of the remaining 20 families was represented by a single species (1.22% each), reflecting a broad but uneven distribution of taxa. Trees constituted 40.2% of species, herbs 29..2%, shrubs 25.6%, and grasses 4.8%. Regarding domestication, wild species comprised 63.41%, cultivated 29.27%, and semi-domesticated species 7.32%. In terms of habitat, parklands harbored 58.54% of species, home gardens 32.93%, and both habitats 8.54% (Table 1, Figures 2 and 3).

Table 1: Medicinal Plants identified in Agroforestry Systems (Parklands and Home gardens)

Scientific Name	Local Name (Hausa)	Common Name	Family	Voucher Specimen No	Habit/ Domestication	Habitat
Balanites aegyptiaca (L.) Delile	Aduwa	Desert date	Zygophyllaceae	BSA001	T/W	PL
Vachellia nilotica (L.) P.J.H.Hurter & Mabb.	Bagaruwa	Babul	Fabaceae	BSA002	T/W	PL
Entada abyssinica Steud. Ex A. Rich	Tawatsa	African Dream Herb	Fabaceae	BSA003	T/W	PL
Musa paradisiaca L.	Ayaba	Banana	Musaceae	BSA004	H/C	HG
Euphorbia balsamifera Aiton	Alyara	Balsam spurge	Euphorbiaceae	BSA005	S/W	PL
Aloe vera (L.) Burm. f.	Kada	Aloe vera	Asphodelaceae	BSA006	S/C	HG
Senna mimosoides (L.) H.S. & Irwin Barneby	Bagaruwa (kasa)	Fishbone cassia	Fabaceae	BSA007	H/W	PL
Eragrostis tremula Hochst. ex Steud.	Burburwa	Love grass	Poaceae	BSA008	G/W	PL
Maerua angolensis DC.	Ciciwa	Bushveld-bead-bean	Capparaceae	BSA009	T/W	PL
Amaranthus hybridus L.	Alayyahu	Spinach	Amaranthaceae	BSA010	H/C	HG
Senegalia senegal (L.) Willd	Dakwara	Gum arabic	Fabaceae	BSA011	T/W	PL
Sclerocarya birrea (A. Rich.) Hochst.	Danya	Marula	Anacardiaceae	BSA012	T/W	PL
Vitex doniana Sweet	Dinya	African black plum	Lamiaceae	BSA013	T/W	PL
Parkia biglobosa (Jacq.) G.Don	Dorawa	African Locust Bean	Fabaceae	BSA014	T/W	PL
Dichrostachys cinerea (L.)Wight & Am.	Dundu	Kalahari Christmas tree	Fabaceae	BSA015	S/W	PL
