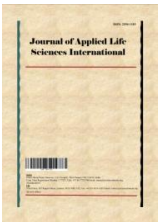

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Diversity, Life Forms, Chorology and Uses of Spontaneous Medicinal Plants in Niamey and Tillabéri Regions, Niger Republic

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Authors' contributions

This work was carried out in collaboration among all authors. Author AJM designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors SD and MMI managed the analyses of the study. Author SM managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Plants are the pharmacy of people in rural and urban areas in West African. However, few studies assessed the ecology and diversity of medicinal plants mostly rural and urban areas. This study assessed the taxonomic composition, life form, chorology and uses of the different organs of the spontaneous medicinal plants in Niamey and Tillabéri regions in Niger. The questionnaire survey consisted of individual interview on 168 traditional healers in two regions. A total of 181 species belonging to 60 families were recorded in Niamey and Tillabéri regions where Fabaceae (19

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species) was the dominate family in two regions. The woody species presented 56.59% of the total recorded flora while the herbaceous species were 43.41%. The biological spectrum showed that phanerophytes (57%) were the dominant followed by therophytes (24%) in both regions. This indicates the use of trees, shrubs and annual plants in the traditional medicines in two regions. It also indicates about the tropical habitat. Chorological analysis results revealed that most of the taxa are Sudano-Zambezian (38%) at African scale. Whereas at global level African species (62%) were the dominant chorotype. Leaves (36%) were the most used parts followed by the bark (20%). These different proportions of uses show that the pharmacopoeia of the study area is based on African savannah trees and shrubs. Given the diversity of plant used traditional medicines recorded in two regions, the study recommends successful integration of the use of medicinal plants into a public health framework for biodiversity conservation in both regions. It is important to strengthen conservation strategies to protect this heritage.

Keywords: Ethnobotany; medicinal plants; life forms; chorology; Sahel; biodiversity; Niger.

1. INTRODUCTION

Medicinal plants offer the considerable socio-economic potential to people in developing countries. They are even more important because they are used by about 80% of populations for primary health care [1,2]. They include all plants that contain one or more substances that can be used for therapeutic purposes or that are precursors to the synthesis of useful drugs [3]. Better still, these plant genetic resources play a cultural role for populations, sometimes with religious functions [4].

In addition, the recurrence of rainfall deficits in recent decades has led to a decline in food production mainly based on rainfed crops [5]. Natural ecosystems are therefore subject to increased exploitation by a population seeking dietary supplements and sources of income, but also from strong pastoral pressure [6]. There is an increasing reduction in plant resources and some species are threatened with extinction worldwide because of climate change and pressure from human activities [7,8,9,10]. This is the case in Niger, where plant resources subject to recurrent droughts and climate change impacts, are undergoing a strong and growing anthropogenic pressure in the face of an ever-increasing population with a population growth rate of 3.83%. This in turn reduces plant biodiversity in general and affects that of medicinal plants in particular [11]. An ethnobotanical survey conducted in the regions of Niamey and Tillabéri showed that they contain nearly 2/3 of the country's forest resources showed that many plants are used in remedies [12]. The fundamental question that arises is how can we reconcile the sustainable exploitation of medicinal spontaneous species and their conservation in a context of socio-economic transformation, strongly linked to climate variability? To answer this question, it is imperative to know the potentialities still available in our forest formations. This knowledge can serve as a baseline situation for the implementation of specific actions aimed at the strategic conservation of these plant species. This study is part of this approach. It aims to assess the ecological diversity of medicinal plants in the Niamey and Tillabéri regions. It is a question of determining their life forms (biological types), their world and African chorologies, as well as the organs harvested for the purposes of the pharmacopoeia.

2. MATERIALS AND METHODS

Ethnobotanical data were collected using purposive sampling based on the sex, age, their origin of knowledge (heritage from the family or out of the family), duration of the exercise, parallel professions, farmers, traditional healers, and other occupations in both regions. The questionnaire survey consisted of individual interview on 168 traditional healers in two regions. The ethnobotanical questionnaires touched the name of the species, the different parts of plants harvested used for medicinal purpose. For biological spectrum and chorological data were collected from the list of the species recorded during the questionnaire and secondary data from published papers. They have been determined for each taxon the life forms, the phytogeographical types in Africa and in the world. This description was developed using scientific documentation [13,14]. For the life forms, we used those classified by Raunkier's and adapted by [15,16] as follow:

2.1 Life Forms

The establishment of the biological spectrum was based on Raunkier's classification adapted by

[15,16].The rate of each of the biological types is evaluated at each station that reflects the conditions of the environment. The definition is based on the position of the buds on the stem and the mechanisms allowing the plants to cross the bad season. Thus, we distinguish according to this author:

1. **Phanerophytes (P):** they are woody, perennial plants whose buds are located more than 50 cm above the ground; they are classified into several types:

    - nanophanerophytes (np) that are between 50 cm and 2 m height;
    - microphanerophytes (mp) 2 to 8 m height;
    - mesophanerophytes (mP) from 8 to 30 m tall;
    - nanophanerophytic creepers and microphanerophytic creepers which are lianas;

2. **Chamephytes (CH):** These are woody or suffrutescent species whose buds are located at a maximum of 50 cm from the ground.
3. Hemicryptophytes are plants whose buds are at ground level.
4. **Geophytes:** These are plants whose perennial organs are buried in the soil, organs from which grow herbaceous overhead stems during the wet season that dry out and fall in the dry season. The organs will remain in the ground to give other stems in the next wet season. Geophytes are distinguished by the nature of the perennial organ:

    • rhizomatous geophytes (Gr)
    • bulbous geophytes (Gb)
    • Tuberculous geophytes (Gt)

5. **Therophytes (T):** These annual plants complete their cycle of development during the wet season to live in the seed state during the dry season.
6. **The lianas:** Liane-microphanerophyte (Lmp) liane-chaméphyte (LCH).

