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Ethno-botanical Survey on Medicinal Plants Traditionally Used to Treat Sickle Cell Anemia in Yakoma Territory (Nord-Ubangi, D. R. Congo)

Samy Ngunde-te-Ngunde[1, 2], Emmanuel Moke Lengbiye[2], Gédéon Ngiala Bongo[2], Narcisse Basosila Bolamba[2], Colette Masengo Ashande[4], Benjamin Gbolo Zoawe[2, 4], Jeff Iteku Bekomo[1, 2], Pius Tshimankinda Mpiana[3], Koto-te-Nyiwa Ngbolua[2, 4, 5, *]

[1]Higher Pedagogical Institute of Yakoma, Yakoma, Nord-Ubangi, Democratic Republic of the Congo
[2]Department of Biology, University of Kinshasa, Kinshasa, Democratic Republic of the Congo
[3]Department of Chemistry, University of Kinshasa, Kinshasa, Democratic Republic of the Congo
[4]Ubangi Bio-Xplore Project, University of Gbado-Lite, Gbado-Lite, Democratic Republic of the Congo
[5]Higher Pedagogical Institute of Abumombazi, Abumombazi, Nord-Ubangi, Democratic Republic of the Congo

Abstract

The aim of this study was to identify medicinal plants used in the traditional treatment of sickle cell disease (SCD) in Yakoma Territory. On the basis of the respondents' free consent, an ethnobotanical survey was carried out using a questionnaire among the Ngbandi traditional healers. The survey showed that 18 plant species are traditionally used by Ngbandi traditional healers to treat SCD in Yakoma territory. They belong to 15 families and 17 genera. Decoction and infusion were the most widely used methods of preparation (34% each) and the most used administration mode was oral route (79%). Five morphological types of which trees are predominant (28%) followed respectively by herbs and shrubs (22% each), lianas (17%) and under shrubs (11%) were recorded. These morphological types belong to four biotopes. Crops were the most predominant biotope (66.7%) followed by the forest (22.2%), fallow and savannah (5.6% each) respectively. The identified species are divided into 6 biological types: mesophanerophytes (39%); dressed therophytes (22%); microphanerophytes (11%); nanophanerophytes (11%); climbing phanerophytes (11%) and lianous phanerophytes (6%). From a chorological point of view, these listed species are mainly pantropical (33.3%) followed by Guineo-Congolian (22.2%); Afro-tropical (16.7%); Centro-Guinean species (11.1%) and American species (5.6%); Centro-Guinean Congolese (5.6%) and Cosmopolitan species (5.6%). This study provides a source of information that can be used as a basis for advanced pharmacological studies to evaluate the therapeutic efficacy and safety of these 18 plant species traditionally used to treat SCD in this part of Ubangi eco-region. For the best of current knowledge, the survey on antisickling plants from this part of Democratic Republic of the Congo is reported for the first time.

Keywords

Sickle Cell Disease, Medicinal Plants, Ngbandi People Pharmacopoeia, Ubangi eco-region, Democratic Republic of the Congo

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* Corresponding author
E-mail address: jpngbolua@unikin.ac.cd (Koto-te-Nyiwa N.)

1. Introduction

Throughout the world, plants have always been used as medicines. Herbal medicines are considered to be of low toxicity and mild compared to pharmaceutical medicines, this leads to the fact that pharmaceutical industries are increasingly interested in the ethno-botanical study of plants [1]. Medicinal plants are a valuable resource for the vast majority of rural populations in Africa, where more than 80% of the population uses them for their primary healthcare [2-5]. In addition, Non-timber Forest Products (NTFPs) have attracted considerable interest in Africa in recent years for their contribution to the household economy and the conservation of plant biodiversity [6-7]. The Democratic Republic of the Congo (DRC) is a reservoir of both faunal and floristic biodiversity [8-11]. Its flora is full of medicinal plants of biopharmaceutical interest and capable of providing new hits molecules [12]. The flora and vegetation of DRC have not always been treated in the same way in the different provinces [13]. While for some regions, such as Kinshasa province [8, 14-16], Kongo Central [13, 16], Sud Ubangi [9] and Equateur [5], on the other hand, in the western part of the country, fairly exhaustive studies have already been carried out there [17-19] meanwhile for others these studies are far to be carried out. This is the case of Nord Ubangi province and more precisely at Yakoma territory.

