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An Ethnobotanical Investigation of Medicinal Plants Utilized for Yellow Fever Treatment in Akure Region, Ondo State, Nigeria

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ABSTRACT

Yellow fever is a viral disease caused by a flavivirus transmitted mainly by *Aedes* mosquitoes [*Aedes aegypti* (L.)]. Despite medical advances, it remains a significant urban health threat, with outbreaks facilitated by dense populations and vector exposure. However, Traditional plant-based remedies are commonly being used alongside modern treatments to alleviate symptoms and provide accessible healthcare options. An ethnobotanical survey was conducted in the Akure region of Ondo State, Nigeria, covering Akure-South and Akure-North Local Government Area to identify medicinal plants used for yellow fever treatment. A total of 200 respondents, including traditional healers, herb sellers, farmers, traders, teachers, civil servants, and artisans with inherited or trained knowledge, were interviewed using a semi-structured questionnaire. Data collected covered botanical names, local names, common names, families, growth habits, plant parts used, modes of preparation, and administration. Data obtained were analyzed using Analysis of Variance (ANOVA) at $p \leq 0.05$ level of significance. ANOVA showed that species occurrence was highly significant without notable differences between locations. Findings revealed 56 plant species across 32 families, Asteraceae, Poaceae, and Zingiberaceae, were the largest representatives with four (4) species each. Relative frequency of citation (RFC) revealed *Azadirachta indica* (13.5%), *Carica papaya* (9%), *Alstonia boonei* (7%), and *Curcuma longa* (7%) as the most frequently used. Leaves were the predominant plant part utilized (51.8%), preparation was mainly by decoction (67.9%) and infusion (30.4%), and trees were the most common growth habit (50%). This study documents the medicinal plants used in the urban Nigerian context for yellow fever treatment, offering scientific validation of traditional medicinal knowledge.

Highlights

- Fifty six medicinal plant species used for yellow fever treatment were documented.
- *Azadirachta indica*, *Carica papaya*, and *Curcuma longa* were most cited.
- Leaves and decoction were the predominant plant parts and preparation methods.

1. Introduction

Medicinal plants are central to global healthcare, particularly in developing regions, and serve as key sources of pharmaceutical leads. The World Health Organization defines medical plants as any plant used regularly or occasionally to address health conditions (WHO, 1998). Sofowora (2008) adds that such plants contain bioactive compounds with therapeutic potential. About 25% of modern drugs in developed countries are derived from plants or their constituents, and roughly 50,000 of an estimated 250,000 higher-plants species or their constituents, and roughly 50,000 of an estimated 250,000 higher-plant

species are reported to have medicinal properties (Govaerts, 2001; Dias *et al.*, 2012). Traditional medicine remains the primary or sole healthcare for nearly 80% of the global population, with up to 85% relying on herbal remedies for diseases prevention and treatment (Hamilton, 2003; Abera, 2014; Ajayi *et al.*, 2014).

Yellow fever is an acute hemorrhagic disease caused by the yellow fever virus (Flavivirus; Flaviviridae), transmitted mainly by *Aedes* mosquitoes, especially *Aedes aegypti* in urban cycles and forest-dwelling species in sylvatic cycles (Monath & Vasconcelos, 2015; WHO, 2019). The disease is endemic in tropical Africa and South

America, with an incubation period of 3–6 days and clinical features ranging from fever, headache and myalgia to severe jaundice, hemorrhage and organ failure in fatal cases (WHO, 2019). Outbreaks are driven by urbanization, human mobility, inadequate vector control, low vaccination coverage and environmental changes that favour mosquito breeding (Monath & Vasconcelos, 2015; WHO, 2019).

Ethnobotanical research documents traditional plant uses, informs conservation and bioprospecting, and provides leads for drug discovery (Manjari *et al.*, 2021; Vallès, 2023; Eduard, 2023; Alam & Sarwar, 2024; Bara, 2026). However, the field faces challenges including erosion of traditional knowledge, limited access to remote communities and ethical issues around intellectual property and benefit-sharing (Sauini *et al.*, 2020; Sauini, 2023; CBD, 2025; Modo, 2026). Participatory approaches and compliance with the Convention on Biological Diversity and the Nagoya Protocol are increasingly recommended to address these concerns (Sauini, 2023; CBD, 2025). In Akure North and South local government areas of Ondo State, Nigeria, yellow fever remains a public-health concern despite the availability of effective vaccines (Kassy *et al.*, 2023). Local communities use traditional medicinal plants to manage the disease, but this knowledge is poorly documented and lacks scientific evaluation, limiting understanding of species identity, preparation methods, dosages, safety and potential integration into formal healthcare. This study documents medicinal plants used against yellow fever in Akure North and South, recording species, plant part used, preparation and administration methods, dosages and reported adverse effects, to conserve traditional knowledge, assess sustainability of use and identify candidates for further pharmacological and toxicological evaluation.

