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Traditional medicinal plants for asthma treatment: An ethnobotanical study from southern Benin

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ABSTRACT

Background: Asthma is a public health issue. Conventional treatments are not only expensive but also have side effects. In southern Benin, traditional medicine remains a primary source of care for asthma. Despite the widespread use of indigenous flora, many of these medical species lack documentation. **Objective:** This study aimed to identify and document medicinal plants used for asthma management in southern Benin. **Materials and Methods:** An ethnobotanical survey was conducted in three major cities, Cotonou, Abomey-Calavi, and Porto-Novo, among 58 market herbalists, 15 plant users, and 9 traditional healers. Structured interviews collected socio-demographic information and therapeutic data. **Results:** A total of 61 plant species from 33 families, including *Liliaceae, Anacardiaceae, Solanaceae, Myrtaceae,* and *Lamiaceae*, were identified. The most frequently cited species were *Pancratium trianthum* (9.7%), *Allium sativum* (8.3%), *Mangifera indica* (6.0%), *Citrus lemon* (4.6%), and *Allium cepa* (4.2%). Leaves were the most commonly used plant part in treatments. Decoction was the predominant preparation method, and oral administration was most frequent. **Conclusion:** This inventory lays the groundwork for integrative pharmacology, where Benin's biodiversity becomes the foundation for new sustainable therapeutic solutions for asthma

Keywords: Ethnobotanical survey, Traditional medicine, Respiratory disease, Plant-based therapy, Indigenous knowledge.

INTRODUCTION

Respiratory diseases are among the major categories of non-communicable diseases, affecting more than one billion people worldwide [1]. Among these, asthma remains the most prevalent, with an estimated 334 million affected patients [2]. In 2019, approximately 262 million people were reported to suffer from asthma, resulting in 461,000 deaths. Most of them occurred in low- and middle-income countries, where underdiagnosis and inadequate treatment remain major challenges [3]. In Africa, the prevalence of asthma is estimated to reach nearly 50 million cases [4], representing a significant public health and economic burden for developing countries. In Benin, an estimated 500,000 to 510,000 people live with asthma. This corresponds to a prevalence of 3,355 cases per 100,000 inhabitants [5].

A variety of factors, including environmental, demographic, and healthcare-related issues, influence asthma in Africa. Key causes of asthma inflation on the continent include urbanization, exposure to allergens and pollutants, and limited access to healthcare [6–8]. Asthma's symptoms are common and can significantly impact the quality of life for affected individuals [8]. The main symptoms include wheezing, shortness of breath, chest tightness, and coughing [7].

Although asthma is not curable, certain medications can alleviate symptoms [9]. However, these treatments may cause side effects that differ depending on the drug type, dosage, and route of administration (such as cough, headache, vomiting, fever, nausea, or insomnia), and treatment resistance has also been observed [6,7]. Corticosteroids are widely used as the main therapeutic option, yet their effectiveness can be limited by oxidative stress. The massive mobilization of inflammatory cells (eosinophils and neutrophils) and the imbalance in the antioxidant system in asthmatic patients are thought to contribute to the overproduction of Reactive Oxygen Species (ROS) [12]. Recently, biological therapies based on monoclonal antibodies, including Anrukinzumab, Gomiliximab, Keliximab, and Canakinumab, have shown potential in reducing disease severity [13]. Unfortunately, these treatments

remain prohibitively expensive and are therefore inaccessible to many patients in developing countries.

Over recent decades, numerous plants with antiallergic and antiasthmatic properties have been studied [14,15]. A study covering the period from 1986 to 2023 drew on seven databases, including Springer, Web of Science, and Scopus. It focused on plants and their bioactive compounds whose anti-asthmatic effects have been experimentally confirmed, identifying 58 plant species and 32 plant-derived compounds exhibiting such activity [15].

In China, complementary and alternative medicine is increasingly employed in asthma management. ASHMI, an anti-asthma intervention based on three medicinal plants, has demonstrated efficacy and safety in murine models of asthma and preliminary clinical studies, and was well tolerated by asthmatic patients[16]. Families of secondary metabolites commonly found in plants, such as flavonoids or coumarins, known for their immunomodulatory, antioxidant, anti-inflammatory, and antiasthmatic effects, are promising candidates for asthma treatment [17-19]. In several African countries, including Togo, Algeria, Tanzania, Nigeria, and Congo, a wide variety of medicinal plants is traditionally used to manage asthma [20-22]. The most commonly used plant families are the *Fabaceae*, followed by *Euphorbiaceae*, *Asteraceae*, *Lamiaceae*, *Rutaceae*, and *Rubiaceae*.

Despite the importance of these, few ethnobotanical studies have specifically focused on plants used in southern Benin to treat asthma. The most relevant documented plants used for respiratory diseases in general, including some for asthma and lung infections [23]. Documenting this traditional knowledge is essential for preserving cultural heritage. Therefore, the present study aims to catalogue, through an ethnobotanical survey, the plant species used in the traditional pharmacopoeia of Benin for the management of asthma.

MATERIAL AND METHODS

Study area

The ethnobotanical survey was carried out in three major cities in southern Benin: Cotonou (6°21'N, 2°26'E), Abomey-Calavi (6°26'N, 2°21'E), and Porto-Novo (6°29'N, 2°36'E). These cities are situated within the Guineo-Congolian phytogeographical region, characterized by a sub-equatorial climate with an annual rainfall of about 1,100 to 1,300 mm and an average temperature of 27-28 °C. Cotonou and Abomey-Calavi are located in the Littoral and Atlantic departments. Porto-Novo is located approximately 30 km to the east in the Ouémé department. Southern Benin hosts the largest and most active traditional herbal markets in the country, with several specialized herbal stalls in Abomey-Calavi and Porto-Novo. These markets are primarily managed by women from different ethnic groups, notably the Fon, Goun, Adja, Yoruba, and Nago, who play a central role in the collection, processing, and commercialization of medicinal plants. This region was chosen for the study because it concentrates the highest population density, the greatest burden of asthma and respiratory diseases, and the most dynamic traditional medicine trade in Benin. The proximity of these three cities also facilitates access to a high diversity of medicinal plant suppliers and traditional healers while reflecting the strong urban and peri-urban reliance on herbal remedies for asthma management. The data collection points within these cities are represented on the map (Figure 1).

Target population

The respondents included herbalists, traditional healers, and other key informants, such as asthma patients, relatives, and medicinal plant users [24]. Informants were identified through a combination of purposive and snowball sampling techniques. The initial respondents were contacted using the chain referral approach, starting with well-known practitioners. Subsequent informants were then recruited based on recommendations from the initial respondents. To reduce information redundancy, the sampling approach used in market, consisting of selecting one herbalist and skipping adjacent stalls. Participants were chosen based on the diversity and abundance of plant materials available to them. All participants were interviewed only after obtaining prior informed oral consent.

