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ORIGINAL RESEARCH ARTICLE

Species Diversity, Conservation Status, and Ethnobotanical Significance of Medicinal Root Plants in Katsina State, Nigeria

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ABSTRACT
Medicinal root plants are central to traditional healthcare systems, yet information on their diversity, ethnobotanical uses, and conservation status in northern Nigeria remains limited. This study assessed species richness, evenness, ethnobotanical significance, and conservation status of medicinal root plants across six Local Government Areas (LGAs) in Katsina State, Nigeria. A mixed-methods approach was adopted, integrating ethnobotanical surveys of 240 respondents with ecological sampling from 150 quadrats. Plant diversity was evaluated using the Shannon–Wiener diversity index (H') and Equitability (EH). Ethnomedicinal uses and conservation status were documented using standard criteria. Nineteen plant families were recorded, with Fabaceae being the most dominant (26.9%). Site A exhibited the highest species diversity (H' = 3.7) and evenness (EH = 0.95). Medicinal roots were predominantly used for the treatment of malaria and gastrointestinal disorders. Most species were classified as Least Concern (LC), including *Adansonia digitata* and *Parkia biglobosa*. However, threatened taxa were identified, such as *Khaya senegalensis* (Vulnerable), *Combretum glutinosum* and *Sclerocarya birrea* (Endangered), and *Borreria stachydea* (Data Deficient). Rare plant families, notably Moraceae, were sparsely represented (0.17%). The findings highlight spatial variation in medicinal plant diversity and emphasize the continued reliance on root-based remedies in Katsina State. The presence of threatened and poorly documented species underscores the need for targeted conservation and sustainable harvesting strategies. This study contributes to global ethnomedicinal documentation efforts and supports earlier findings on medicinal plant use in the region.

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Ethnobotany, medicinal roots, biodiversity, distribution, Shannon index, Nigeria

INTRODUCTION

Medicinal plants form the backbone of traditional healthcare in northern Nigeria, where plant roots are particularly valued for their therapeutic properties. Recent estimates suggest 70-80% of Katsina State's rural population depends on herbal remedies for primary healthcare needs (Kankara *et al.,* 2020). Roots are frequently used due to their high concentrations of bioactive compounds, employed in treatments ranging from malaria to digestive disorders (Abdullahi *et al.,* 2021). However, systematic documentation of these medicinal root species particularly their ecological distribution remains limited in Nigeria's savanna regions.

Katsina State's unique vegetation zone, transitional between Sudanian and Sahelian ecologies, hosts a distinct assemblage of medicinal flora. While ethnobotanical studies like those of (Kankara *et al.,* 2020) have catalogued plant uses in the region, few have examined how species richness and evenness vary across different local government areas. This gap hinders understanding of ecological patterns that could inform sustainable harvesting practices and clarify plant community relationships in semi-arid environments.

This study bridges this knowledge gap by analyzing the diversity and distribution of medicinal root plants across six Katsina LGAs. Using quadrant-based ecological sampling and ethnobotanical surveys, we quantify species richness (Shannon-Weiner Index) and (Equitability Index) while documenting indigenous use cases. Our approach builds on earlier work but introduces rigorous spatial analysis of medicinal root distributions, offering new insights into their ecology in northern Nigeria's savannas.

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METHODOLOGY

Study Area

Katsina State (Figure 1) (12°5'N, 7°6'E) spans 23,938 km² of Sudanian savanna (Rumah *et al.,* 2010). Six LGAs were sampled:

- Katsina Central: Batagarawa, Kaita (Site A)

- Katsina North: Dutsi, Mani (Site B)

- Katsina South: Malumfashi, Dandume. (Site C).

Fieldwork combined ecological surveys with ethnobotanical interviews to document both plant distributions and traditional knowledge. For the ecological data collection, we used a quadrant sampling approach of Stohlgren *et al.* (1994) with plots (10m x 10m each), spaced 20 meters apart to ensure independent sampling (Figure 2). Within each plot, all plants with medicinal roots were counted, identified, and recorded. Local names and uses of these plants were gathered through structured interviews with 240 community members (40 respondents per LGA), including traditional healers, farmers, and elders knowledgeable about plant medicine.