2. Materials and Methods

Study Area

This research was conducted from May to June 2024 in two different Local Government Areas (LGAs) of Ondo State, Nigeria: Akure South and Akure North. Akure South is located between longitude 4.944055°E and latitude 7.491780°N, covering an area of 331 km² with a population of approximately 353,711 (2006 census). The study sites in Akure South included Oke Ijebu, Ilesha Garage, Oja Oba, and Isolo Market. Akure North is situated between longitudes 5.8286°E and latitude 6.96375°N, spans 660 km² and had a population of 131,587 as of 2006. Study locations within Akure North were: Oba-ile, Shasha, Ogbese, and Igoba. The region experiences a tropical humid climate with distinct wet (March to September) and dry (November to February) seasons. Vegetation in Akure falls within forest zones, including gallery forests and forest reserves.

Experimental Setup: Ethnobotanical Survey

The survey documented plant species traditionally used for yellow fever treatment across the selected communities. Four communities from each LGA were purposively selected based on their urban characteristics and proximity to herbal markets. A total of 200 respondents (100 per LGA) who were familiar with yellow fever and its treatment using plants were interviewed. The data collection employed semi-structured interviews, encouraging open dialogue to capture detailed ethnobotanical knowledge following the approach of Kayode *et al.* (2009). Interviews focused on obtaining information about the local

plant names, plant parts used in treatment, levels of utilization, and perceived effectiveness against yellow fever. This approach aimed to identify plant species with higher therapeutic significance.

Data Collection

Respondents, including students, traditional practitioners, farmers, and traders, were individually approached using a defined sampling method and voluntarily consented to participate. Information on socio-demographic variables such as sex, age, occupation, religion, and socioeconomic status was recorded. Data detailing the family name, scientific and local names of plants, parts used, common names, growth habits, cultivation methods, and preparation techniques were systematically documented and alphabetized.

Data Analysis

Descriptive statistics, specifically frequency and percentage, were employed to analyze socio-demographic data. For the ethnobotanical survey results, three quantitative measures were applied: Analysis of Variance (ANOVA),

Relative Frequency of Citation (RFC), and Use Value (UV). Relative Frequency of Citation (RFC) (%): According to (Tardío and Prado-de-Santayana, 2008; Oluwajuyigbe and Ige, (2025). RFC was calculated using the formula:

$$RFC (\%) = \frac{\text{Number of respondent interviewees citing species}}{\text{total number of respondent interviewed}} \times \frac{100}{1}$$

$$RFC (\%) = \frac{FC (\%)}{n} \times \frac{100}{1}$$

Use Value (UV) was computed as:

$$UVs = \frac{\sum Ui}{ns};$$

Where,

Ui = the sum of the total number of use citation by all informants for a given species

ns = the total number of informants interviewed for species.

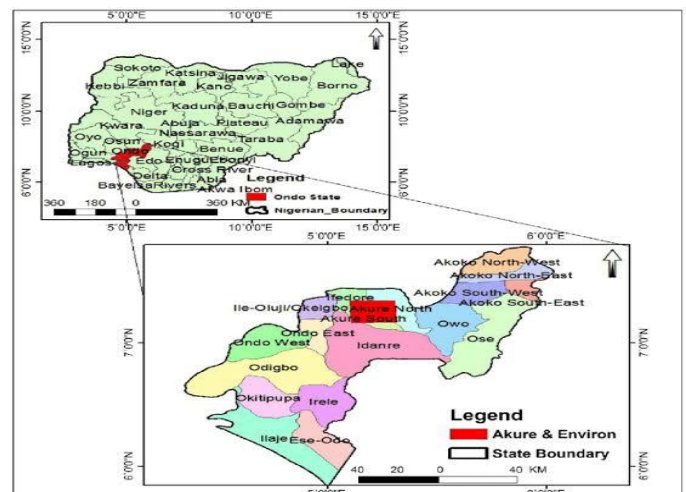


Fig. 1: Map of Nigeria showing the map of Akure, Source: Jaimz (2004)

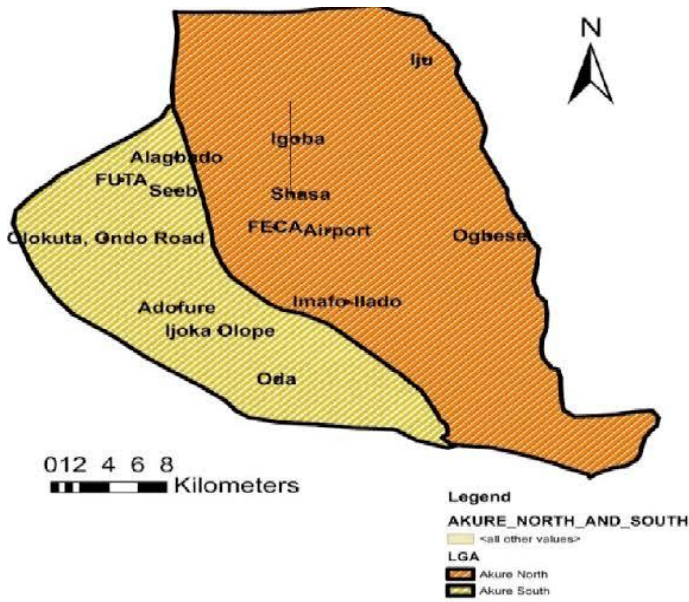


Fig.2: Map of Akure North and South Local Government Area. Source: Jaimz (2004).