Senna sieberiana DC.	Malga	African laburnum	Fabaceae	BSA016	S/W	PL
Senna alata L. Roxb.	Filasko	Ringworm bush	Fabaceae	BSA017	S/W	HG
Faidherbia albida (Delile) A. Chev.	Gawo	Winter thorn	Fabaceae	BSA018	T/W	PL
Andropogon gayanus Kunth	Gambaa	Gamba grass	Poaceae	BSA019	G/W	PL
Ficus platyphylla Delile	Gamji	Guttapercha tree	Moraceae	BSA020	T/W	PL
*Striga hermonthica (*Delile) Benth.	Gaugai	Purple witchweed	Orobanchaceae	BSA021	H/W	PL
Combretum micranthum G. Don	Geza	Kinkeliba	Combretaceae	BSA022	S/W	PL
Borassus aethiopum Mart.	Giginya	African fan palm	Arecaceae	BSA023	T/W	PL
Mitracarpus scaber Zucc.	Goga masu	Button grass	Rubiaceae	BSA024	H/W	PL
Carica papaya L.	Gwanda	Pawpaw	Caricaceae	BSA025	S/C	HG
Annona senegalensis Pers.	Gwandar daji	Wild custard apple	Annonaceae	BSA026	S/WorC	PL/HG
Boswellia dalzielii Hutch.	Hano	Frankincense tree	Burseraceae	BSA027	T/W	PL
Psidium guajava L.	Gwaba	Guava	Myrtaceae	BSA028	S/C	HG
Vernonia amygdalina Delile	Shuwaka	Bitter leaf	Asteraceae	BSA029	H/WorC	HG
Ximenia Americana L.	Tsada	Yellow plum	Olacaceae	BSA030	S/W	PL
Hyphaene thebaica (L.) Mart	Goruba	Dum palm	Arecaceae	BSA031	T/W	PL
Vitellaria paradoxa C.F. Gaertn.	Kadanya	Shea butter tree	Sapotaceae	BSA032	T/W	PL
Piliostigma reticulatum (DC.) Hochst.	Kalgo	Mountain Ebony	Fabaceae	BSA033	S/W	PL
Combretum hypopilinum Diels	Kantakara	Bush Willow	Combretaceae	BSA034	T/W	PL
Diospyros mespiliformis Hochst. ex A. DC.	Kanya	African ebony	Ebenaceae	BSA035	T/W	PL
Mangifera indica L.	Mangwaro	Mango	Anacardiaceae	BSA036	T/C	HG
Prosopis africana (Guill. & Perr.) Taub	Kirya	African mesquite	Fabaceae	BSA037	T/W	PL
Cymbopogon citratus (DC.) Stapf	Cittar ganye	Lemon grass	Poaceae	BSA038	G/C	HG
Abelmoschus esculentus (L.) Moench	Kubewa	Okro	Malvaceae	BSA039	H/C	HG