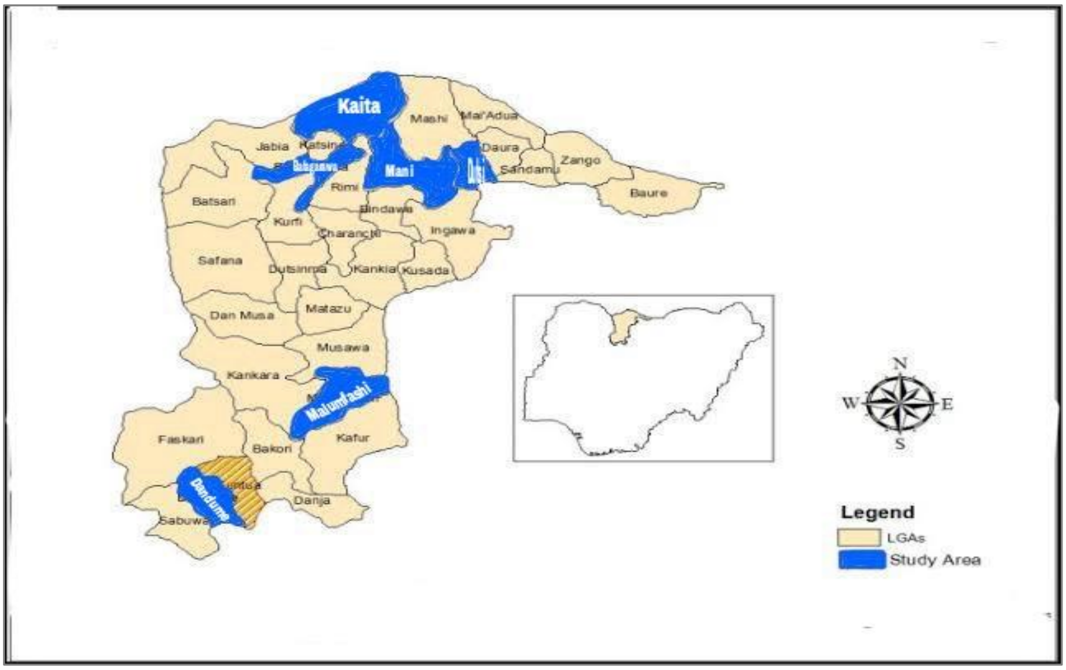

Figure 1; Katsina State Map showing the Sampled Local Government Areas

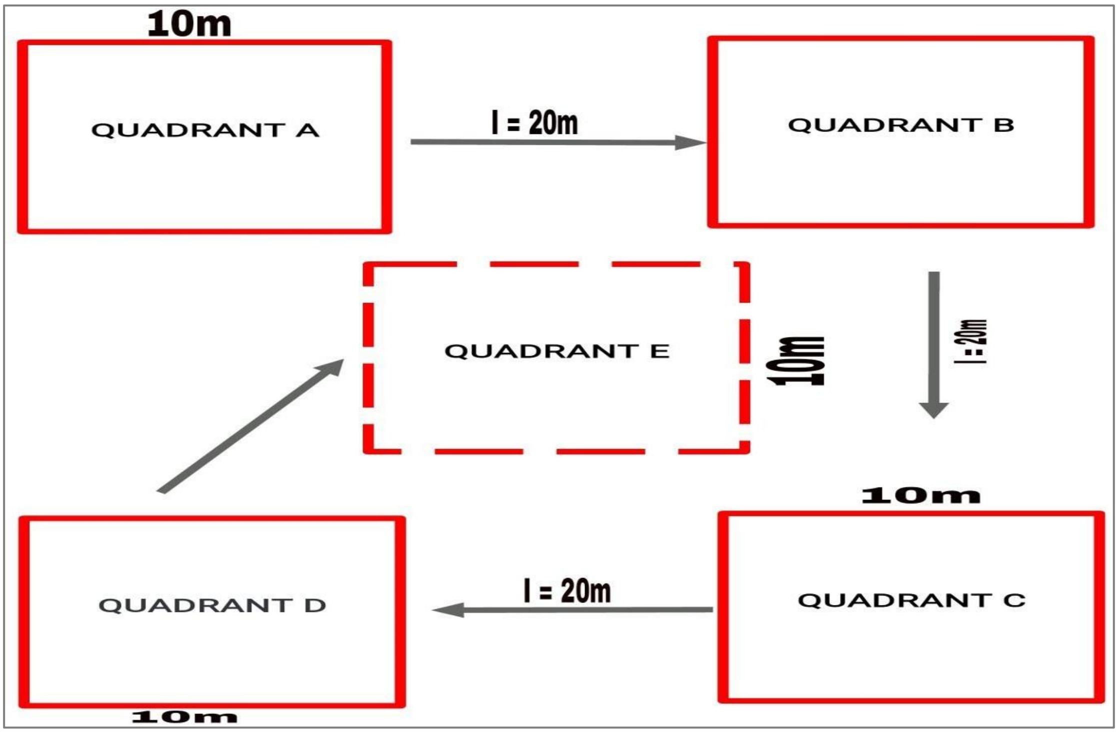

Figure 2: Quadrants employed in the study Area.