3. Results

Table 1 shows the socioeconomic clarification of the respondents in Akure region. The results showed that (55%) of the respondents were

female and (45%) of the respondents were male, the age of the respondents ranged from 18-29 years old (19.5%), 30-39 years old (23%), 40-49 years old (29.5%), 50-59 years old (13.5%), 60-69 years old (7.5%), and 70-79 years old (5.5%) and 80-89 (1.5%). Age distribution analysis showed that the 40-49 years cohort recorded the highest frequency (29.5%). The occupation of most of the respondents were trader (40.5%), followed by herb seller (16%), while farmers and traditional practitioner were (15.5%), teacher (5.5%), student (5%), civil servant (3.5%) and artisan (2.5%). This table also shows that source of knowledge of the respondents; training (31%), ancestral (69%). Table 2 shows the identified plants used for the treatment of yellow fever with their families, local names and common names.

Table 3 shows distribution of medicinal plants according to their families, Asteraceae, Poaceae, and Zingiberaceae had the highest plants species. The total number of identification or occurrence of plants species showed that *Azadirachta indica* A. Juss occurred most (27) and followed by *Carica papaya* L. (18) *Alstonia boonei* De wild and *Cymbopogon citratus* DC. stapf (14). The lowest plant species was *Abrus precatorius* Linn, *Aloe barteri*, *Allium Fistulosum* L., *Anacardium occidental* L., *Annona muricata* L., *Argemone mexicana* L., *Bambusa vulgaris* L., *Balanites aegyptiaca* L. Delile, and *Calotropis pocera* W. Table 4 shows the analysis of variance of plants species used for the treatment of yellow fever, the individual locations studied are not significantly different from one another, suggesting a standardized or uniform distribution of these plant species across the sampled areas.

Table 1: Socio-economic characteristics of respondents in Akure, Ondo State

Features	Description	Proportion of Respondents (%)			Average Percentage (%)
		Akure South	Akure North	Total	
Sex	Male	46	44	90	45
	Female	58	52	110	55
Age	18 – 29	20	19	39	19.5
	30 – 39	27	19	46	23
	40 – 49	30	29	59	29.5
	50 – 59	9	18	27	13.5
	60 – 69	11	4	15	7.5
	70 – 79	4	7	11	5.5
	80 – 89	3	0	3	1.5
Occupation	Traditional Practitioner	13	14	27	13.5
	Farmers	17	10	27	13.5
	Herb seller	19	13	32	16
	Trader	34	47	81	40.5
	Civil servant	1	6	7	3.5
	Teacher	9	2	11	5.5
	Artisan	5	0	5	2.5
Source of Knowledge	Student	6	4	10	5
	Ancestral	75	63	138	69
	Training	29	33	62	31

Table 2: List of identified medicinal plants used for the treatment of yellow fever showing their families, local name, common names, plant parts used and habit

Botanical Names	Families	Local Names	Common Names	Plant Part Used	Habit
<i>Abrus precatorius</i> Linn	Fabaceae	Oju Ologbo	Crab's eye	Leaves	Shrub
<i>Adansonia digitata</i> Linn	Bombaceae	Ose	Baobab	Leaves	Tree
<i>Aframomum melgueta</i> Schum.	Zingiberaceae	Ataare	Alligator pepper	Leaves	Herbs
<i>Allium cepa</i> L.	Amaryllidaceae	Alubosa	Onion	Bulb	Herbs
<i>Allium fistulosum</i> L.	Amaryllidaceae	Ayuu	Garlic	Bulb	Herbs
<i>Allium sativum</i> L.	Amaryllidaceae	Alubosa elewe	Spring onion	Leaves	Herbs
<i>Aloe barteri</i> L.	Liliaceae	Eti- erin	Aloe vera	Leaves	Herbs
<i>Alstonia boonei</i> De-wild	Apocynaceae	Ahun	Stool wood, Cheese wood	Leaves	Herbs
<i>Anacardium occidentale</i> Linn	Anacardiaceae	Kasu	Cashew	Fruit	Shrubs
<i>Ananas comosus</i> (L.) Merr.	Bromeliaceae	Ope oyinbo	Pine apple	Bark	Tree
<i>Annona muricata</i> L	Annonaceae	Saga	Soursop	Leaves	Shrub
<i>Argemone mexicana</i> L.	Papaveraceae	Egun arugbo	Mexican poppy	Leaves	Herbs
<i>Azadirachta indica</i> A. juss	Meliaceae	Dongoyaro	Neem leaf	Leaves	Tree
<i>Balanites aegyptiaca</i> L. Delile	Zygophyllaceae	Teji, darigaj aduwa	Desert dates	Roots	Tree
<i>Bambusa vulgaris</i> L.	Poaceae	Oparun	Bamboo	Leaves	Woody perennial grass
<i>Bridelia ferruginea</i> Benth.	Euphorbiaceae	Ira	Ira	Leaves	Tree
<i>Calotropis procera</i> W. T Aiton	Apocynaceae	Ewe bomubomu	Apple of Sodom	Leaves	Tree
<i>Carica papaya</i> L.	Caricaceae	Ibepe	Pawpaw	Leaves	Tree
<i>Carthamus tinctorius</i> L.	Asteraceae	Osin bafo	Starflower	Seeds	Herbs
<i>Ceiba pentandra</i> L.	Malvaceae	Gbesi	Kapok tree	Leaves	Tree
<i>Chromolaena odorata</i> (L.) R.M.King and H.Rob.	Asteraceae	Akintola	Siam weed, Rouge plant	Leaves	Shrubs
<i>Citrus aurantiifolia</i> Swingle	Rutaceae	Osan wewe	Lime	Fruit	Tree
<i>Citrus limon</i> L. Osbeck	Rutaceae	Osan lemon	Lemon	Fruit	Tree
<i>Citrus sinensis</i> L. Osbeck	Rutaceae	Osan	Orange	Leaves	Tree
<i>Cocos nucifera</i> Linn	Areaceae	Ewe Agbo	Coconut	Fruit	Tree
<i>Costus afer</i> Ker Gawl	Zingiberaceae	Ireke omode	Twisted ginger	Whole plant	Herbs
<i>Curcuma longa</i> L.	Zingiberaceae	Ata ile pupa	Turmeric	Root	Herbs
<i>Cymbopogon citratus</i> (DC.) Stapf	Poaceae	Koriko oba	Lemon grass	Leaves	Herbs
<i>Dialium guineense</i> Willd.	Fabaceae	Ayun	Velvet tamarind	Bark	Tree
<i>Diospyros mespiliformis</i> Hochst ex A. DC	Ebenaceae	Kanya	Africa ebony	Bark	Tree
<i>Eucalyptus camaldulensis</i> Dehnh.	Myrtaceae	Eucalyptus	Eucalyptus	Bark	Tree
<i>Ficus sycomorus</i> L.	Moraceae	Jogbo	Sycamore fig	Leaves	Tree
<i>Floscopa africana</i> C. B Clarke	Commelinaceae	Toronini	African flower	Leaves	Shrubs
<i>Garcinia kola</i> Heckel (Guttiferae)	Clusiaceae	Orogbo	Bitter kola	Fruits	Tree
<i>Gossypium hirsutum</i> Linn	Malvaceae	Owu	Cotton plant	Leaves	Shrubs
<i>Hibiscus sabdariffa</i> L.	Malvaceae	Zobo	Hibiscus	Leaves	Shrubs
<i>Khaya senegalensis</i> A.	Meliaceae	Oganwo	African mahogany	Bark	Tree