Scientific Name	Local Name (Hausa)	Common Name	Family	Voucher Specimen No	Habit/ Domestication	Habitat
Cenchrus pedicellatus (Lam.) Morone	Kyasuwa	Hairy fountain grass	Poaceae	BSA040	G/W	PL
Lawsonia inermis L.	Lalle	Henna	Lythraceae	BSA041	S/W	HG
Guiera senegalensis J.F. Gmel.	Sabara	Moshi medicine	Combretaceae	BSA042	S/W	PL
Khaya senegalensis (Desr.) A. Juss	Madaci	African mahogany	Meliaceae	BSA043	T/W	PL
Ziziphus mauritiana Lam.	Magarya	Indian jujube	Rhamnaceae	BSA044	S/W	PL
Anogeissus leiocarpa (DC.) Guil. & Perr.	Marke	African birch	Combretaceae	BSA045	T/W	PL
Punica granatum L.	Ruman	Pomegranate	Lythraceae	BSA046	S/C	HG
Senna singueana (Delile) Lock	Runhu	Wild cassia	Fabaceae	BSA047	S/W	PL
Cissus quadrangulari L.	Rama	Veld grape	Vitaceae	BSA048	H/W	HG
*Senegalia ataxacantha (*DC.) Kyal. Boatwr.	Sarkakkiya	Flame thorn	Fabaceae	BSA049	S/W	PL
Albizia chevalieri Harms.	Katsari	Flat crown	Fabaceae	BSA050	T/Wor C	PL
Ficus polita Vahl.	Durumi	Heart- leaved Fig	Moraceae	BSA051	T/W	PL/ HG
Senna obtusifolia (L.) H.S. Irwin & Barneby	Tafasa	Sickle pod	Fabaceae	BSA052	H/W	PL/ HG
Detarium microcarpum Guill. & Perr.	Taura	Sweet dattock	Fabaceae	BSA053	T/W	PL
Tamarindus indica L.	Tsamiya	Tamarind	Fabaceae	BSA054	T/W	PL
Ocimum basilicum L.	Daddoya	Sweet basilicum	Lamiaceae	BSA055	H/C	HG
Calotropis procera (Aiton.) W.T.Aiton.	Tumfafiya	Sodom apple	Apocynaceae	BSA056	S/W	PL
Leptadenia hastata (Pers.) Decne	Yadiya	Wild jute	Apocynaceae	BSA057	S/WorC	PL
Allium cepa L.	Albasa	Onion	Amaryllidaceae	BSA058	H/C	HG
Leucas martinicensis (Jacq.) R.Br.	Kan barawo	White wort	Lamiaceae	BSA059	H/W	PL
Telfairia occidentalis Hook.f.	Ugu	Fluted pumpkin	Cucurbitaceae	BSA060	H/C	HG
Ficus thonningii Blume	Shiriya	Common wild fig	Moraceae	BSA061	T/W	HG
Jatropha curcas L.	Cindazugu	Barbados nut	Euphorbiaceae	BSA062	S/C	HG
Centaurea perrottetii DC.	Surandi	Star-thistle	Asteraceae	BSA063	H/W	PL
Mentha piperata L.	Naanaa	Spearmint	Lamiaceae	BSA 064	H/C	HG
Senna occidentalis (L.) Link	Raidoree	Coffee senna	Fabaceae	BSA065	H/W	HG
Caralluma dalzielii N.E. Brown	Karan massallaci	Mosque reed	Apocynaceae	BSA066	H/W	HG
Lannea acida A. Rich.	Faru	African grape	Anacardiaceae	BSA067	T/WorC	PL
Bauhinia rufescens Lam.	Tsatstsagi	Silver butterfly	Fabaceae	BSA068	S/W	PL
Anacardium occidentale L.	Yazawa	Cashew	Anacardiaceae	BSA069	T/C	HG
Cucurbita maxima Duchesne	Kabewa	Pumpkin	Cucurbitaceae	BSA070	H/C	HG
Citrus aurantifolia (Christm.) Swingle	Lemun tsami	Lemon	Rutaceae	BSA071	T/C	HG
Solanum lycopersicum L.	Tumatir	Tomato	Solanaceae	BSA072	H/C	HG
Azadirachta indica A. Juss.	Bedi	Neem	Meliaceae	BSA073	T/WorC	PL/ HG
Ipomoea batatas (L.) Lam.	Dankalin hausa	Sweet potato	Convolvulaceae	BSA074	H/C	HG
Adansonia digitata L.	Kuka	Baobab	Malvaceae	BSA075	T/W	PL
Moringa oleifera Lam.	Zogale	Drumstick tree	Moringaceae	BSA076	T/C	HG
Phoenix dactylifera L.	Dabino	Dates palm	Arecaceae	BSA077	T/C	HG
Acanthospermum hispidum DC.	Yawo	Bristly starbur	Asteraceae	BSA078	H/W	PL
Hibiscus sabdariffa L.	Sobo	Roselle	Malvaceae	BSA079	H/C	PL HG
Crinum ornatum (Aiton) Albasar kwadi Herb.		River lily	Amaryllidaceae	BSA080	H/W	HG
Spermacoce stachydea DC. Alkamar turwa		False buttonweed	Rubiaceae	BSA081	H/W	PL
Eucalyptus camaldulensis Turare Dehnh.		Eucalyptus	Myrtaceae	BSA082	T/C	PL