Plant identification was done first through local names provided by respondents, then cross-checked with available botanical resources (Nicolson *et al*., 2023). To analyze the data, we calculated species diversity using the Shannon-Weiner Index (H') and evenness distribution using the Equitability Index (EH). These indices helped determine how many different species were present (richness) and how evenly they were spread across the sites (evenness). The ethnobotanical data were organised to show which plant families were most commonly used and their medicinal applications. This mixed approach allowed us to compare ecological patterns with traditional use, providing a full picture of medicinal root plants in the region.

Statistical analysis

The ethnobotanical data collected were organized in a Microsoft Excel spreadsheet.

The information of the respondents was evaluated using simple percentage.

The shannon diversity index or shannon weiner index (H') and Shannon equitability index (EH) was employed to assess the diversity richness and evenness of species with medicinal root usage within the study area. The formula for calculating the (H') is:

$H = \Sigma pi * \ln(pi)$

Where:

Σ: A Greek symbol that means "sum"

ln: Natural log

pi: The proportion of the entire community made up of species i

The higher the value of H, the higher the diversity of species in a particular community. The lower the value of H, the lower the diversity.

The value for H ranges between 1.5 and 4.5. The lower values indicate more diversity, while the higher values indicate less diversity.

Note: The value of the Shannon-Weaver diversity index may be higher than 1.5 to 3.5 and only rarely exceeds 4.5 (Shannon *et al.,* 1949).

The formula for calculating the Shannon equitability index (EH) is:

$EH = H / \ln(N)$

The value for EH ranges between 0 and 1 where 1 indicates complete evenness.

A higher index value indicates greater diversity with more evenly distributed species and lower values indicates less diversity.