Ethnobotanical survey

The survey was conducted between October 4, 2022, and December 30, 2022. A total of 82 people were interviewed. Data were collected using structured survey forms and include two categories of information. The first category included sociodemographic characteristics relative to respondents, such as age, sex, level of education, and ethnic group [25]. The second category focused on ethnobotanical knowledge related to asthma treatment, including the local names of the disease, plant species used, plant parts utilized, methods of preparation, routes of administration, dosage, and frequency of use.

Data Analysis

Data were analyzed using the Statistical Package for Social Science (SPSS) version 20.0. Descriptive statistics, including percentages, frequencies, and means, were calculated to summarize the socio-demographic characteristics of informants and the ethnobotanical data. Comparative analysis of means was performed to evaluate differences in plant use reports across markets. Correlations between variables were determined using Spearman's rank correlation test. In addition, Principal Component Analysis (PCA) was carried out to explore the relationships between vernacular names and the different areas. All results were considered statistically significant at $p < 0.05$.

RESULTS

Geographical distribution of respondents

The geographical distribution of the 82 respondents shows a strong concentration in Cotonou, followed by Abomey-Calavi and Porto-Novo. Table 1 shows the detailed distribution.

Socio-demographic characteristics of respondents

The majority of respondents were female (78.0%) and had no formal education (57.3%). Knowledge of the use of medicinal plants for the treatment of asthma was reported across all age groups, with the highest proportion observed among respondents aged 40-50 years (34.15%), followed by those aged 30-40 years (32.93%). Respondents over 50 years of age accounted for 25.61%, while those aged 20-30 years represented the smallest proportion (7.32%) (Table 2).

Ethnic groups of respondents and vernacular names for asthma

The respondents belonged to different ethnic groups, with the Fon being the most represented (81.71%), followed by the Yoruba (9.75%), with the other ethnic groups accounting for a small proportion of the sample (Figure 2). This distribution is consistent with the most frequently cited vernacular name for asthma, Gbôhlihlè, which was predominantly reported by the respondents.

Principal component analysis for the relationships between the vernacular plant names and survey cities

The first component explains 39.3% of the total variance, while the second and third components together account for the remaining 60.7%. The correlation circle illustrating the relationship between vernacular names and surveyed cities (Figure 3) is presented below. The most frequently cited vernacular names associated with asthma treatment are Gbôhlihlê in Cotonou, Agbôkpin in Abomey-Calavi, and Gbôdjan in Porto-Novo.

Symptoms reported according to respondent type

Several symptoms are reported among respondents. The Table 3 summarizes those largely recognized as being directly related to asthma. The most frequently reported symptoms were difficulty breathing and coughing. Difficulty breathing was mentioned by 93.1% of herbalists and 86.7% of resource persons. Coughing was cited by 56.9% of herbalists and 73.3% of resource persons. Other symptoms, such as chest pain, nausea, accelerated pulse, and insomnia, were rarely reported

Taxonomic diversity and popularity of plants used

The plants reported belong to 33 families. The most represented families globally are *Liliaceae* (up to 66,6%), *Anacardiaceae, Apocynaceae*, *Fabaceae* (up to 33,3 per cent), *Lamiaceae* (26,7%) (Table 4).

Identified plant species and their frequency of citation

Sixty-one (61) plant species were cited by the respondents (Table 5). *Pancratium trianthum* was the most frequently cited species (9.68%). Two other plant species, *Allium sativum* and *Mangifera indica,* showed citation frequencies ranging between 5% and 8%, while eleven species had frequencies between 2% and 5% (*Citrus lemon, Allium cepa, Xylopia aethiopica, Calotropis procera, Thonningia sanguinea, Acacia nilotica, Anacardium occidentale, Musa sinensis, Morinda lucida, Monodora myristica, and Syzygium aromaticum*).

Botanical parts used in traditional medicine

In the study area, leaves are the most commonly used plant part for asthma treatment, with a percentage (45.1%), followed by bulbs (42.7%), fruits (24.4%), bark (17.1%), and roots (13.4%). The remaining parts, including stem, bulb, flower, rhizome, and the whole plant, collectively accounted for 36.6% of reported uses (Figure 4).

Plant part preparation

Five preparation methods were employed in the treatment of asthma, including maceration, fumigation, alcohol-based extraction, decoction, trituration, direct consumption, kernel oil preparation, and infusion (Figure 5). Decoction was identified as the predominant method of preparation among all three respondent categories: herbalists (82.8%), resource persons (73.3%), and traditional healers (88.9%).

Routes of administration for medicinal plants reported

Two main routes were reported: oral and nasal. The oral route was predominant, accounting for 96% of the cited uses, while nasal administration represented only 4%.

Dosages of the recipes

Regarding the frequency of administration, the majority of respondents reported taking herbal remedies three times (morning, noon, and evening) daily (62.2%), followed by twice daily (morning and evening) in 25.6% of cases. Less frequently reported patterns included once-daily intake (4.9%) and variable administration depending on symptom severity (7.3%) (Figure 6).

Table 1: Geographical distribution of respondents

Cities		Locations	Numbers
Abomey-calavi		Godomey	2
		Tokpa	5
		Togba	3
		Womey	2
		Tokan	2
		IIta	1
		Aïtchédji	1
		Zogbadjè	1
		Mariagléta	1
	Subtotal 1		18
Cotonou		Adjahagon	1
		Agbolilamè	1
		Aidjèdo	1
		Bélier	2
		Dantokpa	3
		Dégaakon	1
		Fidjrossè	1
		Fifadji	3
		Ganhi	1
		Gbèdjromèdé	1
		Gbégamey	1
		Houénoussou	2
		Mènontin	1
		Vèdoko	3
		Vossa	1

		Wologuèdè	2
		Zogbo	1
		Agbolilamè	1
		Avotrou	1
		Cas-auto	2
	Subtotal 2		31
Porto-Novo		Djassin	2
		Ouando	4
		Avakpa	2
		Songhaï	1
	Subtotal 3		9
Total			58

Traditional healers	
Cities	Numbers
Abomey-Calavi	5
Cotonou	2
Porto-Novo	2
Total	9
Users and relatives	
Numbers	Numbers
Abomey-Calavi	11
Cotonou	1
Porto-Novo	3
Total	15

Table 2: Socio-demographic characteristics of respondents

Parameters	Variables	Numbers	Percentages (%)
Ages	20-30	6	7.3
	30-40	27	32.9
	40-50	28	34.2
	>50	21	25.6
Gender	Male	18	22.0
	Female	64	78.1
Educational level	Unscholarized	47	57.3
	Primary	10	12.2
	Secondary	15	18.3
	University	10	12.2
Length of service	0-10	8	9.8
	10-20	29	35.4
	20-30	24	29.3
	>30	21	25.6
Cities	Abomey-Calavi	34	41.5
	Cotonou	35	42.7
	Porto-Novo	13	15.9