<i>Lawsonia inermis</i> L.	Lythraceae	Lalli	Henna tree	Leaves	Shrubs
<i>Lablab purpureus</i> (L.) Sweet	Fabaceae	Enyikworwa	Hyacinth bean	Leaves	Herbs
<i>Mangifera indica</i> L.	Anacardiaceae	Mangoro	Mango	Bark	Tree
<i>Moringa oleifera</i> Lam.	Moringaceae	Ewe igbale	Moringa	Leaves	Shrubs
<i>Milicia excelsa</i> (Welw) C.C. Berg.	Moraceae	Iroko	Iroko tree	Bark	Tree
<i>Musa paradisiaca</i> L.	Musaceae	Ogede odo	Plantain	Leaves	Tree
<i>Myrianthus arboreus</i> P. Beauv.	Urticaceae	Ujuju / Ibi sere	Monkey fruit	Leaves	Herbs
<i>Pennisetum purpureum</i> Schumach.	Poaceae	Epakun	Elephant grass	Leaves	Herbs
<i>Psidium guajava</i> L.	Myrtaceae	Guava	Guava	Bark	Tree
<i>Pyrus communis</i> L.	Rosaceae	Afoka	Pear	Leaves	Tree
<i>Saccharum officinarum</i> L.	Poaceae	Ikoro / Ireke	Sugar cane	Leaves	Shrubs
<i>Spondias mombin</i> L.	Anacardiaceae	Okikan / Iyeye	Yellow mombin	Bark	Tree
<i>Tithonia diversifolia</i> (Hemsl) A. Gray	Asteraceae	Sepeleba	Tree marigold	Root	Tree
<i>Vernonia amygdalina</i> Delile	Asteraceae	Ewuro	Bitter leaf	Leaves	Shrubs
<i>Vitis vinifera</i> L.	Vitaceae	Efo Ajara	Grape	Fruit	Vine
<i>Xylopiya aethiopica</i> (Dunal) A.	Annonaceae	Eearu Alamo	Africa pepper	Seed	Tree
<i>Zingiber officinale</i> Roscoe	Zingiberaceae	Ata Ijere	Ginger	Root	Herbs