2.2 Phytogeographical Spectrum

The phytogeographical distribution of species based on their chorological affinities has been described at the African and global levels. In African phytogeographical zones, we have the affinities:

1. Guino-congolian (GC);
2. Guino-congolian-Sudano-Zambezian (GC-SZ);
3. Sudano-Zambezian (SZ);
4. Sudano-zambezian-Saharo-sindian (SZ-Sah.S);
5. Saharo-sindian (Sah.S);
6. Guineo-Congolian-Sudano-Zambezian-Saharo-sindian (GC-SZ-Sah.S);
7. Saharo-sindian- mediterranean (Sah.S-Med);
8. Sudano-Zambezian-Saharo-Sindian-Mediterranean (SZ-Sah.S-Med).

In the World phytogeographical zones, we have the affinities:

1. African (A);
2. Pantropical (Pt) existing throughout the tropical zone in Africa, Asia and America;
3. Palaeotropical (Pal) species common to Asia, tropical Africa and some islands of the Indian;
4. Afro-Malagasy (AM) common to Africa in Madagascar to the Comoros Islands, Mascaraignes Islands and Seychelles;
5. Cosmopolitan (Co) species whose range covers the entire world;
6. Afro-Neotropical (An), common to Africa and tropical America.

2.3 Data Analysis

We analyzed the data using descriptive statistics in Excel to determine the percentage of each family based on the species richness, the percentage of each life form, chorotypes and the proportion of the organs used the pharmacopoeia in the two regions.

3. RESULTS AND DISCUSSION

3.1 Diversity of Medicinal Plants

The study recorded 181 of spontaneous medicinal species belonging to 60 families; the most represented were the *Fabaceae* (19 species with 10.50%), *Asclepiadaceae*, *Caesalpiniaceae*, *Combretaceae* and *Mimosaceae* (9 species each with 4.97%), *Capparaceae*, *Euphorbiaceae*, *Poaceae* and *Rubiaceae* (8 species each, with 4.42%) from 181 species. A total of 29 families were monospecific as shown in Table 1.

The dominance of *Fabaceae* reported in agroforestry systems in Niger which dominance

was due to the socio-economic of the family [17,18]. For instance, [18] reported that the dominance of *Fabaceae* in agroforestry systems was due to its socio-economic importance such as one of the uses is medicinal utilization. Such utilization may explained the dominance of this family in our study area. Such dominance may be explained according to the findings of Molares et al. [19] who reported that the *Fabaceae* species are of great medicinal importance in indigenous and urban communities. This dominance could be due to the adaptability of the *Fabaceae* species to support large ecological amplitude in terms of climate and soils as reported by Clarice et al. [20]. This dominance is an indication of diversity of a given environment [21]. It is also of great importance to vitality of a given ecosystem as *Fabaceae* species are nitrogen-fixing plants. Added to that, *these families* have been found in abundance in the forest galleries of the Biosphere Reserve of Ouedraogo [22] conducted a study from *Hippopotamus* stream in Burkina Faso witch reflecting a similar results on the flora. Thus, this author has counted about 82 medicinal plant species, belonging to 35 botanical families of which six were found most frequently cited *Combretaceae* (15%), *Caesalpiniaceae* (10%), *Mimosaceae* (7%), *Rubiaceae* (6%), *Moraceae* (5%) and *Fabaceae* (5%). However, our results contradict some findings. For instance, in Cameroon, Mpondo (2017) recorded 90 medicinal plant species divided into 47 families and 83 genera, with a clear dominance of the *Euphorbiaceae* family (11.11%), followed by *Fabaceae* and *Malvaceae* (5.55% both) and *Rubiaceae* (4.44%). Bouziane [23] reported from Algeria, the dominance of *Lamiaceae* (18 genera), *Apiaceae* (14 genera), *Asteraceae* (10 genera), *Rosaceae* (7 genera) among 134 species belonging to 57 families were recorded. According to Tahri et al. [24], in an ethnobotanical survey conducted in Settat (Morocco), 90 species belonging to 44 families, with the most represented being *Lamiaceae* (17.58%), *Apiaceae* (9.89%), *Asteraceae* (6.59%), *Fabaceae* (5.49%), *Myrtaceae* and *Poaceae* (4.39% each) were recorded, *Lamiaceae* predominate, followed by the *Apiaceae* family, *Asteraceae* with 24.61%, 7.68% and 6.14% respectively listed plants [25].

3.2 Ecology of Medicinal Plants

3.2.1 Biological spectrum

The medicinal flora of the Niamey and Tillaberi regions includes 14 biological types. The spectrum is dominated by phanerophytes (more than 50% of species) followed by therophytes (24%) and chaméphytes (6%). Among the phanerophytes, the microphanerophytes are the most dominant (34% of the species) then the mesophanerophytes and the nanophanerophytes (9% each) as indicated (Fig. 1). The dominant morphological types were woody species (56.59%) while herbaceous plants presented 43.41% of the total flora.

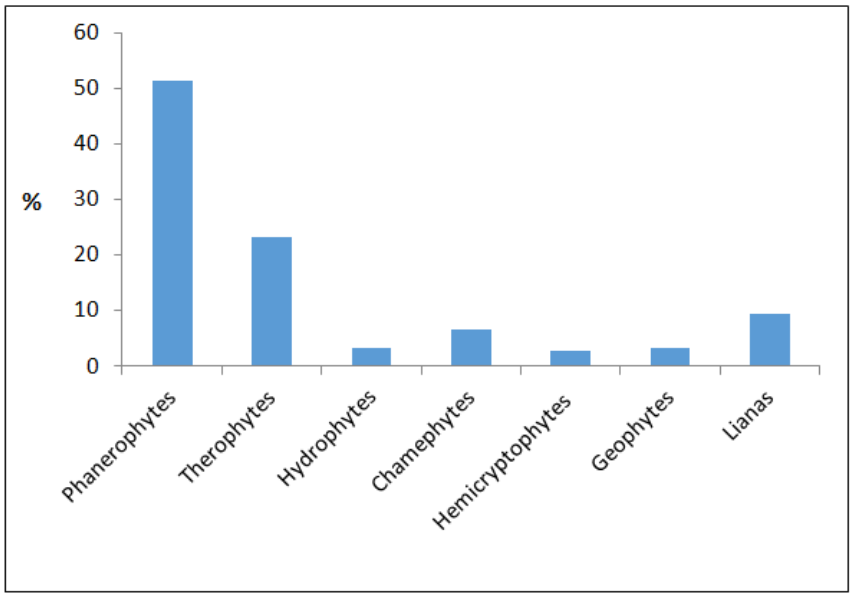

Fig. 1. Biological spectrum of the medicinal plant species recorded in study areas