T=Trees S= Shrubs H=Herbs W= Wild C=Cultivated WorC=Wild/Cultivated PL=Parklands HG=Home gardens PL/HG=Parklands /Home garden

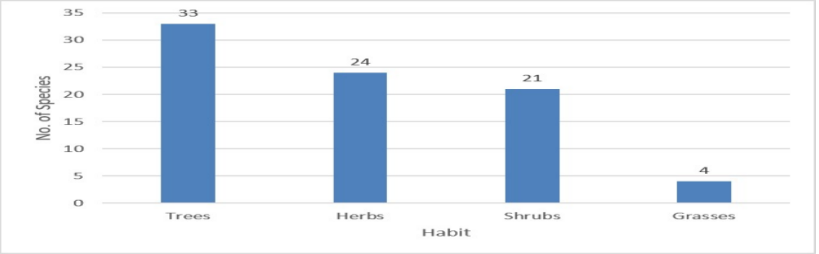

Figure 2: Distribution of Medicinal Plant Families recorded in agroforestry systems.
Note: Numbers above each bar indicate the number of medicinal plant species recorded in each family category

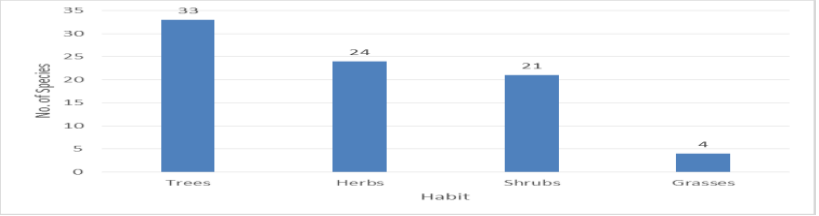

Figure 3: Habit Status of Medicinal Plants found in Agroforestry Systems
Note: Numbers above each bar indicate the number of medicinal plant species in each growth habit category

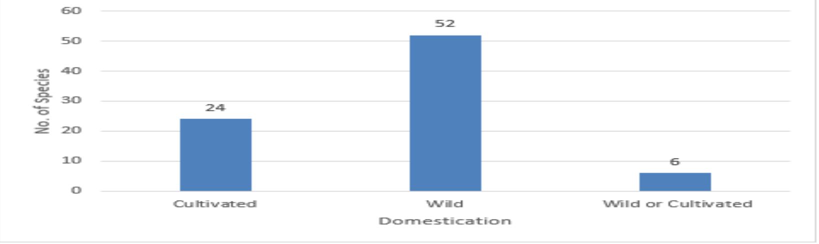

Figure 4: Domestication Status of Medicinal Plants found in Agroforestry Systems
Note: Numbers above each bar indicate the number of medicinal plant species recorded in each domestication category.

Diversity Comparison between Agroforestry and Non-Agroforestry Systems

Shannon–Wiener diversity (H′) varied across land-use types (Table 2). Parklands exhibited the highest mean diversity (H′ ≈ 1.76), followed by homegardens (H′ ≈ 1.61), while open farmlands recorded the lowest mean diversity (H′ ≈ 0.90) (Table 2)

Table 2: Descriptive Statistics of Shannon- Weiner Diversity (H′) **Across Land-Use Systems**

Land use System	Sample Size (N)	Shannon- Weiner Diversity (H′) (mean ± SD)
Parklands	60	1.75 ± 0.30
Homegardens	60	1.61 ± 0.44
Open farmlands	60	0.91 ± 0.48

Welch's ANOVA Results for Shannon- Weiner Diversity (H') **Across Land-Use Systems**

Welch's ANOVA revealed significant differences in medicinal plant diversity among land use systems (F (2,105.584) =69.647, $p < 0.001$. (Table 3)

Table 3: Welch's ANOVA Results for Shannon- Weiner Diversity (H′) **across land-use systems**

Variable	Welch Statistic (F)	df1	df2	p-value
Shannon-Weiner Diversity (H')	69.65	2	105.58	< 0.001

Post-Hoc Test (Games- Howell)

Pairwise comparisons revealed significant differences in species diversity among land use types. Diversity in parklands was significantly higher than in Homegardens (Mean Difference =0.1535, p=0.03) and Open farmlands (Mean Difference = 0.8623, $p < 0.001$). Similarly, homegardens had significantly higher diversity than open farmlands (Mean Difference =0.7088, $p < 0.001$).