Table 3: Symptoms reported by respondent type

Symptoms	Relative frequency by respondent types (%)	
	Herbalists	Resource persons
Difficulty breathing	93.1	86.7
Chest pain	0	6.7
Nausea	1.7	0
Accelerated pulse	1.7	0
Coughing	56.9	73.3
Insomnia	5.2	0

Table 4: Species families

Botanical family	Percentage of reports (%)	The group with the highest percentage
Amaranthaceae	6.9	Herbalists
Asparagaceae	3.4	Herbalists
Asphodelaceae	11.1	Traditional healers
Anacardiaceae	33.3	Traditional healers
Annonaceae	11.1	Traditional healers
Apocynaceae	33.3	Traditional healers
Arecaceae	10.3	Herbalists
Balanophoraceae	11.1	Traditional healers
Buxaceae	6.7	Key informants
Capparaceae	5.2	Herbalists
Caricaceae	1.7	Herbalists
Casuarinaceae	1.7	Herbalists
Combretaceae	5.2	Herbalists
Cucurbitaceae	6.7	Key informants
Cyperaceae	6.7	Key informants
Euphorbiaceae	22.2	Traditional healers
Fabaceae	33.3	Traditional healers
Lamiaceae	26.7	Key informants
Liliaceae	66.6	Traditional healers
Malvaceae	5.1	Herbalists
Meliaceae	11.1	Traditional healers
Musaceae	13.3	Key informants
Myristicaceae	11.1	Traditional healers
Myrtaceae	13.8	Herbalists
Phyllanthaceae	6.7	Key informants
Poaceae	12.8	Traditional healers
Rosaceae	6.7	Key informants
Rubiaceae	10.3	Herbalists
Solanaceae	16.8	Herbalists
Verbenaceae	11.1	Traditional healers
Vitaceae	11.1	Traditional healers
Zingiberaceae	13.3	Key informants

Table 5: Identified plant species and citation frequency

N°	Plants	Numbers	Percentages (%)
1	*Pancratium trianthum Herb.*	21	9.7
2	*Allium sativum L.*	18	8.3
3	*Mangifera indica L.*	13	6.0
4	*Citrus lemon L.*	10	4.6
5	*Allium cepa L.*	9	4.2
6	*Xylopia aethiopica (Dunal) A.Rich.*	8	3.7
7	*Calotropis procera (Aiton) W.T.Aiton*	7	3.2
8	*Thonningia sanguinea Vahl*	7	3.2
9	*Acacia nilotica (L.) Willd.*	6	2.8
10	*Anacardium occidentale L.*	6	2.8
11	*Musa sinensis Sagot.*	6	2.8
12	*Morinda lucida Benth.*	5	2.3

13	*Monodora myristica (Gaertn.) Dunal*	5	2.3
14	*Syzygium aromaticum L.*	5	2.3
15	*Allium ascalonicum L.*	4	1.8
16	*Chenopodium ambrosioides L.*	4	1.8
17	*Elaeis guineensis Jacq.*	4	1.8
18	*Eucalyptus camaldulensis Dehn.*	4	1.8
19	*Euphorbia hirta L.*	4	1.8
20	*Zingiber officinale Roscoe*	4	1.8
21	*Khaya senegalensis (Desr.) A.Juss.*	4	1.8
22	*Ocimum basilicum L.*	4	1.8
23	*Ocimum gratissimum L.*	4	1.8
24	*Aloe vera L.*	3	1.4
25	*Caesalpinia pulcherrima L.*	3	1.4
26	*Crateva religiosa G.Forst.*	3	1.4
27	*Terminalia avicennioides Guill. & Perr.*	3	1.4
28	*Abrus precatorius L.*	2	1.0
29	*Aframomum melegueta (Roscoe) K.Schum.*	2	1.0
30	*Carissa spinarum L.*	2	1.0
31	*Chlorophytum blepharophyllum Schweinf. ex Baker*	2	1.0
32	*Cocos nucifera L.*	2	1.0
33	*Kalanchoe pinnata (Lam.) Pers.*	2	1.0
34	*Lippia chevalieri Moldenke*	2	1.0
35	*Nicotiana tobacum L.*	2	1.0
36	*Thymus vulgaris L.*	2	1.0
37	*Abelmoschus esculentus (L.) Moench*	1	0.5
38	*Azadirachta indica A.Juss.*	1	0.5
39	*Buxus sempervirens L.*	1	0.5
40	*Carica papaya L.*	1	0.5
41	*Casuarina equisetifolia L*	1	0.5
42	*Catharanthus roseus (L.) G.Don*	1	0.5
43	*Clerodendrum capitatum (Willd.) Schumach. & Thonn.*	1	0.5
44	*Cola laurifolia Mast.*	1	0.5
45	*Cymbopogon citratus (DC.) Stapf*	1	0.5
46	*Cyperus articulatus L.*	1	0.5
47	*Macrosphyra longistyla (DC.) Hiern*	1	0.5
48	*Malus domestica (Suckow) Borkh.*	1	0.5
49	*Mentha spicata L.*	1	0.5
50	*Momordica charantia L.*	1	0.5
51	*Parkia biglobosa Jacq.) R.Br. ex G.Don*	1	0.5
52	*Phaseolus vulgaris L.*	1	0.5
53	*Phyllanthus amarus Schumach. & Thonn.*	1	0.5
54	*Philenoptera cyanescens Schumach. & Thonn.) Roberty*	1	0.5
55	*Saccharum officinarum L.*	1	0.5
56	*Salvia rosmarinus Spenn.*	1	0.5
57	*Spondias mombin L.*	1	0.5
58	*Trichilia emetica Vahl*	1	0.5
59	*Triplochiton scleroxylon K.Schum.*	1	0.5
60	*Vitis vinifera L.*	1	0.5
61	*Waltheria indica L.*	1	0.5