Table 1. Species number and percentage per family

Families	NB species	%
Fabaceae	19	10.50
Asclepiadaceae	9	4.97
Caesalpiniaceae	9	4.97
Combretaceae	9	4.97
Mimosaceae	9	4.97
Capparaceae	8	4.42
Euphorbiaceae	8	4.42
Poaceae	8	4.42
Rubiaceae	8	4.42
Asteraceae	5	2.76
Cucurbitaceae	5	2.76
Acanthaceae	4	2.21
Anacardiaceae	4	2.21
Convolvulaceae	4	2.21
Moraceae	4	2.21
Bombacaceae	3	1.66
Meliaceae	3	1.66
Pedaliaceae	3	1.66
Scrophulariaceae	3	1.66
Solanaceae	3	1.66
Tiliaceae	3	1.66
Vitaceae	3	1.66
Amaranthaceae	2	1.10
Arecaceae	2	1.10
Bignoniaceae	2	1.10
Burseraceae	2	1.10
Elatinaceae	2	1.10
Lamiaceae	2	1.10
Malvaceae	2	1.10
Rhamnaceae	2	1.10
Sterculiaceae	2	1.10
Agavaceae	1	0.55
Aizoaceae	1	0.55
Amaryllidaceae	1	0.55
Annonaceae	1	0.55
Araceae	1	0.55
Asparagaceae	1	0.55
Balanitaceae	1	0.55
Boraginaceae	1	0.55
Salicaceae	1	0.55
Chrysobalanaceae	1	0.55
Cochlospermaceae	1	0.55
Commelinaceae	1	0.55
Cyperaceae	1	0.55
Ebenaceae	1	0.55
Flacourtiaceae	1	0.55
Hyacinthaceae	1	0.55
Hyppocrateacae	1	0.55
Loganiaceae	1	0.55
Loranthaceae	1	0.55
Menispermaceae	1	0.55
Nympheaceae	1	0.55
Olacaceae	1	0.55
Periplocaceae	1	0.55

Families	NB species	%
Polygalaceae	1	0.55
Pontederiaceae	1	0.55
Salvadoraceae	1	0.55
Sapindaceae	1	0.55
Sapotaceae	1	0.55
Tribulaceae	1	0.55
Total	181	100

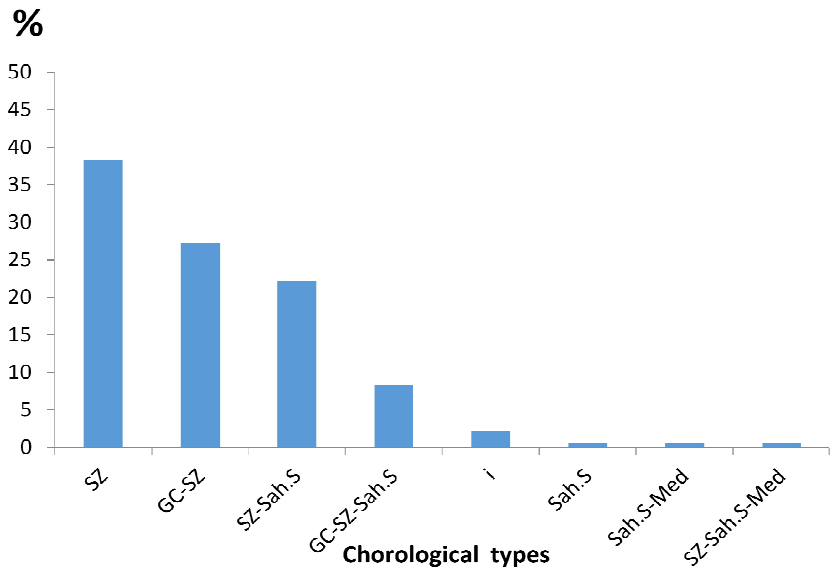

Fig. 2. Chorological types spectrum at African level of medicinal species in the study areas
Legend: 1.Guino-congolian (GC); 2. Guino-congolian-Sudano-Zambezian (GC-SZ); 3. Sudano-Zambezian (SZ); 4. Sudano-zambezian-Saharo-sindian (SZ-Sah.S); 5. Saharo-sindian (Sah.S); 6. Guineo-Congolian-Sudano-Zambezian-Saharo-sindian (GC-SZ-Sah.S); 7. Saharo-sindian- mediterranean (Sah.S-Med); 8. Sudano-Zambezian-Saharo-Sindian-Mediterranean (SZ-Sah.S-Med)

The dominance of phanerophytes in the medicinal flora of the two regions could be due the permanence of those plants throughout year. One of the practical of implication of this dominance of the some part of the phanerophytes can be harvested for medicinal purpose at any season during the year. The phanerophytes in this study consists of the dominance of microphanerophytes, plants with 2 to 8 m height that are composed of trees and shrubs. This dominance suggests the crucial role that woody species play in traditional medicines as reported by Abate et al. [26]. However, the dominance of the therophytes indicates the use of annual plants in traditional medicine. In our study, the dominance of phanerophytes and therophytes indicates about the tropical environment of the two regions. For instance, there is also a strong presence of therophytes, well adapted to the ecosystems of the study area (North-Sudan) marked by some aspect of aridity. An optimal annual stock of therophyte medicinal plants can easily be built up at a specific time, the end of the rainy season. In addition to that, Mpondo et al. [27] found out 11 biological types with megaphanerophytes dominance estimated at 12.22%. Furthermore, according to Adomou et al. [28] in their study on medicinal plants sold in the market of Abomey-Calavi (Benin), 68% of species are phanerophytes. N'Guessan et al. [29] made the similar observations on emmenagogue plants used in traditional medicine, also by Gnagne et al. [30] on plants used in the treatment of diabetes, and even Sylla et al. [31], with respectively 90.90% and 85.18%. In fact, phanerophytes represent 80 to 90% of biological types in tropical and equatorial zones [32,33], which would explain these different results. The more importance biological types, according to the inventory of Bouziane [23] are hemicryptophytes and phanerophytes.