Table 3: Enumeration of frequency citation and their used value of each species

Botanical name	No of informant citing species	Used value	Rfc (%)
<i>Abrus precatorius</i> Linn	1	0.005	0.5
<i>Adansonia digitata</i> Linn	2	0.01	1
<i>Aframomum melegueta</i> . Schum	2	0.01	1
<i>Allium cepa</i> L	3	0.015	1.5
<i>Aloe barteri</i> L.	1	0.005	0.5
<i>Alstonia boonei</i> De Wild	14	0.07	7
<i>Allium sativum</i> Lin	2	0.01	1
<i>Allium fistulosum</i> L.	1	0.005	0.5
<i>Anacardium occidentale</i> L.	3	0.015	1.5
<i>Ananas comosus</i> L. Merr	1	0.005	0.5
<i>Annona muricata</i> L.	1	0.005	0.5
<i>Argemone mexicana</i> L.	1	0.005	0.5
<i>Azadirachta indica</i> A. Juss	27	0.135	13.5
<i>Bambusa vulgaris</i> L.	1	0.005	0.5
<i>Balanites aegyptiaca</i> L. Delile	1	0.005	0.5
<i>Bridelia ferruginea</i> Benth.	2	0.01	1
<i>Carica papaya</i> L.	18	0.09	9
<i>Calotropis procera</i> W.T Aiton	1	0.005	0.5
<i>Carthamus tinctorius</i> L.	1	0.005	0.5
<i>Ceiba pentandra</i> L. Gaten	1	0.005	0.5
<i>Chromolaena odorata</i> L. R.M.King and H.Rob..	3	0.015	1.5
<i>Cinnamomum verum</i> Pres	2	0.01	1
<i>Citrus aurantifolia</i> Swingle	7	0.035	3.5
<i>Citrus limon</i> L. Osbeck	6	0.03	3
<i>Citrus sinensis</i> L. Osbeck	4	0.02	2
<i>Cocos nucifera</i> Linn.	1	0.005	0.5
<i>Costus afer ker</i> Gwal.	9	0.045	4.5

<i>Curcuma longa</i> L.	14	0.07	7
<i>Cymbopogon citratus</i> (DC.) Stapf	2	0.01	1
<i>Dialium guineense</i> Willd.	1	0.005	0.5
<i>Diospyros mespiliformis</i> Hochst ex A. DC	1	0.005	0.5
<i>Eucalyptus camaldulensis</i> Delial	1	0.005	0.5
<i>Ficus sycomorus</i> L.	1	0.005	0.5
<i>Floscopa africana</i> CB.Clarke	1	0.005	0.5
<i>Garcinia kola</i> Heckel (Guttiferae)	2	0.01	1
<i>Gossypium hirsutum</i> Linn.	2	0.01	1
<i>Hibiscus sabdariffa</i> L.	2	0.01	1
<i>Khaya senegalensis</i> A.	1	0.005	0.5
<i>Lawsonia inermis</i> L.	1	0.005	0.5
<i>Lablab purpureus</i> (L.).Sweet	1	0.005	0.5
<i>Morinda lucida</i>	6	0.03	3
<i>Moringa oleifera</i> Lam.	7	0.035	3.5
<i>Mangifera indica</i> L.	8	0.04	4
<i>Milicia excelsa</i> (Welw) C. C Berg.	2	0.01	1
<i>Musa paradisiaca</i> L.	1	0.005	0.5
<i>Myrianthus arboreus</i> P. Beauv	1	0.005	0.5
<i>Pennisetum purpureum</i> Schumach.	2	0.01	1
<i>Pyrus communis</i> L.	6	0.03	3
<i>Saccharum officinarum</i> L.	2	0.01	1
<i>Spondias mombin</i> L.	2	0.01	1
<i>Tithonia diversifolia</i> (Hems) A. Gray	3	0.015	1.5
<i>Vernonia amygdalina</i> Delile	3	0.015	1.5
<i>Psidium guajava</i> L.	6	0.03	3
<i>Vitis vinifera</i> L.	2	0.01	1
<i>Xylopiya aethiopia</i> (Dunal) A. Rich	1	0.005	0.5
<i>Zingiber officinale</i> Roscoe	2	0.01	1

Table 4: Analysis of variance

Source of variation	Sum of sqrs	Df	Mean square	F	Sig
Species	632.920	55	11.508	6.912	0.00
Location	10.938	1	10.938	6.570	0.013
Error	91.563	55	1.665		

Table 5: Frequency and percentage of growth habit of the medicinal plant species use for the treatment of yellow fever

Habit	Frequency	Percentage (%)
Tree	28	50
Herbs	16	28.5
Shrubs	10	17.9
Vine	1	1.8
Grass	1	1.8
Total	56	100

Table 5 presents the growth habit distribution of the documented medicinal plants. Trees emerged as the most dominant growth habit, recorded with the highest frequency of 28. This high reliance on arboreal species often reflects their structural dominance, year-round availability, and resilience to seasonal changes in the local ecosystem. Conversely, vines represented the least utilized growth habit, occurring only once (1). Table 6 outlines the frequency distribution of the plant parts utilized in herbal formulations. The leaf emerged as the most

frequently used part, recorded 29 times. Biologically, leaves serve as the primary site of manufacture and storage for diverse phytochemical compounds synthesized through photosynthesis. These include

bioactive secondary metabolites such as alkaloids, tannins, coumarins, flavonoids, essential oils, and inulins, which accumulate in high concentrations within foliar tissues. Additional plant components utilized in lesser frequencies include the bark (12), root (6), fruit (4), bulb (2), seed, and the whole plant (1)

Table 6: Frequency and percentage of plant part used for the treatment of yellow fever

Plant part used	Frequency	Percentage (%)
Leaves	29	51.8
Bark	12	21.4
Root	6	10.7
Whole plant	1	1.8
Fruit	4	7.1
Blub	2	3.6
Seed	2	3.6
Total	56	100