Table 6: Plants used in the treatment of asthma in southern Benin

Plants	Vernacular names	Type of plants	Preparation mode	Family	Plant parts used	Alone or in combination
Pancratium trianthum Herb.	lily (engl); kuyoma (f); ganganlubasa (g);ishumèri, dandan (y).	Herb	Decoction, trituration	Amaryllidaceae	Bulb	Alone and in combination
Allium sativum L.	Ail (fr); garlic (engl); ayo (f, g, y).	Herb	Decoction, kernel oil preparation, direct consumption, maceration, infusion, fumigation,	Alliaceae	Bulb	Alone and in combination
Mangifera indica L.	Mango, mangue, manguier (fr); (common) mango (engl); manga, amanga, yovoslotin (y, n);	Tree	Decoction, Trituration, Infusion, direct consumption	Anacardiaceae	Leaves, Barks	Alone and in combination
Citrus lemon L.	Lemon (engl); (f)	Tree	Decoction, Trituration, infusion, fumigation, macération	Rutaceae	Fruits	Alone and in combination
Allium cepa L.	Oignon (fr); (common) onion (engl); ayoma, ayomasa, xèhunmè, vovo, massa (f, g), ganganlubasa (g): ambassa, alubosa gambari, konan nugbe (y)	Herb	Decoction, direct consumption, infusion	Alliaceae	Bulb	In combination
Xylopia aethiopica (Dunal) A.Rich.	Piment noir de Guinée, poivrier de Guinée. arbre à épices (fr); Guinea pepper (engl.); kpéjélékun, sesedo, erunje, eru (f, y);	Tree	Decoction	Annonaceae	Seed	Alone and in combination
Calotropis procera (Aiton) W.T.Aiton	Arbre à soie, pomme de Sodome, bois pétard, mudar de grand taille (fr); Sodom apple (engl); amouman, bomou bomou (f); boum boum, kpamon (y);	Shrub	Decoction, infusion	Asclepiadaceae	Leaves	Alone and in combination
Thonningia sanguinea Vahl	Ground pineapple (engl); tèdè, atin-ma-wu-do (f, g); adele, ade ile, oyalè, oya ilè (y, n).	Herb	Decoction, maceration	Balanophoraceae	Roots	Alone and in combination
Acacia nilotica (L.) Willd.	Gommier rouge (fr), gbanni (g, f)	Tree	Decoction	Leguminosae-Mimosoideae	Leaves, barks	Alone and in combination
Anacardium occidentale L.	Cajou, acajou, anacardier, pomme de cajou, noix de cajou (fr); cashew nut (engl); akaju (f, g); kaju, ekaju (y)	Tree/Shrub	Decoction	Anacardiaceae	Barks, feuilles	in combination
Musa sinensis Sagot.	Banane plantin (fr), kwekwe (f)	Herb	Decoction, maceration,	Musaceae	Fruits	Alone and in combination
Morinda lucida Benth.	xwesin ou xwenswe (f, g)	Shrub	Decoction, maceration, kernel oil preparation	Rubiaceae	Leaves	Alone and in combination
Monodora myristica (Gaertn.) Dunal	Muscadier africain, faux muscadier (fr); sasalikun, sasalo gbakwin, sasagbakun, nyimalo (f, g); ariwo, abolako, she ishasha gbakun (y)	Tree	Decoction	Annonaceae	Seed	in combination
Syzygium aromaticum L.	Giroflier (fr), Atikingbadota (f)	Tree	Decoction, trituration	Myrtaceae	Flower buds	in combination

Allium ascalonicum L.	Échalotte (fr); shallot (engl.); alubosa elewe, alubosa onishu (f)	Herb	Maceration, direct consumption,	Amaryllidaceae	Bulb	in combination
Chenopodium ambrosioides L.	Chénopode (fr); amahun kokwe, mawanwan amatluzu, godo, azogbidiwa (f), ma-ntulusi, emigbe (y)	Herb	Decoction	Chenopodiaceae	Leaves	in combination
Elaeis guineensis Jacq.	Palmier à l'huile (fr); oil palm (engl); detin (f); Igi okpè, opè, okpè, ènyi (y)	Tree	Decoction, maceration, kernel oil preparation	Arecaceae	Kernels	Alone and in combination
Eucalyptus camaldulensis Dehn.	Eucalyptus rouge, eucalyptus rostré, gommier rouge (fr); river red gum, Murray red gum (engl).	Tree	Decoction	Myrtaceae	Leaves	in combination
Euphorbia hirta L.	Herbe d'Australie (fr); hundi hundi asu, anonsika, nonsiwé (f); akponyon, kplonvi, koligosu vovo (g); emi Ile, egè Ilè, egèlè, nyahun ayira (y)	Herb	Infusion, decoction,	Euphorbiaceae	Leaves	in combination
Zingiber officinale Roscoe	Gingembre (fr), Dotè (fr)	Herb	Infusion, fumigation, maceration	*Zingiberaceae*	Rhizomes	in combination
Khaya senegalensis (Desr.) A.Juss.	Caïlcédrat, acajou du Sénégal (fr); Senegal mahogany, dry zone mahogany (engl); zunzatin, biri agao (f); agawu, gamo, tere (g); oganwo, ago, aganwo (y)	Tree	Decoction	Meliaceae	Barks, leaves	in combination
Ocimum basilicum L.	Basilic (fr); basil (engl); kesu kesu, xesu xesu, xisi xisi (f); akohun (g); ofèn (y);	Herb	Decoction	Lamiaceae	Leaves	in combination
Ocimum gratissimum L.	Gros basilic, plante moustique, buisson thé, flle fièvre (fr); tchao, tchan madiwé, tchama dido, xèbioso (f, g); efinrin, simonuwa, are bla, aribla (y)	Herb	Decoction	Lamiaceae	Leaves	in combination
Aloe vera L.	Lys du désert (fr),	Herb	Decoction, trituration	Asphodelaceae	Leaves	in combination
Caesalpinia pulcherrima L.	Orgeuil de Chine (fr); pride of Barbados (engl).	Shrub	Decoction	Leguminosae-Caesalpinioideae	Leaves	in combination
Crateva religiosa G.Forst.	Crateva sacre (fr); onton zunzen (f, g); tanyia, tamyia (y)	Tree	Trituration	Capparaceae	Leaves	in combination
Terminalia avicennioïdes Guill. & Perr.	Alotun, alotudiesama, pavu (f)	Shrub	Decoction	Combretaceae	Leaves	in combination
Abrus precatorius L.	Liane à réglisse (fr), Viviman(f, g), Djèndjènkoudjèn, Odjouéga (y)	climber	Decoction	Fabaceae	Leaves	in combination
Aframomum melegueta (Roscoe) K.Schum.	Graine de paradis, poivre de Guinée, maniguette, malaguette, poivre de meleguette (fr); grains of paradise, Guinea pepper, melegueta pepper (engl); atakoun, watchi (f, g), oburo, atanre, atayè, ataliya, ata isa, tètègboko (y)	Herb	Alcoolature, maceration	Zingiberaceae	Kernels	in combination
Carissa spinarum L.	Avia, aviavìè (f) oshun, oshin shin (y)	Shrub	Decoction	Apocynaceae	Kernels	in combination