RESULTS

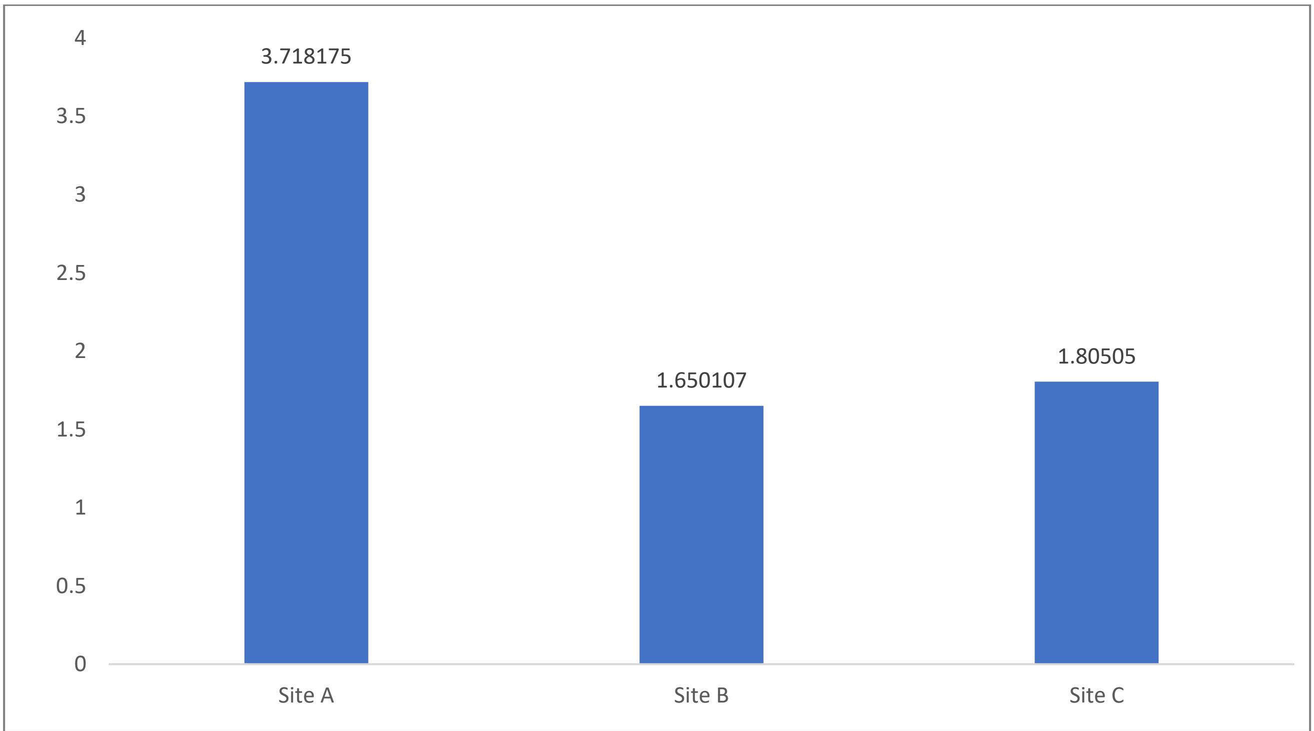

Figure 3: Shannon-Weaver Index

Table 1: Categories of Ailments treated with the documented plants species

Species	Local Name	Family	Ailment Treated	FC	RFC	FL (%)	(∑Ui/N)	VI	UV
Acacia ataxacantha	Sarkakiya	Fabaceae	Sore throat	2	0.0083	50	0.0208	0.14	2
			Toothache	2	–	100			2
			Cough	1	–	50			1
Adansonia digitata	Kuka	Malvaceae	Pile	84	0.35	–	0.3917	0.84	50
			Hydration	14	–	17.8	_	_	14
			Malnutrition	30	–	45.2	_	_	30
Anacardium occidentale	Kashu	Anacardiaceae	Cough	4	0.025	33.3	0.0292	0.2	4
			Pile	3	–	83.3	0.0292	_	3
Anogeissus leiocarpus	Marke	Combretaceae	Cough	103	0.43	88.3	0.5	0.82	82
			Pile	_	–	66.9			22
			Gonorrhea	_	–	10.6			9
			Pneumonia	_	–	1.9			7
Archidendron chevalieri	Katsari	Fabaceae	Fever	3	0.0123	66.6	0.0292	0.12	3
			Pile	2	–	100	_		2
			Dysentery	2	–	66.6			2
Azadirachta indica	Bedi	Meliaceae	Fatigue	88	0.37	64.7	0.5208	0.28	8
			Pile	50	–	80.6	_	_	50
			Yellow fever	67	–	94.3	_	_	67
Balanites aegyptiaca	Aduwa	Zygophyllaceae	Infection	22	0.1	68.1	0.0958	0.84	14

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Table 1 continued

Species	Local Name	Family	Ailment Treated	FC	RFC	FL (%)	(∑Ui/N)	VI	UV
			Menstruation	8	–	18.1	_	_	8
			Ruqya	1	–	86.3	_	_	1
Bauhinia reticulate	Kalgo	Fabaceae	Blood tonic	55	0.23	47.2	0.2125	0.42	11
			Fever			89.1			37
			Heart problem			10.9			3
Borreria stachydea	Alkamar turuwa	Rubiaceae	Dysentery	9	0.04	77.8	0.025	0.5	3
			Infection			44.4		_	2
			Miscarriage			11.1		_	1
Calotropis procera	Tumfaffiya	Apocynaceae	Cancer	39	0.16	5.1	0.0617	0.12	2
			Leprosy			64.1	_	_	8
			Snake bite			43.5	_	_	11
			Ruqya			7.6	_	_	1
Carissa spinarum	Gizaki	Apocynaceae	Constipation	3	0.013	33.3	0.0167	0.06	2
			Pile			100	_	_	2
Citrus aurantifolia	Lemun Tsami	Rutaceae	Fatigue	32	0.13	78.1	0.2625	0.74	13
			Fever			87.5	_	_	29
			Skin Related Problems			59.4	_	_	21
Combretum glutinosum	Taramniya	Connareceae	Pile	8	0.03	87.5	0.0375	0.08	7
			Ruqya				_	_	2

To be continued next page

Table 1 continued

Species	Local Name	Family	Ailment Treated	FC	RFC	FL (%)	(∑Ui/N)	VI	UV
Combretum micranthum	Geza	Combretaceae	Hypertension	99	0.41	47.4	0.65	0.82	12
			Fatigue			6.1	_	_	68
			Stomach pain			78.7	_	_	55
			Protection against witch			4	_	_	2
			Witlow			89.8	_	_	19
Detarium microcarpum	Taura	Fabaceae	Constipation	10	0.042	70	0.0542	0.32	5
			Pile			50	_	_	8
Diospyros mespiliformis	Kanya	Ebenaceae	Fatigue	15	0.62	40	0.1167	0.16	4
			Fever	_	_	86.6	_	_	9
			Man power	_	_	46.7	_	_	2
			Pile	_	_	73.3	_	_	11
Erythrina senegalensis	Munjirya	Fabaceae	Blood Tonic	3	0.0123	33.3	0.0167	0.94	1
			Enhance Digestion			66.6			2
			Infection			100			1
Eucalyptus camaldulensis	Turare	Myrtaceae	Malaria	5	0.021	100	0.0333	0.26	5
			Typhoid			60			3
Euphorbia balsamifera	Aliyara	Euphobiaceae	Pile	2	0.0083	100	0.0083	0.12	2
Faidherbia albida	Gawo	Fabaceae	Fever	11	0.046	72.7	0.0625	0.08	9
			Infection			36,3			4