Herbal medicinal products are currently experiencing a significant revival of interest, and it is thanks to scientific studies based on analytical methods and new experiments that the medical world is increasingly discovering the validity of empirical prescriptions for medicinal plants [20]. Among the scientific disciplines interested in traditional herbal medicine, ethnobotany is considered as a science which translates popular knowledge into scientific knowledge. The aim of the present study, which is the first in Ubangi eco-region, was to identify and characterize medicinal plants traditionally used in Yakoma territory for the management of sickle cell disease, and to evaluate their ecological characteristics (morphological types, biological types, phytogeographic distributions and biotopes).

2. Material and Methods

2.1. Study Area

The Yakoma Territory with an estimated population of about 409,444 inhabitants is located in the Nord-Ubangi province, DRC. Yakoma Territory is bounded in the Uélé and Ubangi rivers, which in turn border the Central African Republic, to the northeast by the Bondo and Aketi territories (Bas-Uélé Province), to the northwest by the Mobayi-Mbongo and Businga territories, and to the south by the Bumba territory (Mongala Province). The Yakoma Territory belongs to AW_4 climate (humid tropical climate). Yakoma sector where the surveys were carried out is characterized by savannah vegetation; the species that predominates in this ecosystem is an invasive plant species *Chromolaena odorata* (also called as fuga or sida in Ngbandi dialect).

2.2. Methodology

Participants were selected based on their knowledge on the Congolese traditional pharmacopeia, thus the survey had 60 participants over 50 years. A questionnaire was administered to different categories of participants namely: traditional healers, old people with a tremendous knowledge on the use of medicinal plants and patients suffering from Sickle Cell Aneamia (SCA). We were able to collect specific information on the local names (vernacular nouns) of different plants used traditionally for the management of Sickle Cell Aneamia, the method preparation along with the route of administration. The identification of different plants collected was performed at the Herbarium of the Department of Biology precisely in the Laboratory of Systematic Botany and Plant Ecology which is in partnership with INERA at the University of Kinshasa. The investigation was conducted between August and October 2019. In this study, plant species were identified according to the third version of the botanical classification of angiosperms established by the Angiosperm Phylogeny Group (APG III), Chase and Reveal [21] and APG III [22].

The ecological data have been described as follows: Morphological types: Tree, Shrub, Under shrub, Herb, Liana; Biological types: Climbing phanerophytes (Phgr), Dressed therophytes (Thd), Mesophanerophytes (Msph), Microphanerophytes (Mcph), Lianous phanerophytes (Lph); Nanophanerophytes (Nph); Phytogeographic distribution: Afro-tropical species (At), Pan-tropical species (Pan), Guineo-Congolese species (GC), American species (Am), Centro-Guinean Congolese species (CGC), Centro-Guinean species (Cguin), Cosmopolitan species (Cosm); Biotopes: Crop (cult), Forest (Fo), Savannah (Sa) or Fallow (Ja).

3. Results and Discussion

Table 1 provides information on the ethno-botanical and ecological data of the plants listed

Table 1. Ethno-botanical and ecological data on the inventoried medicinal plant species.