Chlorophytum blepharophyllum Schweinf. ex Baker	Baka (y).	Herb	Decoction	Anthericaceae	Leaves	in combination
Cocos nucifera L.	Cocotier (fr); coconut (palm) (engl); agonkè (f); agbon, egbo agbon (y)	Tree	Maceration	Arecaceae	Fruits	in combination
Kalanchoe pinnata (Lam.) Pers.	Plante de la résurrection, (fr); life plant (engl), jàmaku, tome, tesuma (f); acèma, asè mà, otome (g); koropo, kanti kantiu, abamoda, èru odundun (y)	Herb	Infusion, fumigation, maceration	Crassulaceae	Leaves	in combination
Lippia chevalieri Moldenke	Thé de Gambie (fr); aglala, aklala, nyè ya, nyinya, danhome fià, pobè fià, kanhun (f); efinrin gogoro (y)	shrub	Decoction	Verbenaceae	Leaves	in combination
Nicotiana tobacum L.	Tabac (fr), Taba (f)	Herb	Decoction	Solanaceae	Leaves	in combination
Thymus vulgaris L.	Thym commun, Farigoule (fr),	Shrub	Decoction	Lamiaceae	Leaves	in combination
Abelmoschus esculentus (L.) Moench	Fèvi (f), Gombo(fr)	Herb	Direct consumption	Malvaceae	Fruits	Alone
Azadirachta indica A.Juss.	Neem (fr, engl), kininutin (f, g); dogon yaro (y).	Tree	Decoction	Meliaceae	Leaves	in combination
Buxus sempervirens L.	Buis commun (fr),	Shrub	Decoction	Buxaceae	Leaves	in combination
Carica papaya L.	Papayer, papayier, arbre à melon (fr); papaya, paw paw (engl); kpèn (f); gbègpè (g); igi bèkpe, ibèpè, sheyinbo, shigun (y)	Tree	Decoction	Caryophyllacea e	Leaves, Roots	in combination
Casuarina equisetifolia L	Filao (fr); coast she-oak, ironwood, whistling pine (engl)	Tree	Decoction	Casuarinaceae	Barks	in combination
Catharanthus roseus (L.) G.Don	Pervenche de Madagascar (fr); Madagascar periwinkle (engl); flawe (f); bobo (y).	Herb	Decoction	Apocynaceae	Leaves	in combination
Clerodendrum capitatum (Willd.) Schumach. & Thonn.	Agoliswe, agonsweswe, zokplotin, yeswe, wema (f, g); iye, feremomi (y)	Shrub	Decoction	Verbenaceae	Leaves	in combination
Cola laurifolia Mast.	Laurier (fr);joloba (f); fomu (y).	Tree	Infusion, decoction	Sterculiaceae	Leaves	in combination
Cymbopogon citratus (DC.) Stapf	Citronnelle, fausse citronnelle, herbe citron (fr); lemon grass (engl); tcha (f); koriko oba, koko oba, koriko oyibo, tii oba (y)	Herb	Decoction, infusion	Poaceae	Leaves	in combination
Cyperus articulatus L.	Grand jonc, souchet articulé (fr), fen, ofen, ablinhan (f), ifin, ore, orin (y).	Herb	Decoction	Cyperaceae	Leaves	in combination

Macrosphyra longistyla (DC) Hiern	Zikiti gowun, zigidi gowun (f); conycerè (g); ikunku èkun (y), Zinguidigahoun (g).	Shrub	Decoction	Rubiaceae	Leaves	in combination
Malus domestica (Suckow) Borkh.	Pommier commun (fr)	Tree	Decoction	Rosaceae	Fruits	in combination
Mentha spicata L.	Menthe (fr)	Herb	Infusion, decoction,	Lamiaceae	Leaves	in combination
Momordica charantia L.	Poire de balsam, concombre africain, liane merveille, margose (fr); bitter gourd, balsam pear, bitter melon, African cucumber, karela (engl); nyensinken, slosinkan (f); aslosinkan, aduken (g); ejinrin (y, n)	Climber	Decoction	Cucurbitaceae	Leaves	in combination
Parkia biglobosa Jacq.) R.Br. ex G.Don	Néré, nété, arbre à farine, arbre à fauve, mimosa pourpre (fr); West-African locust bean (engl); ahwatin, (f); ayidan abata, osho ogba, igba (y)	Tree	Maceration, decoction	Leguminosae-Mimosoideae	Roots	in combination
Phaseolus vulgaris L.	Haricot commun (fr),	Herb	Direct consumption	Fabaceae	Fruits	in combination
Phyllantus amarus Schumach. & Thonn.	Phyllanthus amer (fr); henlenwe (f); ashasha (y, n); sobaru (ba); banna banna biriku (d).	Herb	Decoction, infusion	Euphorbiaceae	Leaves	in combination
Philenoptera cyanescens Schumach. & Thonn.) Roberty	Liane indigo, vigne indigo (fr), Yoruba indigo (engl), aho ma, gbodudogo (f), èlu (y)	Climber	Decoction	Fabaceae	Leaves	in combination
Saccharum officinarum L.	Canne à sucre (fr); sugarcane (engl); léké (f, g); ireke (y).	Herb	Decoction	Poaceae	Stems	in combination
Salvia rosmarinus Spenn.	Romarin, rose marine, encensier (fr),	Shrub	Decoction	Lamiaceae	Leaves	in combination
Spondias mombin L.	Prunier mombin, prune myrobalan, prune d'or (fr); Java plum, yellow mombin, hog plum (engl); akikontin, aklokontin, sèma, akukon, ahlihon (f); aklokon, jogbema, jogbi (g); iyeye, eyeye, okika, ekika, ekan (y)	Tree	Decoction	Anacardiaceae	Leaves	in combination
Trichilia emetica Vahl	Mafouraire (fr); roka, mafuire (engl); civi. tchivi (f); ogodu, ogoudou, wushioko (y, n).	Tree	Decoction, maceration	Meliaceae	Leaves	in combination
Triplochiton scleroxylon K.Schum.	Samba (fr); odum (engl); xwetin (f); arère, ogu, gwiogu (y).	Tree	Trituration	Malvaceae	Leaves	in combination
Vitis vinifera L.	Raisin, grappe (fr); grapevine (engl).	Climber	Direct consumption	Vitaceae	Fruits	in combination
Waltheria indica L.	Adassounsoun-ma (f, g), okoro oman (y)	Herb	Decoction	Sterculiaceae	Roots	Alone