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Table 1 continued

Species	Local Name	Family	Ailment Treated	FC	RFC	FL (%)	(∑Ui/N)	VI	UV
			Toothache			54.5			2
Faretia apodanthera	Kurukuru	Rubiaceae	Stomach pain	8	0.033	100	0.0333	0.44	8
Ficus sycomorus	Bauraen Hausa	Moraceae	Cough	37	0.154	70.2	0.1542	0.24	20
			Dysentery			78.3			16
			Pile			83.7			21
Gardenia aqualla	Gaude	Rubiaceae	Fever	12	0.05	75	0.0833	0.58	8
			Fatigue			16.6			4
			Man Power			58.3			3
			Pile			91.6			5
Grewia mollis	Dargaza/Kakaya	Malvaceae	Fever	3	0.0125	33.3	0.025	0.18	1
			Dysentery			33.3			2
			Pile			100			3
Guiera senegalensis	Sabara/Barbarta	Combretaceae	Stomach Pain	102	0.425	92.1	0.7167	0.24	88
			Pile			57.8			71
			Toothache			5.8			13
Jatropha curcas	Cinidazugu	Euphobiaceae	Dysentary	27	0.113	33.3	0.15	0.22	15
			Miscarriage			11.1			2
			Pile			81.4			19

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Table 1 continued

Species	Local Name	Family	Ailment Treated	FC	RFC	FL (%)	(∑Ui/N)	VI	UV
Khaya senegalensis	Madaci	Meliaceae	Fatigue	24	0.1	37.5	0.175	0.44	17
			Fever			87.5			22
			Hypertension			29.2			3
Lannea acida	Faru	Anacardiaceae	Cough	22	0.092	77.2	0.1292	0.74	6
			Fatigue			27.3			16
			Gonorrhea			4.5			8
			Heart Problem			13.6			1
Lawsonia inermis	Lalle	Lamiaceae	Fever	18	0.075	33.3	0.0792	0.18	7
			Witlow			100			2
Mangifera indica	Mangoro	Anacardiaceae	Fever	32	0.133	96.8	0.1917	0.8	9
			Dysentery			68.7			13
			Pile			25			24
Mitracarpus hirtus	Goga Masu	Rubiaceae	Dermatitis	17	0.071	17.6	0.1542	0.46	13
			Diabetes			5.8			8
			Dysentery			52.9			4
			Infection			29.4			2
			Miscarriage			11.7			9
			Stroke			5.8			1
Moringa oliefera	Zogala	Moringaceae	Blood Tonic	96	0.4	89.5	0.9542	0.88	88

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Table 1 continued

Species	Local Name	Family	Ailment Treated	FC	RFC	FL (%)	(∑Ui/N)	VI	UV
			Enhance Digestion			48.9			49
			Hydration			80.2			22
			Hypertension			64.5			55
			Infection			37.5			12
			Snake bite			14.5			3
Parkia biglobosa	Dorowa	Fabaceae	Fever	19	0.08	57.8	0.1542	0.32	8
			Dysentery			47.3			11
			Pile			73.6			18
Prosopis africana	Kirya	Fabaceae	Fever	7	0.03	42.8	0.0375	0.14	1
			Dysentery			14.2			3
			Pile			100			5
Psidium guajava	Gwaba	Myrtaceae	Diarrhea	14	0.067	14.2	0.1417	0.26	3
			Malaria			85.7			12
			Typhoid			100			10
			Stomach Pain			42.8			9
Rourea coccinea	Tsamiyar Kasa	Connareceae	Enhance Digestion	6	0.025	33.3	0.0292	0.1	3
			Breast Milk Supplement			100			4
Sclerocarya birrea	Danya	Anacardiaceae	Heart Problem	3	0.0125	100	0.0208	0.26	1
			Fatigue			33.3			1

To be continued next page

Table 1 continued

Species	Local Name	Family	Ailment Treated	FC	RFC	FL (%)	(∑Ui/N)	VI	UV
			Pile			100			3
Senegalia senegal	Dakwara	Fabaceae	Stomach Pain	9	0.037	77.7	0.0375	0.38	6
			Ruqya			44.4			3
Senna arereh	Malga	Fabaceae	Fever	2	0.083	50	0.0167	0.26	2
			Pile			100			2
Senna italic	Filisko	Fabaceae	Dysentery	11	0.046	81.8	0.0583	0.36	9
			Stomach Pain			54.5			5
Senna occidentalis	Tafasar Masar	Fabaceae	Infection	39	0.163	43.5	0.175	0.36	25
			Stomach Pain			56.4			6
			Pile			84.6			11
Senna singueana	Runhu	Fabaceae	Pile	9	0.037	77.7	0.0458	0.06	4
			Stomach Pain			22.2			7
Tamarindus indica	Tsamiya	Fabaceae	Fever	46	0.192	69.5	0.1833	0.38	6
			Fatigue			17.3			33
			Hydration			60.8			3
			Pile			95.6			2
Urana lovata	Kafi Rama	Malvaceae	Dysentery	4	0.02	25	0.0333	0.28	4
			Pile			100			4
Vachellia nilotica	Bagaruwa	Fabaceae	Inflammation of Gums	22	0.092	22.7	0.1	0.62	5