The woody plants are the most abundant morphological type in our study (103 woody species). These biological and morphological characteristics make it possible to ensure a permanent availability of the raw material used in the pharmacopoeia. These results corroborate those of Dibong et al. [34] witch reported that woody plants represented (60%) of the study area, as well as Sylla et al. [31] (81.48% of woody species), Kouchadé et al. [35] (53.68% woody plants). Added to that are 33.33% trees among the identified plants [27]. Ambé et al. [32] stated that the plants used are mainly trees and shrubs (74.6%). Several other authors have noted the importance of ligneous plants in medicinal flora [36,37].

3.2.2 Phytogeographical spectrum

At African level, the chorological spectrum analysis of medicinal plants in our study revealed 9 African chorotypes mainly Sudano-Zambezian (38%), Guino-congolian-Sudano-Zambezian (27%), Sudano-Zambezian-Saharo-Sindian (22%), Guineo-Congolian-Sudano-Zambezian-Saharo-Sindian (8%) species for the spectrum (Fig. 2).

The chorology analysis results at global level on the medicinal plants in the study area showed that African species come first, followed by paleotropical and then pantropical species (Fig. 3). The results give clearly preponderance of African species then of widely distributed species: paleotropical and pantropical (29%) followed by afrotropical (10%) [28]. Afrotropical species (34.44%) are the most cited [27]. A high proportion of widely distributed species may be a degradation index [38]. This describes the chorological affinities of the medicinal species in the study area, but also proves that the pharmacopoeia bequeathed to us is based on African plants well known to our predecessors for having been in contact and observed this heritage for a long time. The medicinal flora studied must be described essentially from an African ways.Thus, among the 9 phytogeographical types characterizing the African chorology of our medicinal plants (three phytogeographical types), the Sudano-Zambezian (38%), Guineo-Congolian-Sudano-Zambezian (27%), and Sudano-Zambezian-Saharo-Sindian (22%) are the most encountered. The geographical location of our study area, distributed between the Sudan and Saharan regions explains the strong presence of the binding species (GC-SZ, SZ-Sah. S.). The high proportion of Sudano-Zambezian species in the medicinal flora shows that it corresponds to a Sudanian pharmacopoeia. However, despite the

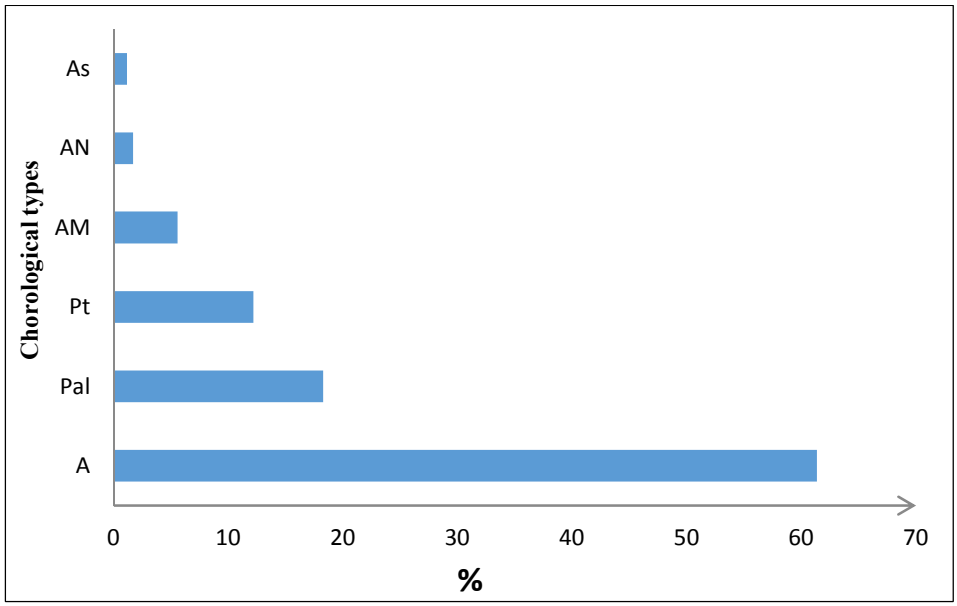

Fig. 3. Chorological types spectrum at World level of medicinal species in the study areas

Legend: 1. African (A); 2.Pantropical (Pt) existing throughout the tropical zone in Africa, Asia and America; 3.Palaeotropical (Pal) species common to Asia, tropical Africa and some islands of the Indian ; 4.Afro-Malagasy (AM) common to Africa in Madagascar to the Comoros Islands, Mascaraignes Islands and Seychelles ; 5. Cosmopolitan (Co) species whose range covers the entire world; 6. Afro-Neotropical (An), common to Africa and tropical America

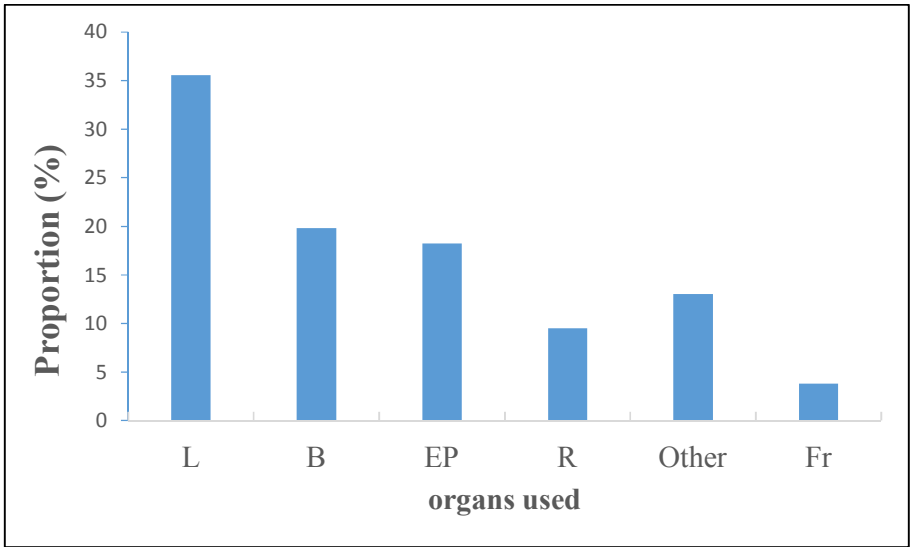

Fig. 4. Proportion of different plant parts used in pharmacopeia

Legend: L = Leaves, B = barks, EP = Entire plant, R = root, Fr = flower, Other = organ associations.

shifting of isohyets towards the south for several decades [11,39], the local cultures built for a long time are maintained mainly around the species of more or less humid zones (SZ and GC -SZ).