Legend: *fr: french, f: fongbe, g: goungbe, y: yoruba, engl: english*

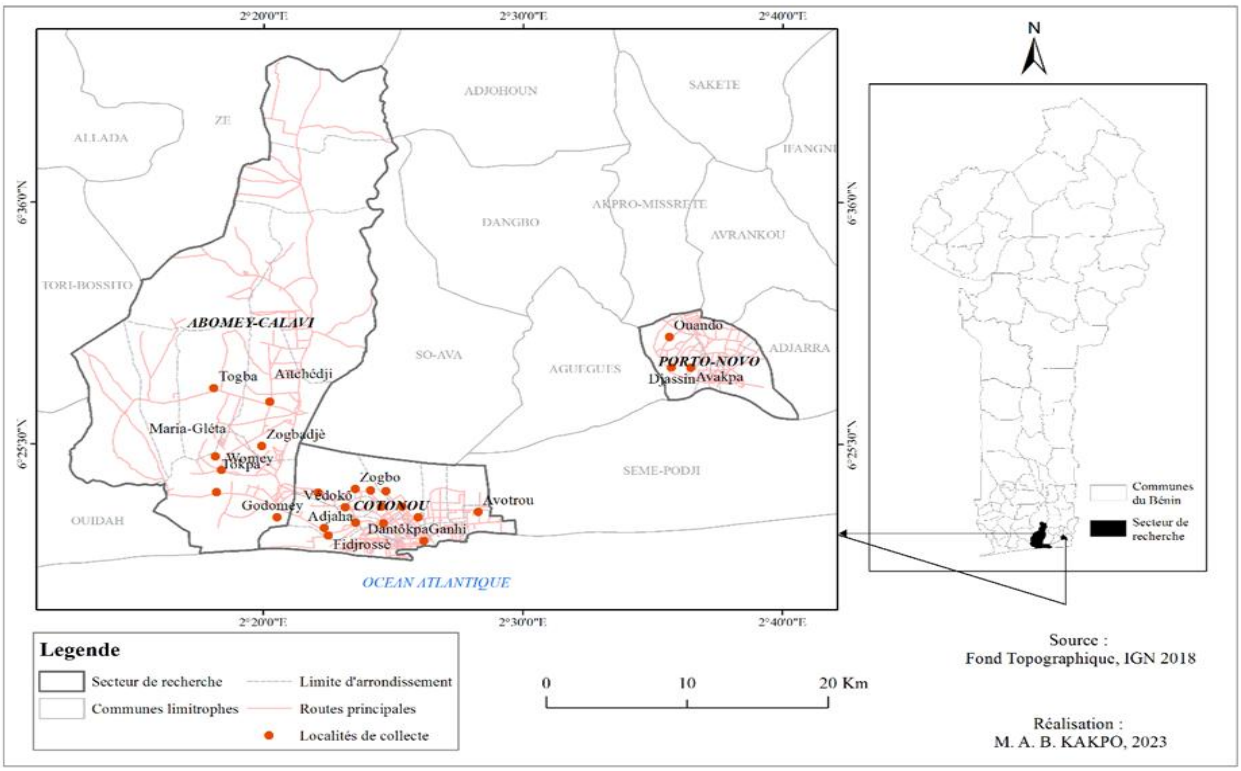

Figure 1 : Study Area

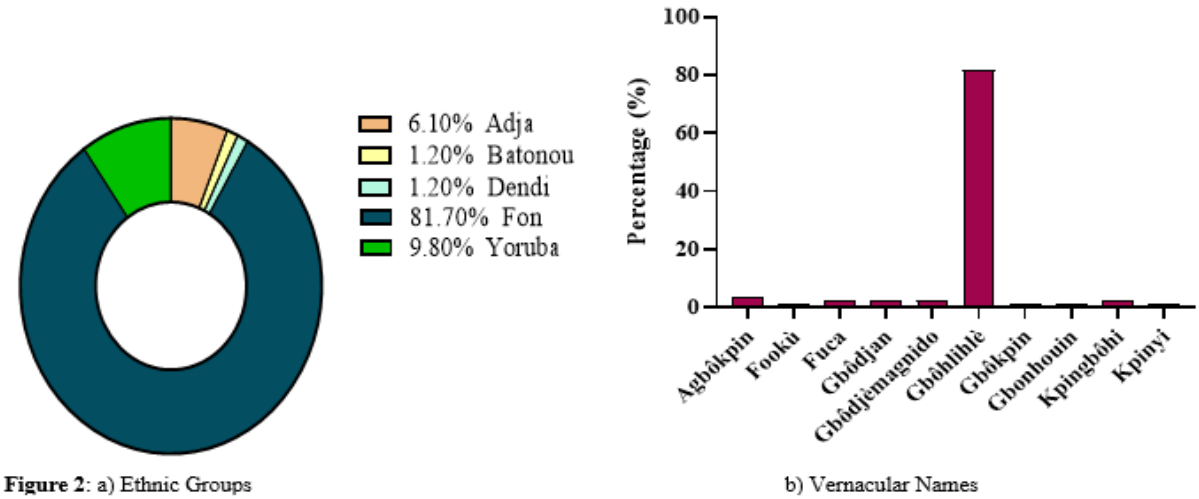

Figure 2: a) Ethnic Groups b) Vernacular Names

Figure 2: a) Ethnic groups, b) Vernacular names

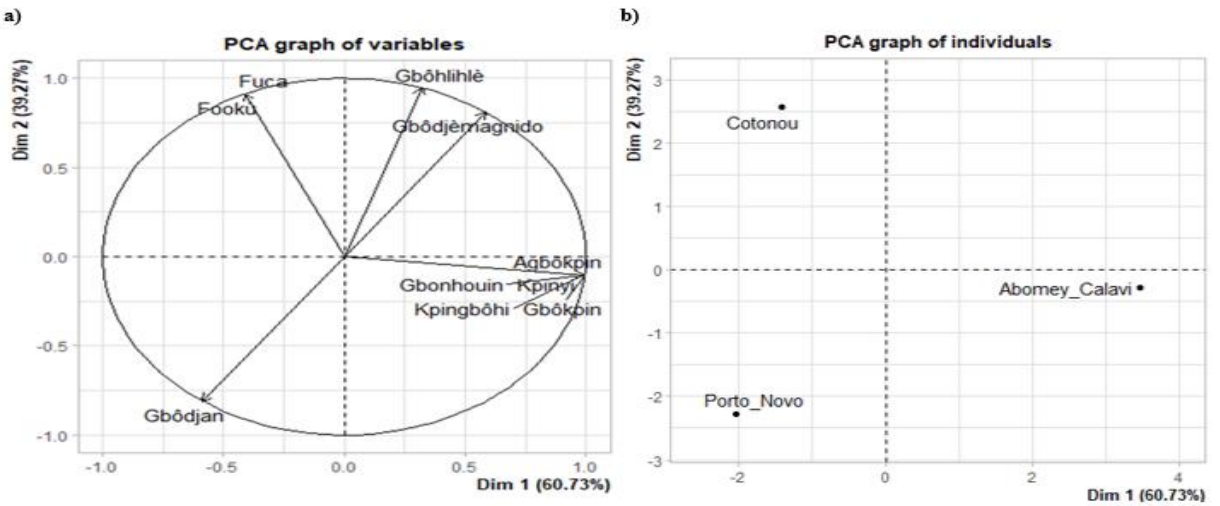

Figure 3: a) Correlation circle of vernacular names, b) Projection of cities onto the first factorial plane defined by axes 1 and 2, defined by vernacular Names