N°	*Scientific accepted name (Family)*	Local name	Used parts	Preparation mode	Mode of administration	Ecological characteristics			
						MT	BT	PD	Biotope
01	*Alchornea cordifolia* (Schumach. & Thonn.) Müll. Arg. (Euphorbiaceae)	Mbombonzi	Leaves	Decoction	Oral route	Shrub	Mcph	At	Fo
02	*Anthocleista schweinfurthii* Gilg. (Gentianaceae)	Benzangu	Root/Leaves	Infusion	Oral route	Tree	Msph	GC	Fo
03	*Basella alba* L. (Basellaceae)	Singo	Leaves	Cooking	Oral route	Herb	Thd	Pan	Cult
04	*Bidens pilosa* L. (Compositae)	Ngenge	Leaves	Decoction	Oral route	Herb	Thd	Pan	Ja
05	*Carica papaya* L. (Caricaceae)	Papaye	Leaves	Infusion	Oral route	Shrub	Msph	Pan	Cult
06	*Coffea canephora* Pierre ex A. Frochner (Rubiaceae)	Kafé	Seed	Infusion	Oral route	Shrub	Msph	CGC	Cult
07	*Cola acuminata* (P. Beauv.) Schott & Endl. (Malvaceae)	Liyo, Makasu	Stem bark	Decoction	Oral route	Tree	Msph	GC	Fo
08	*Elaeis guineensis* Jacq. (Arecaceae)	Mbulu	Flower ashes	Infusion	Oral route	Tree	Msph	Pan	Cult
09	*Hibiscus acetosella* Welw. Ex Hiern. (Malvaceae)	Ngaingai	Leaves	Decoction	Oral route	Under shrub	Nph	Cgui	Cult
10	*Hibiscus sabdariffa* Rottb. (Malvaceae)	Ngaingai	Leaves	Decoction	Oral route	Under shrub	Nph	Cgui	Cult
11	*Periploca nigrescens* Afzel. (Apocynaceae)	Kpumanza	Leaves	Maceration	Washing	Liana	Phgr	GC	Fo
12	*Morinda lucida* Benth. (Rubiaceae)	Gere	Root bark	Maceration	Washing	Shrub	Msph	GC	Sav
13	*Musa paradisiaca* L. (Musaceae)	Fondo	Leaves	Infusion	Washing	Herb	Thd	Pan	Cult
14	*Persea americana* Mill. (Lamiaceae)	Avoka	Root	Decoction	Oral route	Tree	Msph	Cosm	Cult
15	*Phytolacca dodecandra* L'Hér. (Phytolaccaceae)	Singo ngbandi	Leaves	Cooking	Oral route	Liana	Lph	Am	Cult
16	*Portulaca triangularis* Jacq. (Portulacaceae)	Kpelekpele	Leaves	Cooking	Oral route	Herb	Thd	At	Cult
17	*Psidium guajava* L. (Myrtaceace)	Kangele	Leaves	Infusion	Oral route	Tree	Mcph	Pan	Cult
18	*Psophocarpus scandens* (Endl.) Verdc. (Leguminosae)	Ngasâ	Leaves	Cooking	Oral route	Liana	Phgr	At	Cult

The results obtained in this table show that 18 plant species belonging to 15 families and 17 genera have been recorded in the medicinal flora of the Ngbandi people in Yakoma territory, Nord Ubangi Province, DRC.

The different families of the listed plant species are represented in the figure below.

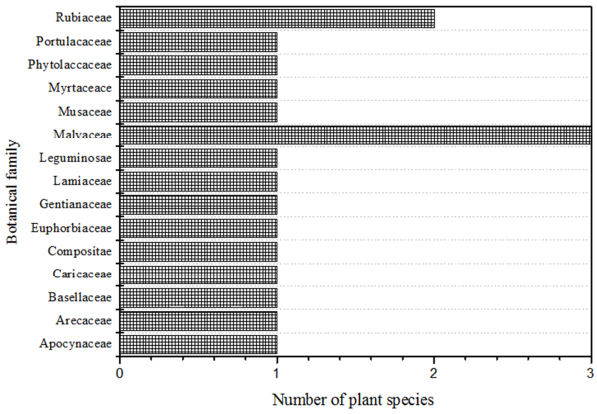

Figure 1. Different families of the listed plant species according to the number of species per family.

It is observed from the above figure that the 18 plant species listed are divided into 15 families. The Malvaceae family is representing by three species followed by the Rubiaceae family with two plant species. The remaining families like Arecaceae, Apocynaceae, Basellaceae, Caricaceae, Compositae, Euphorbiaceae, Gentianaceae, Lamiaceae, Leguminosae, Musaceae, Myrtaceae, Phytolaccaceae and Portulacaceae have one species each. These findings are similar to those of Gnagne *et al.* [23] who reported the high representativeness of Malvaceae, and this could be justified by the grouping of two subfamilies into one family in the new botanical classification.

The figure 2 shows the different parts used.

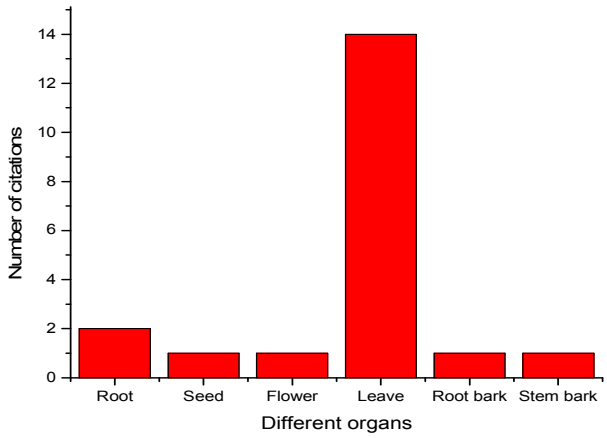

Figure 2. Different plant parts used.