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Table 1 continued

Species	Local Name	Family	Ailment Treated	FC	RFC	FL (%)	(∑Ui/N)	VI	UV
			Pile			86.3			19
Vachellia seyel	Diddishi	Fabaceae	Stomach Pain	2	0.083	100	0.0167	0.04	2
			Pile			100			2
Vitellaria paradoxa	Kadanya	Sapotaceae	Constipation	16	0.0067	63.6	0.0792	0.22	7
			Pile			68.7			12
Vitex doniana	Dinya	Lamiaceae	Dysentery	4	0.02	25	0.0292	0.23	3
			Pile			100			4
Ximenia americana	Tsada	Ximeniaceae	Bloody Darrhea	11	0.046	63.6	0.0542	0.04	4
			Pile			81.8			8
			Ruqya			18.2			1
Ziziphus mauritiana	Magarya	Rhamnaceae	Blood Tonic	14	0.058	45.4	0.0708	0.62	6
			Stomach Pain			85.7			11

The Shannon-Weaver Index suggests that higher values indicate higher diversity. This shows that, site A with a 3.7 index has the highest diversity among the three sites. Site C follows with a slightly higher index of 1.8, and site B has the lowest diversity at 1.6 as indicated in Figure 3 above. These values imply that site A has a more diverse ecological community compared to sites B and C, where higher Shannon-Weaver Index values indicate high diversity.

Species evenness was observed to be the highest at Site A (EH = 0.95), as shown in Figure 4, suggesting a relatively balanced distribution of individuals across species. Such elevated evenness is generally correlated with moderate or low-intensity disturbances, which can mitigate competitive exclusion while preventing a few species from dominating the community. Conversely, Site C (EH = 0.46) and Site B (EH = 0.42) displayed significantly lower evenness, indicating community dominance by a restricted number of species. This trend is often associated with habitat alteration and human-induced disturbances, which modify resource availability and favour disturbance-tolerant or opportunistic species, consequently diminishing overall evenness (Bello *et al.*, 2020).

These patterns reveal an important ecological trade-off: human activity either reduces total species numbers (lowering H') or creates uneven distributions (lowering EH), with only pristine areas like Site C maintaining both measures at moderate levels (Adedoja *et al.,* 2023).

The exceptional dominance of Fabaceae (26.9%) and rarity of Moraceae (0.17%) further confirm how anthropogenic pressures reshape medicinal plant communities (Kankara *et al.,* 2015).

DISCUSSION

The Shannon–Wiener diversity index (Figure 3) indicated significant spatial variation in the structure of plant communities across the three sites. Site A exhibited the highest species diversity (H' = 3.7), signifying a community that is both structurally complex and rich in species, which is characteristic of relatively stable Sudan Savannah ecosystems. In contrast, Site C demonstrated moderate diversity (H' = 1.6), while Site B recorded the lowest diversity (H' = 1.8), suggesting increasingly simplified plant assemblages. These variations imply a gradient of ecological conditions, likely influenced by differing climatic constraints and levels of anthropogenic disturbance.

Species evenness displayed a similar pattern. Site A achieved very high evenness (EH = 0.95), indicating a fair distribution of individuals across species. In contrast, Sites C (EH = 0.46) and B (EH = 0.42) showed diminished evenness, reflecting the dominance of a limited number of species and a reduction in community balance. Such patterns of dominance are typical of disturbed habitats where competitive or disturbance-tolerant species thrive.