Table 7: Frequency and percentage of mode of preparation of plant species used for the treatment of yellow fever

Mode of preparation	Frequency	Percentage (%)
Decoction	38	67.9
Infusion	17	30.4
Maceration	1	1.8
Total	56	100

Table 8: Identified plants used for the treatment of yellow fever with mode of preparation and administration

Botanical Names	Families	Local Names	Common Names	Plant Part Used	Mode of Preparation	Mode of Administration
<i>Abrus precatorius</i> Linn	Fabaceae	Oju Ologbo	Crab's eye	Leaves	Infusion	Drink one cup twice
<i>Adansonia digitata</i> Linn	Bombaceae	Ose	Baobab	Leaves	Infusion	Drink one cup twice
<i>Aframomum melegueta</i> Schum.	Zingiberaceae	Ataare	Alligator pepper	Leaves	Decoction	Drink one cup three times daily
<i>Allium cepa</i> L.	Amaryllidaceae	Alubosa	Onion	Bulb	Decoction	Drink 3ml cup thrice daily
<i>Allium fistulosum</i> L.	Amaryllidaceae	Ayuu	Garlic	Bulb	Infusion	Drink one cup three times daily
<i>Allium sativum</i> L.	Amaryllidaceae	Alubosa elewe	Spring onion	Leaves	Decoction	Drink 1 - 2 cup thrice daily
<i>Aloe barteri</i> L.	Liliaceae	Eti- erin	Aloe vera	Leaves	Infusion	Drink 3ml twice daily
<i>Alstonia boonei</i> De-wild	Apocynaceae	Ahun	Stool wood, Cheese wood	Leaves	Decoction	Drink one cup in the morning and night
<i>Anacardium occidentale</i> Linn	Anacardiaceae	Kasu	Cashew	Fruit	Decoction	Drink one cup thrice a day
<i>Ananas comosus</i> (L.)	Bromeliaceae	Ope oyinbo	Pine apple	Bark	Decoction	Drink one cup thrice a day
<i>Annona muricata</i> L.	Annonaceae	Saga	Sour sop	Leaves	Decoction	Drink 1 - 2 cups of tea daily
<i>Argemone mexicana</i> L.	Papaveraceae	Egun arugbo	Mexican poppy	Leaves	Decoction	Drink one cup a day
<i>Azadirachta indica</i> A. Juss	Meliaceae	Dongoyaro	Neem leaf	Leaves	Infusion	Drink one cup once daily
<i>Balanites aegyptiaca</i> L. Delile	Zygophyllaceae	Teji,darigaj aduwa	Desert dates	Roots	Decoction	Drink 1 - 2 cups of tea daily
<i>Bambusa vulgaris</i> L.	Poaceae	Oparun	Bamboo	Leaves	Decoction	Drink 1 - 2 cups of tea daily
<i>Bridelia ferruginea</i> Benth.	Euphorbiaceae	Ira	Bridelia or blackbird tree	Leaves	Decoction	Drink 1 cup of tea daily
<i>Calotropis procera</i> W. T Aiton	Apocynaceae	Ewe bomubomu	Apple of Sodom	Leaves	Decoction	Drink 1 cup of tea twice daily
<i>Carthamus tinctorius</i> L.	Asteraceae	Osin bafo	Starflower	Seeds	Infusion	Drink 1 - 2 cups of tea daily
<i>Ceiba pentandra</i> L.	Malvaceae	Gbesi	Kapok tree	Leaves	Infusion	Drink 1 cup of tea daily
<i>Chromolaena odorata</i> (L.)	Asteraceae	Akintola	Siam weed, Rouge plant	Leaves	Infusion	Drink 1 - 2 cups of tea daily
<i>Cinnamomum verum</i> Pres.	Lauraceae	Kasia	Cinnamon	Barks	Decoction	Drink 1 - 2 cups of tea daily
<i>Citrus aurantiifolia</i> Swingle	Rutaceae	Osan wewe	Lime	Fruit	Decoction	Drink 1 - 2 cups of tea daily
<i>Citrus limon</i> L. Osbeck	Rutaceae	Osan lemon	Lemon	Fruit	Decoction	Drink 3ml thrice daily
<i>Citrus sinensis</i> L. Osbeck	Rutaceae	Osan	Orange	Leaves	Infusion	Drink 3ml thrice daily
<i>Cocos nucifera</i> Linn	Arecaceae	Ewe Agbon	Coconut	Fruit	Decoction	Drink 3ml thrice daily
<i>Costus afer</i> ker Gawl	Zingiberaceae	Ireke omode	Twisted ginger	Whole plant	Decoction	Drink morning and night
<i>Curcuma longa</i> L.	Zingiberaceae	Ata ile pupa	Turmeric	Root	Maceration	Drink 1 - 2 cups twice daily
<i>Cymbopogon citratus</i> (DC.) Stapf	Poaceae	Koriko oba	Lemon grass	Leaves	Infusion	Drink 1 - 2 cups of tea daily
<i>Dialium guineense</i> Willd.	Fabaceae	Ayun	Velvet tamarind	Bark	Infusion	Drink 1 - 2 cups of tea daily
<i>Diospyros mespiliformis</i> Hochst ex A. DC	Ebenaceae	Kanya	Africa ebony	Bark	Decoction	Drink 1 cup of tea daily
<i>Eucalyptus camaldulensis</i> Dehnh.	Myrtaceae	Eucalyptus	Eucalyptus	Bark	Decoction	Inhaler the vapor
<i>Ficus sycomorus</i> L.	Moraceae	Jogbo	Sycamore fig	Leaves	Infusion	Drink 1 cup of tea daily
<i>Floscopa africana</i> C. B Clarke	Commelinaceae	Toronini		Leaves	Decoction	Drink 1 cup of tea thrice daily