According to Sylla et al. [31], the Guineo-Congolian-Sudano-Zambezian species are the most important (48.15%), a similar result to those obtained in other studies [32]: 43%, [30]. Further, Betti and Mebere [40] reports significant dominance of Guinean species (67.54%), as well as [28] who inventoried 29% of Guinean people. For N'Guessan et al. [29], also the medicinal plants studied are Guineo-Congolian (54,54%) and Sudano-Zambezian (36,36%). While Bouziane [23] affirms the abundance of the Mediterranean elements. The plants introduced represent 18% in the study of Gnagneet al. [30] ; 9.09% according to N'Guessan et al. [29], unlike our work where they are only 2%. The influence of foreign cultures is therefore not remarkable in the flora studied.

3.3 Uses of Plant Organs in Pharmacopoeia in Niamey and Tillabéri Regions

3.3.1 Harvested plant parts

Our analysis showed that each parts of recorded plant species is used as medicine. Nevertheless, the most used parts are the leaves (36%), the bark (20%), or the entire plant (18%) (Fig. 4). Organs are rarely used in mixture with each other or with exudates (gum, latex).

Leaves and bark are the preferred parts, followed by the entire plant and root. Leaves are the part of the plant commonly used with 38.46% [29], and 39.33% according to El Hilah et al. [25]. In 41% of cases, the listed medicinal plants were solicited for their leaves [41]. For Sylla et al. [31] leaves are the most used organs (68.89%) in the treatment of malaria in the district of Abidjan. Bouziane [23] reports that leaves are the most used part (46.30%), followed by fruits and seeds (26.17% each) and flowers (21.13%). [42,36] have also asserted the primacy of leaves in the pharmacopoeia compared to other plant organs.

Debarking is very important for the species *Pteleopsis suberosa* (*Fabaceae*) in which a whole branch is completely stripped of its cortical part. Woody species are most often asked for their bark or their roots [27]. The choice of these organs is explained by their ease in being harvested and their availability in all seasons [28]. The ease and speed of harvest can explain the high frequency of leaf use [43].

The organs are chosen according to the specialty [44]. Ouedraogo and Abate et al. [22,36] has reported the preferential use of leaves for medicinal preparations intended for children, and roots for the care of adults This practice may have a role in the conservation of certain species. Indeed, if the removal of the leaves of a tree to a certain extent (up to 50%) does not affect its existence [41], the exploitation of the bark or the root can cause a great risk for its survival or for its ecosystem [45,46].

In addition, the harvest is anarchic, regardless of the amount to be taken, or a suitable technique as noted by [27]. The herbaceous plants are completely unearthed; the only alternative for the survival of these species is the harvest after production and release of diaspore. Sellers of medicinal plants collect species that cause the early death of trees, shrubs, herbs and lianas [38]. The removal of organs or whole plants for the purposes of the pharmacopoeia is a common practice that is an important factor of stress in plants especially for those who are employed in various fields [47] or geophytes [40]. The debarkation of the trunks and branches of some species could explain their important mortality in the botanical reserve of Noflaye (*Khaya senegalensis, Prosopis africana*). These species are endangered in the reserve [48]. The removal of the root affects the vegetative aspect as well as the physiology of the plant [49].

Regarding the selection of harvested organs, current knowledge allows us to analyze medicinal plants and often to understand the use recommended by our ancestors [50]. Empirical at the beginning, this use can have scientific bases. Indeed, the leaves, the bark and the roots are generally rich in secondary metabolites responsible for the biological properties of the plants [51,52,53,54].

All the 15 tree species protected under the law establishing the forest regime in Niger belong to the medicinal flora studied. Several authors have reported the use of these plants in various fields (food, craft, real estate ...). Among these highly sought-after species with special status, 4 namely *Sclerocarya birrea*, *Acacia nilotica*, *Ziziphus mauritiana*, *Khaya senegalensis* are among the most commonly used species in traditional medicine [55].

On the study carried out in the W Biosphere Reserve of Niger, several woody species that have become rare or disappeared, much in demand for the traditional pharmacopoeia, were cited by the interviewees. These plants 24 species namely *Abrus precatorius*, *Albizia chevalieri*, *Annona senegalensis*, *Anogeissus leiocarpa*, *Bombax costatum*, *Commiphora africana*, *Detarium microcarpum*, *Diospyros mespiliformis*, *Entada africana*, *Ficus ingens*, *Ficus platyphylla*, *Ficus sycomorus*, *Khaya senegalensis*, *Kigelia africana*, *Lannea acida*, *Lannea microcarpa*, *Parkia biglobosa*, *Prosopis africana*, *Pterocarpus erinaceus*, *Securidaca longipedunculata*, *Tamarindus indica*, *Terminalia avicennioides*, *Ximenia americana* are among our list of spontaneous medicinal plants. The role of natural reserves and national parks in the conservation of medicinal plants is not negligible [56].

In Niger, the context of climate change and ecosystem degradation exacerbated by anthropogenic effects, leading to a loss of biodiversity [12], could compromise the perpetuity of medicinal plant production if adequate measures are taken in favour of sustainable development are not taken.