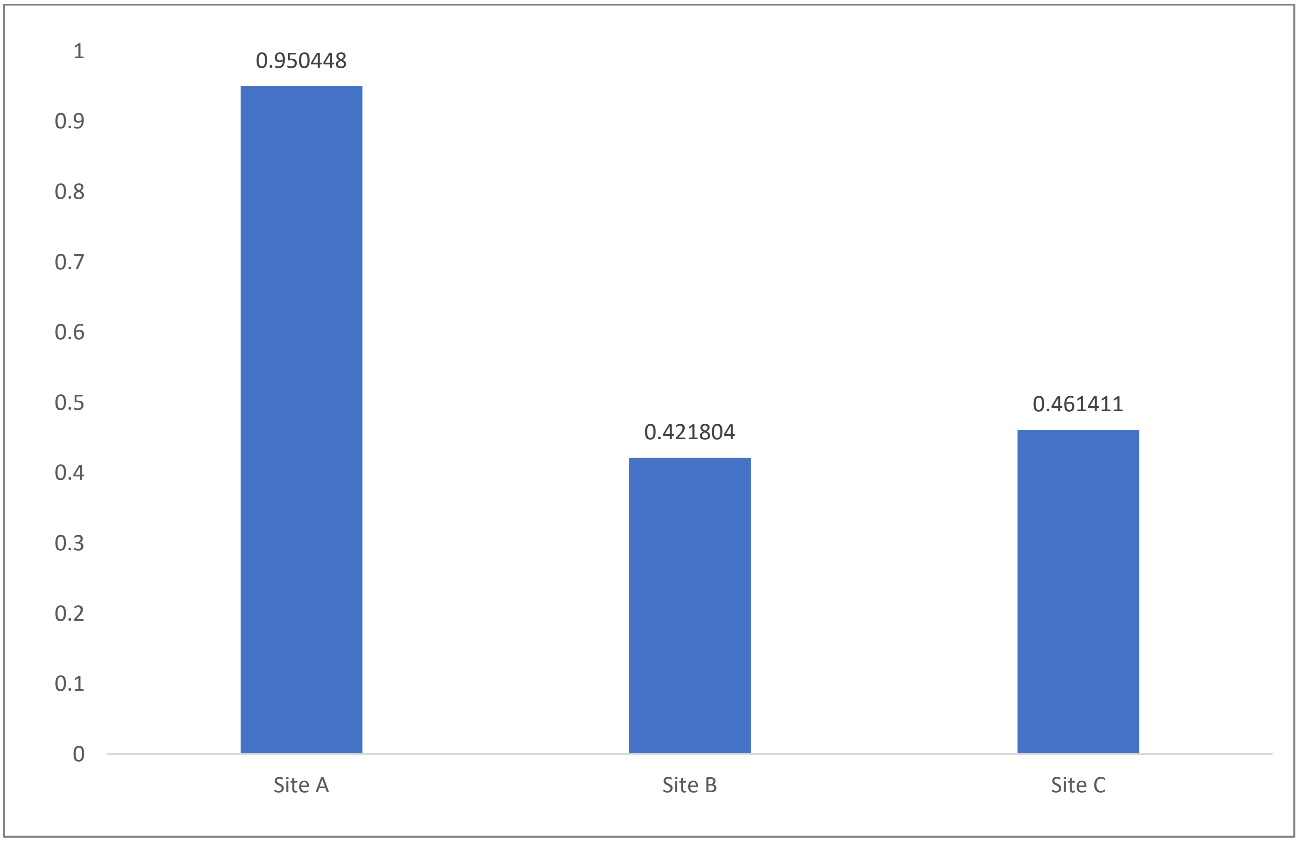

Figure 4: Shannon equitability index

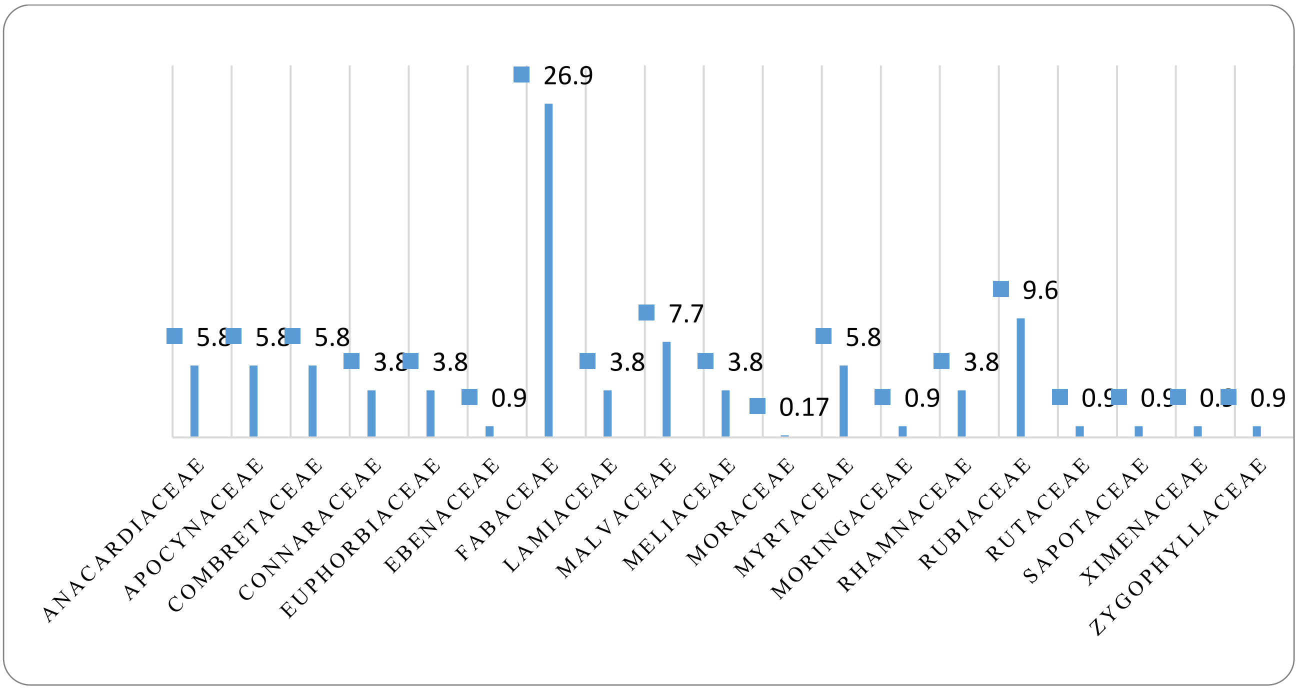

Figure 5: Family Distribution of Plants

The elevated diversity noted at Site A corresponds with established Shannon index values for Sudan Savannah ecosystems, which generally range from H' = 3.5 to 4.2 (Oke *et al.,* 2007). This supports the notion that Site A maintains numerous structural characteristics of relatively intact savannah vegetation.

The diversity metrics observed at Site C are similar to those documented in Guinea Savannah regions in Nigeria, where moderate diversity has been linked to intermediate rainfall and mixed land-use practices (Abdullahi *et al.,* 2020). Likewise, the lower diversity at Site B aligns with research from arid and semi-arid regions, including Jigawa State, where severe climatic conditions and limited moisture availability restrict species richness (Mortimore *et al*., 2001).

The remarkably high evenness recorded at Site A stands in stark contrast to previous research conducted in comparable Sudan Savannah ecosystems, which indicated lower evenness values (EH ≈ 0.55) attributed to selective harvesting and the dominance of a limited number of resilient species (Oke *et al*., 2007). The diminished evenness observed at Sites B and C aligns with findings by Bello *et al*. (2020), who associated decreasing evenness with habitat alteration and human-induced pressures.

The notably high evenness at Site A may be accounted for by regulated or low-intensity harvesting practices, which can mitigate competitive exclusion without disproportionately benefiting a narrow range of species. In contrast to intensive extraction methods, moderate disturbances may suppress dominant species, thereby allowing less competitive taxa to thrive, resulting in a more equitable distribution of individuals.

Conversely, the low diversity and evenness at Site B can be primarily linked to climatic stressors, such as insufficient rainfall, elevated temperatures, and inadequate soil moisture, which hinder plant establishment and promote drought-resistant species. Although Site C is less affected by climatic factors, it seems to be influenced by land-use changes and habitat alterations, which have led to a decline in evenness despite moderate levels of diversity.