<i>Garcinia kola</i> Heckel (<i>Guttiferae</i>)	Clusiaceae	Orogbo	Bitter kola	Fruits	Decoction	Drink 3ml thrice daily
<i>Gossypium hirsutum</i> Linn	Malvaceae	Owu	Cotton plant	Leaves	Infusion	Drink 1 - 2 cups of twice daily
<i>Hibiscus sabdariffa</i> L	Malvaceae	Zobo	Hibiscus	Leaves	Infusion	Drink 1 - 2 cups of tea daily
<i>Khaya senegalensis</i> A.	Meliaceae	Oganwo	African mahogany	Bark	Decoction	Drink 1 cup of tea daily
<i>Lablab purpureus</i> (L.).Sweet	Fabaceae	Enyikworwa	Hyacinth bean	Leaves	Decoction	Drink 1 cup of tea daily
<i>Mangifera indica</i> L.	Anacardiaceae	Mangoro	Mango	Bark	Infusion	Drink 1 - 2 cups of tea daily
<i>Milicia excelsa</i> (Welw) C.C. Berg	Moraceae	Iroko	Iroko tree	Bark	Decoction	Drink 1 cup of tea daily
<i>Morinda lucida</i> Benth.	Rubiaceae	Oruwo	African Morinda	Leaves	Decoction	Drink 1 cup of tea daily
<i>Moringa oleifera</i> Lam	Moringaceae	Ewe igbale	Moringa	Leaves	Decoction	Drink 1 cup of tea daily
<i>Musa paradisiaca</i> L.	Musaceae	Ogede odo	Plantain	Leaves	Decoction	Drink 3ml twice daily
<i>Myrianthus arboreus</i> P. Beauv.	Urticaceae	Ujuju / Ibi sere	Monkey fruit	Leaves	Infusion	Drink 1 cup of tea thrice daily
<i>Pennisetum purpureum</i> Schumacher.	Poaceae	Epakun	Elephant grass	Leaves	Decoction	Drink 1 - 2 cups of tea daily
<i>Psidium guajava</i> L.	Myrtaceae	Guava	Guava	Bark	Decoction	Drink 1 - 2 cups of tea daily
<i>Pyrus communis</i> L.	Rosaceae	Afoka	Pear	Leaves	Decoction	Drink 1 cup of tea twice daily
<i>Saccharum officinarum</i> L.	Poaceae	Ikoro / Ireke	Sugar cane	Leaves	Decoction	Drink 1 - 2 cups of tea daily
<i>Spondias mombin</i> L.	Anacardiaceae	Okikan / Iyeye	Yellow mombin	Bark	Infusion	Drink 1 cup of tea daily
<i>Tithonia diversifolia</i> (Hemsl) A. Gray	Asteraceae	Sepeleba	Tree marigold	Root	Decoction	Drink 3ml thrice daily
<i>Vernonia amygdalina</i> Delile	Asteraceae	Ewuro	Bitter leaf	Leaves	Decoction	Drink 1 cup of tea morning and night
<i>Vitis vinifera</i> L	Vitaceae	Efo Ajara	Grape	Fruit	Decoction	Drink 1 cup of tea twice daily
<i>Xylopiya aethiopica</i> (Dunal) A.	Annonaceae	Eearu Alamo	Africa pepper	Seed	Decoction	Drink 1 cup of tea daily
<i>Zingiber officinale</i> Roscoe	Zingiberaceae	Ata Ijere	Ginger	Root	Decoction	Drink 1 - 2 cups of tea thrice daily

Table 7 evaluates the traditional methods used to prepare the medicinal plant formulations. Decoction was recorded as the most prevalent method of preparation, accounting for 67.9% (n = 38) of the total cases, followed by infusion at 30.4% (n = 17). The overwhelming preference for decoction (boiling the plant parts) is highly consistent with the anatomical data in Table 6, where bark, roots, and tough leaves required thermal extraction to effectively dissolve and release their active phytochemical groups, such as alkaloids and tannins. Conversely, maceration was the least utilized technique, appearing only once (1.8%), indicating that cold or room-temperature solvent extraction is rarely relied upon by local practitioners for treating yellow fever symptoms. Table 8 document the preparation and therapeutic delivery of the identified medicinal plants used for treating yellow fever within Akure. It provides a comprehensive inventory of each specific plant species along with its unique mode of preparation and subsequent route of administration.