4. CONCLUSION

The spontaneous and sub spontaneous medicinal flora of the Niamey and Tillaberi regions is rich in 181 species. It consists mainly of African phanerophytes and therophytes, and then widely distributed (paleotropical and pantropical) with regard to world chorology. The phytogeographical distribution in Africa ranks them among the Sudano-Zambezians and the Guineo-Congolian-Sudano-Zambezian linkage species in particular. The leaves and bark are the most stressed organs. In some cases, the entire plant is used with fatal consequences on the survival of the plant. It is possible to reconcile the sustainable exploitation of spontaneous medicinal species and their conservation in the studied areas. However, it is necessary and urgent to envisage programs of valorisation of these plants, which associate the conservation and the sustainable exploitation of this inheritance through in particular:

- ✓ The identification of the priority species of our pharmacopoeia, especially the plant species with multiple uses, their ecological characteristics by other ethnobotanical surveys;
- ✓ The sensitization of local stakeholders on the good practice of using medicinal plants to reduce the effect of improper picking on plant survival; preferential organ harvesting, the reduction of which does not affect the life of the plants, for example the replacement of the bark, the root, the whole plant by the leaves when their pharmacological properties are comparable;
- ✓ The integration of medicinal plants into urban reforestation programs.

These are all measures that contribute to the socio-economic development of the regions

studied and our country while allowing future generations to reap the same benefits.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Appendix 1. List of families, life forms and chorology of recorded species

Species	Famille	Life forms	Chorology	
			African chorology	World chorology
Abrus precatorius L.	Fabaceae	Lmp	GC-SZ	Pt
Abutilon pannosum (G.Forst.) Schltdl.	Malvaceae	np	SZ-Sah.S	Pal
Acacia albida (Del.) A. Chev.	Mimosaceae	mP	SZ-Sah.S	A
Acacia erythrocalyx Brenan.	Mimosaceae	Lmp	GC-SZ	A
Acacia nilotica (L.) Willd.ex Del. *Subsp. nilotica*	Mimosaceae	mp	SZ	A
Acacia senegal (L.) Willd	Mimosaceae	mp	SZ	Pal
Acacia seyal Del.	Mimosaceae	mp	SZ-Sah.S	A
Acanthospermum hispidum D.C.	Asteraceae	T	iGC-SZ	N
Adansonia digitata L.	Bombacaceae	mP	SZ	A
Albizzia chevalieri Harms.	Mimosaceae	mp	SZ	A
Ampelocissus grantii (Bak.) Planch.	Vitaceae	LGr	SZ	A
Andira inermis (W.Wright.) Kunth ex DC.	Fabaceae	mp	GC-SZ	AN
Annona senegalensis Pers.	Annonaceae	np	SZ	A
Anogeissus leiocarpa (DC.) Guill. et Perr.	Combretaceae	mP	SZ-Sah.S	A
Aristida sieberiana Trin.	Poaceae	H	SZ	A
Asparagus africanus Lam.	Asparagaceae	Gr	SZ	A
Azadirachta indica A. Juss.	Meliaceae	mp	i	Ind
Bacopa crenata (P. Beauv.) Hepper.	Scrophulariaceae	Hy	GC-SZ	AM
Balanites aegyptiaca (L.) Del.	Balanitaceae	mp	SZ-Sah.S	A
Bauhinia rufescens Lam.	Caesalpiniaceae	mp	SZ-Sah.S	A
Bergia suffruticosa (Del.) Fenzl.	Elatinaceae	CH	SZ-Sah.S	As
Blepharis linariifolia Pers.	Acanthaceae	T	SZ	Pal
Bombax costatum Pellegr.	Bombacaceae	mP	SZ	A
Borassus aethiopum Mart.	Arecaceae	mP	GC-SZ	A
Boscia angustifolia A. Rich.	Capparaceae	mp	SZ	A
Boscia salicifolia Oliv.	Capparaceae	mp	SZ-Sah.S	A
Boscia senegalensis (Pers.) Lam. Ex Poir.	Capparaceae	mp	SZ-Sah.S	A
Boswellia dalzielii Hutch.	Burseraceae	mp	SZ	A
Cadaba farinosa Auct.	Capparaceae	mp	SZ-Sah.S	Pal
Cadaba glandulosa Forsk.	Capparaceae	np	SZ-Sah.S	A
Calotropis procera (Ait*) R. Br.*	Asclepiadaceae	mp	GC-SZ-Sah.S	Pal
Caralluma adscendens (Roxb.)R. Brown	Asclepiadaceae	CH	SZ	A
Cassia italica (Mill.)F.W. Anders.	Caesalpiniaceae	CH	SZ	A
Cassia mimosoides L.	Caesalpiniaceae	T	GC-SZ-Sah.S	Pal
Cassia nigricans Vahl.	Caesalpiniaceae	T	SZ-Sah.S	Pal
Cassia occidentalis L.	Caesalpiniaceae	np	GC-SZ	Pt
Cassia sieberiana DC.	Caesalpiniaceae	mp	GC-SZ	A
Ceiba pentandra (L) Gaertn.	Bombacaceae	mP	GC-SZ	Pt