The significant presence of Fabaceae (26.9%), as shown in Table 1 and Figure 5, further corroborates the impact of human disturbances, as members of this family are particularly well-suited to thrive in stressful conditions, nitrogen-deficient soils, and environments subjected to repeated harvesting. In contrast, the scarcity of Moraceae (0.17%), a family typically associated with mature or less disturbed ecosystems, underscores the selective extraction of ecologically and medicinally important species amid escalating human pressures (Kankara *et al.,* 2015).

In summary, the results reveal a significant ecological trade-off: human activities can lead to a decrease in species richness (lower H'), disrupt the balance of species (lower EH), or both, contingent upon the intensity of the disturbance and the environmental context. Although systems that experience moderate disturbances may preserve a reasonable level of diversity or evenness, prolonged anthropogenic pressure ultimately alters community composition. Only sites that are relatively less disturbed or ecologically buffered are able to sustain both diversity and evenness at moderate to high levels (Adedoja *et al.,* 2023).

CONCLUSION

This study provides important insights into the diversity and traditional uses of medicinal root plants in Katsina State, Nigeria. Our findings reveal that Fabaceae species dominate the medicinal flora (26.9%), consistent with previous regional studies, while rare families like Moraceae (0.17%) require urgent conservation attention. The ecological analysis showed significant variation in species distribution, with undisturbed sites exhibiting higher diversity (H'=3.7) and farmed areas showing higher evenness (EH=0.9), highlighting how human activities influence plant communities. The ethnobotanical data confirmed the continued reliance on root medicines for treating common ailments, preserving valuable traditional knowledge. These results emphasize the need for community-based conservation strategies that protect both biological diversity and cultural heritage. Future research should investigate sustainable harvesting methods and monitor long-term changes in these medicinal plant populations.

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