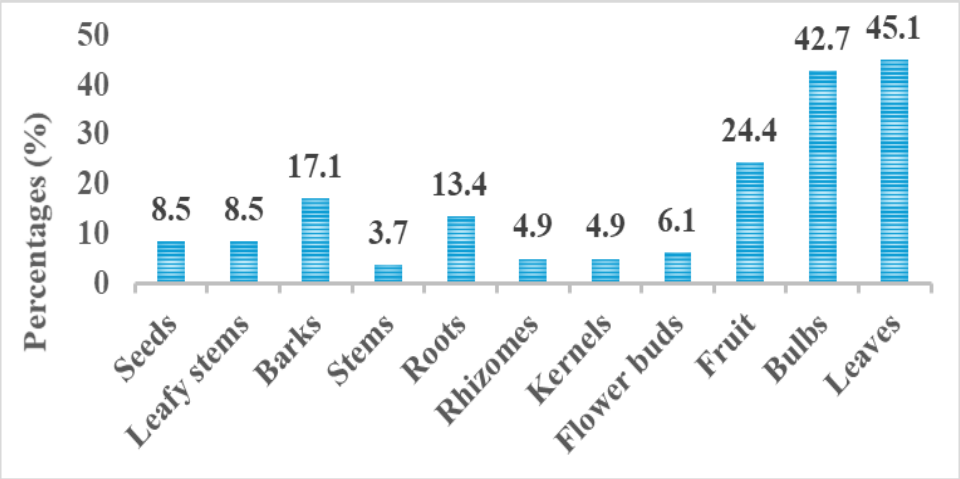

Figure 4: Percentage of the plant parts used

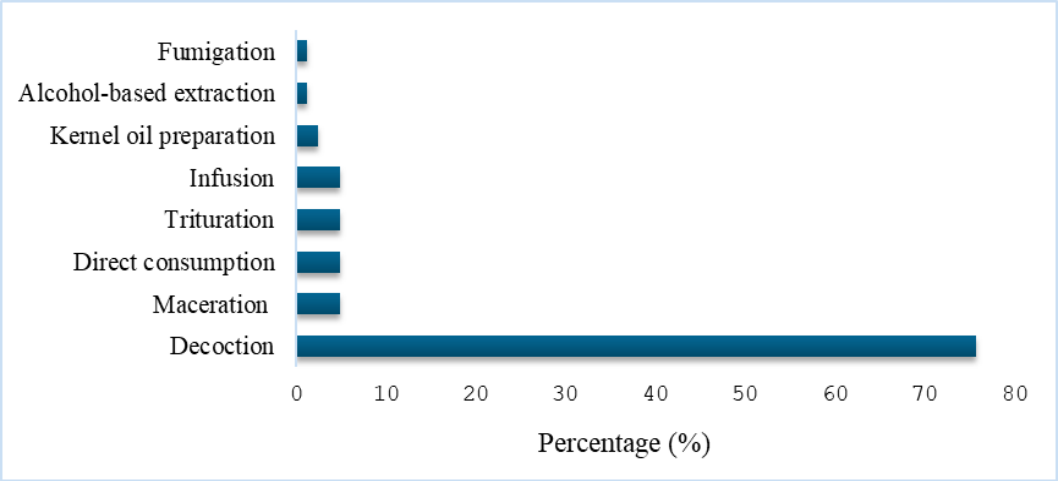

Figure 5: Preparation mode

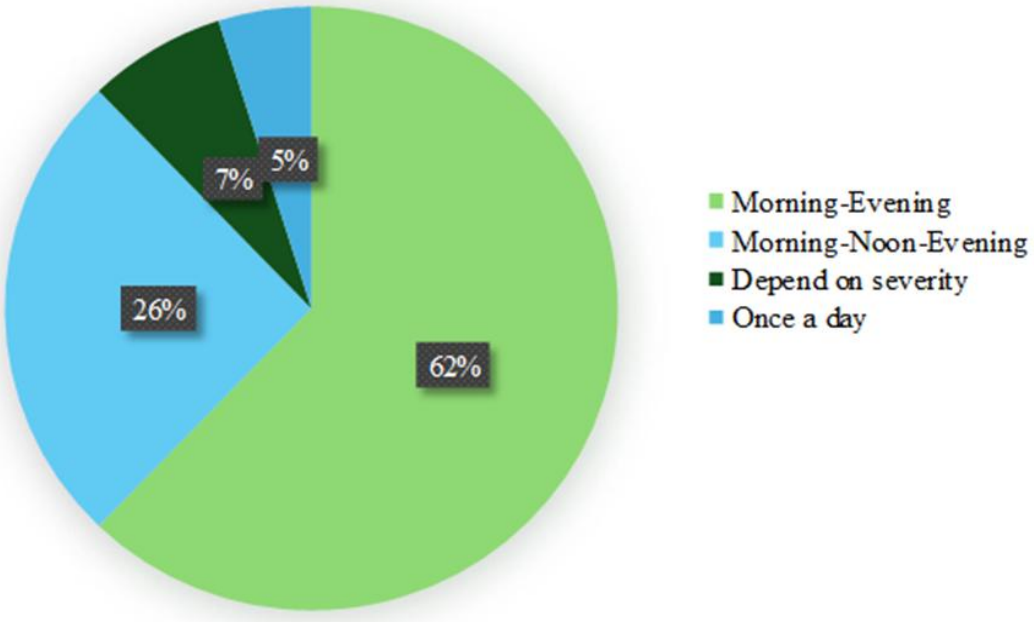

Figure 6: Frequence of use

DISCUSSION

Knowledge of the use of plants in asthma treatment was reported across all age groups, with a clear predominance in the 40-50 age group (34.15%) and the 30-40 age group (32.93%). This was followed by respondents over 50 years old (25.61%) and those aged 20-30 (7.32%). These results suggest that older individuals may have more extensive knowledge of medicinal plants compared with younger age groups. Our findings are consistent with a study conducted in Algeria, where older people were also predominant [26]. Ndavaro *et al* (2024) reported, a significant association between age, sex, and knowledge of plant species, while on the other hand, they found no correlation between age or sex and knowledge regarding the use of these plants [27]. In our study, however, women represented the majority of respondents (78.05%), which may be explained by the fact that our target population consisted of medicinal plant sellers, a group predominantly represented by women in Benin's markets. Similarly, a high level of female participation has been reported in Morocco, where women are recognized as key holders of traditional phytotherapeutic knowledge [28]. Likewise, ethnobotanical surveys conducted in eastern Cameroon also support this trend, revealing that women play a central role in the use of medicinal plants, extending their applications beyond phytotherapy alone [29]. Most respondents were unscholarized (57.32%). These results are consistent with those of Fatima *et al*. (2015), who also reported a predominance of unscholarized participants [30].

The respondents belonged to different ethnic groups, with the Fon being the most represented group (81.71%), followed by the Yoruba (9.75%), with the other ethnic groups accounting for a small proportion. These results can be explained by the fact that the Fon is the most widely spoken language in southern Benin, where our survey was conducted, regarding vernacular names of asthma. "Gbôhlihlè" was the most frequently mentioned by respondents (81.71%). Other vernacular names, including Agbôkpin, Fookù, Fuca, Gbôdjan, Gbôdjèmagnido, Gbôkpin, Gbonhouin, Kpingbôhi, and Kpinyi, were reported less frequently.