Species	Famille	Life	Chorology	
Celosia trigyna L.	Amaranthaceae	T	GC-SZ	Am
Cenchrus prieuri (Kunth.) Maire.	Poaceae	T	SZ-Sah.S	Pal
Centaurea perrottetii DC.	Asteraceae	CH	SZ	A
Chasmanthera dependens Hochst.	Menispermaceae	Lmp	GC-SZ	A
Chrozophora brocchiana Vis.	Euphorbiaceae	np	SZ-Sah.S	A
Cissus quadrangularis L.	Vitaceae	mp	SZ	Pal
Citullus lanatus (Thumb) Matsumara et Nakai	Cucurbitaceae	LT	SZ-Sah.S	Pal
Cleome gynandra L.	Capparaceae	T	GC-SZ-Sah.S	Pt
Cochlospermum planchonii Hook. f.	Cochlospermaceae	Gr	SZ	A
Combretum aculeatum Vent.	Combretaceae	mp	SZ	A
Combretum glutinosum Perr. ex DC.	Combretaceae	mp	SZ	A
Combretum micranthum G.Don.	Combretaceae	mp	SZ	A
Combretum nigricans var elliotii (Engl.Ex Diels) Aubrev.	Combretaceae	mp	SZ	A
Combretum paniculatum Vent.	Combretaceae	mp	GC-SZ	A
Commelina forskalei Vahl.	Commelinaceae	T	SZ-Sah.S	Pal
Commiphora africana (A. Rich.) Engl.	Burseraceae	mp	SZ-Sah.S	A
Corchorus olitorius L.	Tiliaceae	T	GC-SZ-Sah.S	Pal
Crinum ornathum (Ait.)Burg. Hexandr.	Amaryllidaceae	Gb	GC-SZ	A
Crossopteryx febrifuga (G.Don.) Benth.	Rubiaceae	mp	SZ	A
Crotalaria arenaria Benth.	Fabaceae	T	SZ	A
Crotalaria pallida Ait.	Fabaceae	T	GC-SZ	Pt
Croton zambezicus Müll. Arg.	Euphorbiaceae	mp	GC-SZ	A
Cucumis metuliferus Naud.	Cucurbitaceae	LT	GC-SZ	A
Cucumis prophetarum L.	Cucurbitaceae	LT	SZ-Sah.S	Pal
Cymbopogon giganteus Chiov.	Poaceae	H	GC-SZ	A
Cymbopogon schoenanthus (L) Spreng. *subsp.proximus* (A. Rich.) Maire et Weiler	Poaceae	H	SZ-Sah.S	A
Detarium microcarpum Gmill. et Perr.	Caesalpiniaceae	mp	SZ	A
Dicoma tomentosa Cass.	Asteraceae	T	SZ	Pal
Diospyros mespiliformis Hochst. Ex A. DC.	Ebenaceae	mp	GC-SZ	A
Dipcadi cowanii (Ridl.) H.Perrier	Hyacinthaceae	Gb	SZ	A
Echinochloa stagnina (Retz.) P. Beauv.	Poaceae	Hy	SZ	Pal
Eichornia crassipes (Mart.) Solms. Laub.	Pontederiaceae	Hy	i	N
Entada africana Guill. et Perr.	Mimosaceae	mp	SZ	A
Eragrostis tremula Steud.	Poaceae	T	GC-SZ-Sah.S	Pal
Euphorbia balsamifera Ait.	Euphorbiaceae	mp	SZ-Sah.S-Med	A
Euphorbia hirta L.	Euphorbiaceae	T	GC-SZ-Sah.S	Pt
Euphorbia sudanica A. Chev.	Euphorbiaceae	np	SZ	A
Evolvulus alsinioides (L.) L.	Convolvulaceae	T	GC-SZ-Sah.S	Pt

Species	Famille	Life	Chorology	
Feretia apodenthera Del.	Rubiaceae	mp	SZ	A
Ficus platyphylla Del.	Moraceae	mP	SZ	A
Ficus polita Vahl.	Moraceae	mp	GC-SZ	A
Ficus sycomorus L. subsp. *Gnaphalocarpa*(Miq.) Berg.	Moraceae	mP	SZ-Sah.S	A
Ficus thonningii Blume.	Moraceae	mP	GC-SZ-Sah.S	A
Fimbristylis hispidula (Vahl.)Kunth. Subsp. *hispidula*	Cyperaceae	T	GC-SZ	A
Flueggea virosa (Rxb. Ex Willd) *Voigt*	Euphorbiaceae	mp	GC-SZ	Pal
Gardenia sokotensis Hutch.	Rubiaceae	np	SZ	A
Gardenia ternifolia Schum.et Thonn.	Rubiaceae	np	GC-SZ	A
Glossonema boveanum (Decne) Decne *subsp.breveanum*	Asclepiadaceae	CH	Sah.S-Med	A
Grewia bicolor Juss.	Tiliaceae	mp	SZ	A
Grewia flavescens Juss.	Tiliaceae	mp	SZ-Sah.S	Pal
Guiera senegalensis J.G. Gmel.	Combretaceae	mp	SZ	A
Gymnema sylvestre (Retz.) Schultes	Asclepiadaceae	Lmp	GC-SZ	Pal
Heliotropium ovalifolium Forssk.	Borraginaceae	CH	SZ	A
Hygophila senegalensis (Nees) T. Anders.	Acanthaceae	Hé	SZ	A
Hygrophila auriculata (Schumach.) Heine	Acanthaceae	Hé	SZ	Pt
Hyphaene thebaica (L.) mart.	Arecaceae	mP	SZ	A
Hyptis spicigera Lam.	Lamiaceae	T	SZ	Pt
Indigofera astragalina DC.	Fabaceae	T	SZ	A
Indigofera berhautiana Gillet.	Fabaceae	T	SZ	A
Indigofera diphylla Vent.	Fabaceae	T	SZ-Sah.S	Pal
Indigofera hirsuta L. var. hita	Fabaceae	T	SZ-Sah.S	Pal
Indigofera leptoclada Harms.	Fabaceae	T	SZ	A
Indigofera tinctoria L.	Fabaceae	np	GC-SZ	Pal
Ipomoea asarifolia (Desr.)Roem.et Schult.	Convolvulaceae	LCH	GC-SZ-Sah.S	Pt
Ipomoea dichroa Hochst. ex Choisy.	Convolvulaceae	LT	SZ	Pal
Khaya senegalensis (Des.) A. Juss.	Meliaceae	mP	SZ	A
Kigelia africana (Lam.) Benth.	Bignoniaceae	mP	GC-SZ	A
Lagenaria siceraria (Molina) Standl.	Cucurbitaceae	Lmp	GC-SZ-Sah.S	Pt
Lannea acida A. Rich.	Anacardiaceae	mp	GC-SZ	A
Lannea microcarpa Engl. et K. Krauze	Anacardiaceae	mp	SZ	A
Launaea chevalieri O. Hoffm. et Musch.	Asteraceae	T	SZ	A
Lepidagathis anobrya Nees.	Acanthaceae	np	SZ	A
Leptadenia hastata (Pers.) Decne.	Asclepiadaceae	Lmp	SZ-Sah.S	A
Leptadenia pyrotechnica (Forssk.) Decne	Asclepiadaceae	mp	SZ-Sah.S	Pal
Limeum pterocarpum (Gay.) Heimerl.	Aizoaceae	T	SZ-Sah.S	A
Loeseneriella africana (Willd.) Wilczek	Hyppocrateacae	Lmp	GC-SZ	Pal