Table 4: Games-Howell Post-hoc Multiple Comparisons for Shannon- Weiner Diversity (H′)

Comparison	Mean Difference	Std. Error	p-value
Homegardens vs Parklands	0.1535	0.0610	0.03
Homegardens vs Open farmlands	0.7088	0.0849	< 0.001
Parklands vs Open farmlands	0.8623	0.0728	< 0.001

Discussion

This study highlights the rich medicinal plant diversity maintained within agroforestry systems of northern Katsina State, documenting 82 species across 35 botanical families. The dominance of trees and herbs, along with a notable proportion of shrubs, reflects the multifunctional nature of traditional agroforestry where perennial woody species are deliberately retained for ecological stability, livelihood support and medicinal purposes. The presence of cultivated, semi-wild and wild species underscores the dynamic interplay between managed and natural vegetation in sustaining medicinal plant populations, and comparable patterns have been reported across Nigeria, where agroforestry systems such as homegardens serve as reservoirs of medicinal plant diversity (Odewo *et al*., 2022; Ifunanya, 2024). In Katsina State, previous studies similarly highlighted medicinal plant richness within farm margins, semi-managed woodlands, and mixed-cropping systems (Kankara *et al*., 2015, 2022; Gidado and Yaradua, 2022), demonstrating the long-standing ethnobotanical significance of agroforestry landscapes.

The present findings are also consistent with those of Abubakar *et al.* (2019), who reported high tree species diversity in Jema'a Local Government Area of Kaduna State, Kaduna State, Nigeria. Their study identified Fabaceae and Combretaceae among the dominant tree families, similar to the family composition observed in the present study. This similarity suggests that tree-based land-use systems in the Nigerian savanna contribute substantially to the conservation of plant diversity and support the ecological importance of woody vegetation across different landscapes.

Contrary to the common assumption that homegardens support the highest medicinal plant diversity, parklands in northern Katsina State showed higher overall species richness, particularly among trees and shrubs while home gardens exhibited relatively greater herbaceous richness. This pattern likely reflects selective retention of culturally and economically important woody species, lower disturbance and long-term ecological continuity in parklands which favor species persistence and natural regeneration. Diversity patterns between homegardens and parklands are highly context-dependent. In Ethiopian sub-humid lowlands, Tadesse *et al*. (2019) reported higher overall species richness in homegardens compared to parklands due to intensive management and inclusion of exotic species whereas parklands were dominated by native flora. Such contrasts emphasize that local ecological conditions, management intensity and species composition determine diversity outcomes. In northern Katsina State, the higher woody diversity in parklands may additionally be influenced by the small size and high protection of local home gardens, as well as seasonal variations, with the rainy season promoting the abundance of wild species. These findings underscore the complementary roles of parklands and homegardens: parklands act as refugia for native woody species while homegardens enhance access to herbaceous medicinal species for household use.

Patterns of species diversity and abundance further corroborate these observations. Parklands exhibited more balanced species composition and higher diversity indices compared to home gardens and open farmlands whereas open farmlands consistently showed the lowest richness and diversity. Similar trends have been observed in Ghana and Ethiopia, where semi-managed or traditional agroforestry systems consistently outperformed intensive farmlands in maintaining medicinal plant diversity (Yasin *et al.*, 2022; Yeboah *et al*., 2022; Tebkew *et al*., 2024). These findings highlight the importance of land-use heterogeneity, selective species retention, and integrated management in sustaining medicinal plant diversity, a principle that extends across diverse agro ecological and socioeconomic contexts (Nandy and Das, 2013; Maid *et al*., 2021; Pandey *et al*., 2021).

CONCLUSION

This study demonstrates that agroforestry systems, particularly parklands and home gardens, significantly enhance medicinal plant diversity in northern Katsina State. Parklands supported higher woody species richness while homegardens contributed substantially to herbaceous diversity highlighting their complementary ecological roles. In contrast, open farmlands exhibited markedly reduced diversity, emphasizing the negative impact of simplified agricultural systems on biodiversity. These findings underscore the importance of promoting agroforestry as a sustainable land use strategy for conserving medicinal plant resources, supporting rural healthcare and enhancing ecosystem resilience in semi-arid regions. Policies encouraging agroforestry adoption and the integration of indigenous knowledge into land management practices are strongly recommended. Future studies should explore medicinal plant diversity across broader ecological zones and evaluate the long term conservation potential of agroforestry systems under changing climatic conditions.

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