4. Discussion

This ethnobotanical study, conducted in the Akure region of Ondo State, Nigeria, documented the use of medicinal plants for the treatment of yellow fever. The survey revealed a total of 56 plant species belonging to 32 families, underscoring the rich

botanical diversity utilized in traditional healthcare systems within these communities. Families such as Asteraceae, Poaceae,

and Zingiberaceae recorded the highest species occurrence, reflecting their prevalence and potential importance in ethnomedicine. These findings align with other ethnobotanical studies that identified these families as significant reservoirs of medicinal plants due to their wide distribution and therapeutic properties (Dias *et al.*, 2012; Ajayi *et al.*, 2014). This study identified *Azadirachta indica* (Neem), *Carica papaya* (Pawpaw),

Alstonia boonei (Cheese wood), and *Curcuma longa* (Turmeric) as the most frequently cited species with the highest use values. These plants have been previously recognized for their pharmacological properties, including antimicrobial, anti-inflammatory, and antiviral activities, which may contribute to their extensive use in treating febrile illnesses such as yellow fever (Hamilton, 2003; Sofowora, 2008). The prominence of these species in the local pharmacopeia highlights their potential for further phytochemical and pharmacological exploration as candidates for novel therapeutics.

This study revealed that preparation methods predominantly involved decoction (67.9%) and infusion (30.4%), with a small percentage of maceration, reflecting common traditional practices that maximize the extraction of active compounds from plant materials. Leaves were the most frequently utilized plant

part (51.8%), followed by bark and roots, consistent with patterns observed in other ethnobotanical investigations where leaves are preferred for their availability, sustainability, and concentration of bioactive compounds (Martin, 1995; Uprety *et al.*, 2012). The heavy reliance on leaves also suggests a sustainable approach that minimizes destructive harvesting. Similarly, the socio-demographic data revealed that traditional knowledge is transmitted across various community members, including traditional practitioners, farmers, students, and traders, highlighting the pervasive cultural integration of ethnomedicinal practices. The high percentage of knowledge obtained ancestrally (69%) further emphasizes the importance of preserving indigenous knowledge systems, which are at risk due to urbanization and modernization pressures (Albuquerque and Hanazaki, 2009; Oluwajuyigbe and Ige, 2025).

The lack of significant variance between locations ($p > 0.05$) in the ANOVA model indicated spatial homogeneity across the sampled areas (Zar, 2010). This statistical uniformity strongly suggested that these primary medicinal species are uniformly distributed throughout the regional ecosystem, which aligns with typical quantitative ethnobotanical distribution patterns observed in continuous ecological zones (Albuquerque *et al.*, 2014).

The documented medicinal plants exhibited various growth habits dominated by trees (50%), herbs (28.5%), and shrubs (17.9%), reflecting ecological availability and versatility in traditional pharmacotherapy. Trees as dominant medicinal plants suggested longer-term availability and perennial sources compared to herbs and shrubs, which may fluctuate seasonally. Despite vaccinations and modern medical advances, yellow fever remains a public health concern in endemic regions, particularly where healthcare access is limited. Traditional herbal remedies provide affordable, accessible alternatives and play a critical role in primary healthcare delivery, especially in rural Nigeria (Monath and Vasconcelos, 2015; WHO, 2019). This ethnobotanical documentation is vital for preserving this knowledge and serves as a basis for pharmacological validation, bio prospecting, and integration into conventional medicine. However, challenges such as a lack of standardization, dosage control, and scientific validation limit the integration of these traditional remedies into formal healthcare (Wang *et al.*, 2023). Future studies should prioritize phytochemical and toxicological assessments to ensure safety and efficacy (Chanda *et al.*, 2015). Furthermore, conservation efforts are required to safeguard medicinal plant biodiversity against habitat loss and overharvesting, which threaten the sustainability of these valuable resources (SANBI, 2024). Health is a fundamental asset, and herbal medicine remains an integral part of cultural heritage and healthcare, balancing bodily systems through the use of locally available natural resources (WHO, 2025).

In Akure North and South LGAs, a mixture of urban and rural populations depends on both traditional and modern medicine, often relying on herbal remedies due to financial constraints and limited access to formal healthcare. The ongoing destruction of forest habitats and urban expansion threatens the availability of medicinal plants, underscoring the urgent need to survey, document, and conserve these vital resources (Nartey, 2025). Establishing botanical gardens and promoting domestication practices through collaboration among researchers, traditional practitioners, herbal vendors, and farmers are essential to prevent extinction and ensure sustainable use (Tebulo, 2025). Herbal medicine remains an integral part of cultural heritage and healthcare. Challenges faced by traditional medicine practitioners include financial difficulties, inadequate training, dosage, and safety concerns regarding herbal products (Ibrahim *et al.*, 2023).

5. Conclusion

In conclusion, this study enriches the understanding of traditional medicinal plant use against yellow fever in Akure. By documenting species diversity, use patterns, and indigenous knowledge, it contributes to cultural preservation, public health, and potential drug discovery efforts. Therefore, promoting sustainable harvesting and scientific validation will enhance the benefits of these ethnomedicinal plants while ensuring their availability for future generations. It is recommended that government policies focus on providing formal education and training to herbal vendors and traditional healers to enhance the safety, efficacy, and sustainability of traditional medicine practices in Ondo State and beyond.

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Competing Interest

The authors declare that there are no conflicts of interest.

Data Availability Statement

Available upon request.

Ethics Approval

Informed consent was obtained.

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