Species	Famille	Life	Chorology	
Maerua crassifolia Forssk.	Capparaceae	mp	SZ-Sah.S	A
Maeurua angolensis DC.	Capparaceae	mp	SZ	A
Merremia tridentate (L.) Hallier F.	Convolvulaceae	LT	GC-SZ	A
Mitracarpus scaber Zucc	Rubiaceae	T	GC-SZ	A
Mitragyna inermis (Willd.) K.Schum.	Rubiaceae	mp	SZ	A
Momordica balsamina L.	Cucurbitaceae	LT	SZ-Sah.S	Pt
Neocarya macrophylla (Sabine) Prance	Chrysobalanaceae	mp	GC-SZ	A
Neptunia oleracea Lour.	Elatinaceae	Hy	GC-SZ	Pt
Nymphea lotus L.	Nympheaceae	Hy	GC-SZ	A
Ocimum gratissimum L.	Lamiaceae	T	GC-SZ	Pal
Oncoba spinosa Forssk	Salicaceae	mp	GC-SZ	A
Ozoroa insignis Del.	Anacardiaceae	mp	SZ	A
Parkia biglobosa (Jacq.) R.Br. ex G.Don	Mimosaceae	mp	SZ	A
Paullinia pinnata L.	Sapindaceae	Lmp	GC-SZ	AN
Pavetta crassipes K.Schum.	Rubiaceae	mp	SZ	A
Pennisetum americanum (L.) Leeke (use *Pennisetum glaucum*)	Poaceae	T	SZ-Sah.S	A
Pennisetum pedicellatum Trin.	Poaceae	T	GC-SZ-Sah.S	Pal
Pergularia daemia (Forssk.) Chiov.	Asclepiadaceae	np	SZ-Sah.S	Pal
Phyllanthus pentandrus Schumach. & Thonn.	Euphorbiaceae	T	GC-SZ	A
Piliostigma reticulatum (DC.) Hochst.	Caesalpiniaceae	mp	SZ-Sah.S	A
Pistia stratiotes L.	Araceae	Hy	GC-SZ	Pt
Polycarpaea linearifolia (DC.) DC.	Caryophyllaceae	T	SZ-Sah.S	A
Prosopis africana (Guill. & Perr.) Taub.	Mimosaceae	mP	SZ	A
Pseudocedrela kotschyi (Schweinf.) Harms	Meliaceae	mp	SZ	A
Pteleopsis suberosa Engl. & Diels	Combretaceae	mp	SZ	A
Pterocarpus erinaceus Poir.	Fabaceae	mP	SZ	A
Pupalia lappacea (L.) A.Juss.	Amaranthaceae	T	GC-SZ-Sah.S	Pal
Ricinus communis L.	Euphorbiaceae	mp	i	Pal
Rogeria adenophylla J.Gay ex Delile	Pedaliaceae	T	SZ-Sah.S	A
Salvadora persica L.	Salvadoraceae	mp	SZ-Sah.S	Pal
Sansevieria liberica Gérôme & Labroy	Agavaceae	Gr	GC-SZ	A
Sarcocephalus latifolius (Sm.) E.A.Bruce	Rubiaceae	mp	GC-SZ	A
Sarcostemma viminale (L.) R.Br.	Asclepiadaceae	CH		
Schwenkia americana L.	Solanaceae	T	GC-SZ	AN
Sclerocarya birrea (A.Rich.) Hochst	Anacardiaceae	mP	SZ-Sah.S	A
Scoparia dulcis L.	Scrophulariaceae	np	GC-SZ-Sah.S	Pt
Securidaca longipedunculata Fresen.	Polygalaceae	mp	SZ	A
Sesamum alatum Thonn.	Pedaliaceae	T	SZ-Sah.S	A
Sesamum indicum L.	Pedaliaceae	T	GC-SZ	Pt
Sesbania pachycarpa DC.	Fabaceae	T	SZ	AM
Sida ovata Forssk.	Malvaceae	CH	SZ	Pt

Species	Famille	Life	Chorology	
Solanum incanum L.	Solanaceae	np	SZ-Sah.S	Pal
Solanum lycopersicum L.	Solanaceae	T	GC-SZ-Sah.S	N
Solenostemma argel (Delile) Hayne	Asclepiadaceae	np	Sah.S	A
Sterculia setigera Forssk.	Sterculiaceae	mp	SZ	A
Stereospermum kunthianum Cham.	Bignoniaceae	mp	SZ	A
Striga hermonthica (witchweed)	Scrophulariaceae	T	SZ	AM
Strychnos innocua Delile	Loganiaceae	mp	SZ	A
Stylosanthes erecta P.Beauv.	Fabaceae	T	GC-SZ	A
Taccazea apiculata Oliv.	Periplocaceae	Lmp	GC-SZ	A
Tamarindus indica L	Caesalpiniaceae	mP	GC-SZ-Sah.S	Pt
Tapinanthus globiferus (A.Rich.) Tiegh.	Loranthaceae	mp	SZ-Sah.S	A
Tephrosia linearis (Willd.) Pers.	Fabaceae	T	SZ	A
Tephrosia lupunifolia DC.	Fabaceae	CH	SZ	A
Tephrosia obcordata (Lam. ex Poir.) Baker	Fabaceae	CH	SZ	As
Tephrosia purpurea (L.) Pers.	Fabaceae	CH	SZ-Sah.S	Pal
Terminalia avicennioides Guill. & Perr.	Combretaceae	mP	SZ	A
Tribulus terrestris L.	Zygophyllaceae	T	GC-SZ	Pt
Vernonia colorata (Willed .) Drake	Asteraceae	np	GC-SZ	A
Vigna unguiculata (L.) Walp	Fabaceae	LT	GC-SZ	Pt
Vitellaria paradoxa C.F.Gaertn.	Sapotaceae	mp	SZ	A
Vitex doniana Sweet	Lamiaceae	mp	GC-SZ	A
Waltheria indica L.	Sterculiaceae	np	GC-SZ	Pt
Ximenia americana L.	Olacaceae	mp	GC-SZ	Pt
Ziziphus mauritiana Lam.	Rhamnaceae	mp	SZ-Sah.S	A
Ziziphus mucronata Willd.	Rhamnaceae	Lmp	SZ	AM
Zornia glauchidiata Rchb. ex DC	Fabaceae	T	GC-SZ	A

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