The correlation circle of vernacular names (Figure 3A) shows that the names Gbohlihè, Gbodjèmagnido, Agbokpin, Gbonhouin, Kpinyi, Kpingbohi, and Gbokpin were positively correlated with the first axis, while the names Fuca, Fooku, and Gbodjan were negatively correlated with the same axis. The group of appellations Fooku, Gbodjan, Gbohlihè, and Gbodjèmagnido was positively correlated with the second axis, while Agbokpin, Gbonhouin, Kpinyi, Kpingbohi, and Gbokpin were negatively correlated (Figure 3A). The projection of cities in the system of the first two axes (Figure 3B) indicated that the names Fuca, Fooku, Gbohlihè, and Gbodjèmagnido were more frequently cited as vernacular names in Cotonou, while the appellations Agbokpin, Gbonhouin, Kpinyi, Kpingbohi, and Gbokpin were more cited in Abomey-Calavi. The appellation Gbodjan was most frequently cited in Porto-Novo.

Dyspnoea (79.3%), cough (56.9%), and shortness of breath (93.1%) were the symptoms most frequently reported by herbalists. Similar manifestations were also cited by resource persons with dyspnoea (86.7%), cough (73.3%), and shortness of breath (86.7%) as described in Table 3. Among traditional healers, most of these symptoms were largely recognized as being directly related to asthma. Overall, these findings are consistent with those reported by Aoun *et al.* (2022), who showed that dyspnea, cough, and shortness of breath are the most commonly cited symptoms in studies on plants used for the management of respiratory diseases [31].

Sixty-one (61) plant species were cited by the respondents (Table 5). *Pancratium trianthum* was the most frequently cited species (9.68%). Two other plant species, *Allium sativum* and *Mangifera indica*, showed citation frequencies ranging between 5% and 8%, while eleven species had frequencies between 2% and 5% (*Citrus lemon, Allium cepa, Xylopia aethiopica, Calotropis procera, Thonningia sanguinea, Acacia nilotica, Anacardium occidentale, Musa sinensis, Morinda lucida, Monodora myristica, and Syzygium aromaticum*).

Similar ethnobotanical studies conducted in the city of Fez, Morocco, on medicinal and aromatic plants identified *Allium sativum* among the most commonly used species [32]. Likewise, *Mangifera indica* has been the focus of several ethnobotanical investigations due to its widespread traditional use and pharmacological relevance [33].

In the study area, leaves are the most commonly used plant part for asthma treatment, with a percentage (45.1%), followed by bulbs (42.7%), fruits (24.4%), bark (17.1%), and roots (13.4%). The remaining parts, including the stem, bulb, flower, rhizome, and the whole plant, collectively accounted for 36.6% of reported uses (Figure 3). The predominance of leaves, bulbs, and fruits may be explained by their wide availability and ease of harvesting. Similar patterns have been reported in several ethnobotanical studies, in which leaves consistently represent the most frequently used plant organ for respiratory disease management, including asthma [34].

A wide range of preparation methods was reported for the treatment of asthma, including maceration, fumigation, alcohol-based extraction, decoction, trituration, direct consumption, kernel oil preparation, and infusion. Decoction was identified as the predominant preparation method among all three respondent categories: herbalists (82.8%), resource persons (73.3%), and traditional healers (88.9%). This predominance may be attributed to the simplicity of the method and its effectiveness in extracting bioactive compounds from medicinal plants.

Traditional herbal preparations used in the treatment of asthma exhibit considerable diversity in their mode of administration. In the present study, two main routes were reported: oral and nasal. The findings indicate that the oral route was predominant, accounting for 96% of the cited uses, while nasal administration represented only 4%. Although Anderson *et al* have shown that inhalation is the most effective way to reach the respiratory tract, the predominance of oral administration in the present study may be explained by the archaic nature of plant use in our study population.

Regarding the frequency of administration, the majority of respondents reported taking herbal remedies three times (morning, noon, and evening) daily (62.2%), followed by twice daily (morning and evening) in 25.6% of cases. Less frequently reported patterns included once-daily intake (4.9%) and variable administration depending on symptom severity (7.3%) (Figure 5). These variations suggest that dosage frequency is not standardized and may be influenced by individual therapeutic practices, cultural beliefs, or perceptions of asthma severity. Similar variability in dosage regimens has been documented in other ethnobotanical studies, highlighting the empirical nature of traditional medicine and the need for further pharmacological and clinical investigations to establish optimal dosing schedules.

Traditional herbal preparations used in the treatment of asthma exhibit considerable diversity in their modes of administration. In the present study, two main routes were reported: oral and nasal. The findings indicate that the oral route was predominant, accounting for 96% of the cited uses, while nasal administration represented only 4%. Although Anderson *et al* have shown that inhalation is the most effective way to reach the respiratory tract, the predominance of oral administration in the present study may be explained by the archaic nature of plant use in our study population.

CONCLUSION

This survey enabled the documentation of medicinal plants and traditional recipes used in asthma treatment across three departments in southern Benin. The findings indicate that knowledge related to the medicinal use of plants for asthma is widely distributed among different age groups, with a marked predominance among older

individuals. Decoction was identified as the most commonly used preparation method, while oral administration represented the predominant route of use. The most frequently cited species was *Pancratium trianthum* (9.68%), followed by other commonly reported plants, including *Allium sativum*, *Mangifera indica*, *Citrus limon*, *Allium cepa*, *Xylopia aethiopica*, and *Calotropis procera*. Further investigations focusing on the pharmacological efficacy of these plants using appropriate experimental models, as well as their toxicological assessments and the isolation and characterization of bioactive anti-asthmatic compounds, are necessary. Such studies could contribute to the development of safe and effective plant-based pharmaceutical formulations for asthma management.

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Author Contributions

Meto A. B. Kakpo, Boris Cachon, and Ménonvè Atindehou was involved in concept, design and literature review. Meto A. B. Kakpo and Boris Cachon conducted the survey and collected data. Gbèwonmèdéa Hospice Dassou performed the taxonomic identification of plant species. Boris Cachon was involved in statical analysis. Meto A. B. Kakpo, Boris Cachon, and Ménonvè Atindehou draft the original manuscript. Firmin Sagbo, Abdou Satar Akadiri and Latifou Lagnika critically reviewed and edited the manuscript for important intellectual content. All authors read and approved the final version of the manuscript.

Data Availability Statement

The data that support the findings of this study are available and will be made available upon request.

Use of AI in Drafting of Manuscript

The authors declare that they have not used any generative AI/AI-assisted technologies in the writing of this manuscript.

Conflict of interest

The authors declared no conflict of interest.

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