As per the figure 2, it is observed that six organs are used as medication: leaves (70%), followed by roots (10%) and the

other parts (5%), each. These findings are going along with Tahri *et al.* [24] who indicate that leaves are the most commonly used parts in recipe preparation. The large-scale use of roots is a practice that could contribute to the erosion of these phytogenetic resources [15]. These plants are biological resources for the management of sickle cell disease for future generations. To this end, they must be integrated into sustainable management in order to validate and improve the quality and effectiveness of their bio-therapeutic properties.

The figures 3 and 4 show how recipes are prepared and administered.

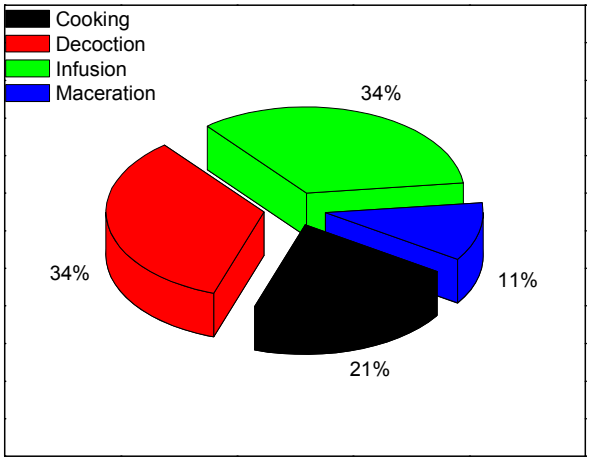

Figure 3. Mode of preparation of different recipes.

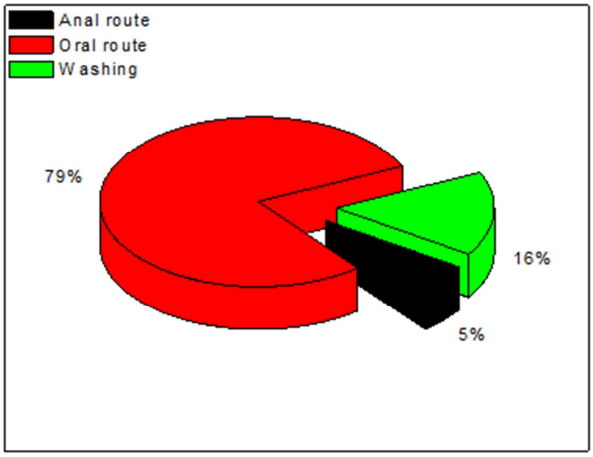

Figure 4. Different administration mode.

From figure 3, four methods of preparation are used of which the decoction and infusion are the most practiced (34% each) while cooking and maceration are used in a moderate manner.

This percentage shows that the local population uses most these two methods of preparation. It was reported by several authors that the local population considers decoction to be an adequate mode to warm the body and disinfect the plant [8, 20]. On the other hand, decoction makes it possible to collect the most active ingredients and reduces or cancels the toxic effect of certain recipes [26]. While Figure 4 shows that the oral route (79%), is the most commonly used in the administration of different recipes in Yakoma territory, followed by washing (16%) and the anal route is the least used (5%). These results corroborate with Gnagne *et al.* [23] which show that the oral route is the most widely used in the administration of phytomedicine.

The figures 5 and 6 provide information on the morphological and biotope types of the plants identified.

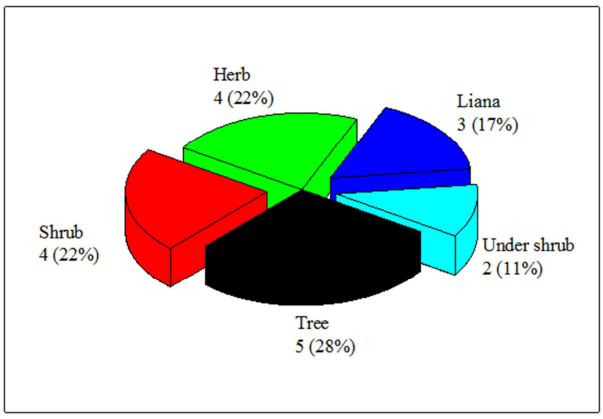

Figure 5. Morphological types.

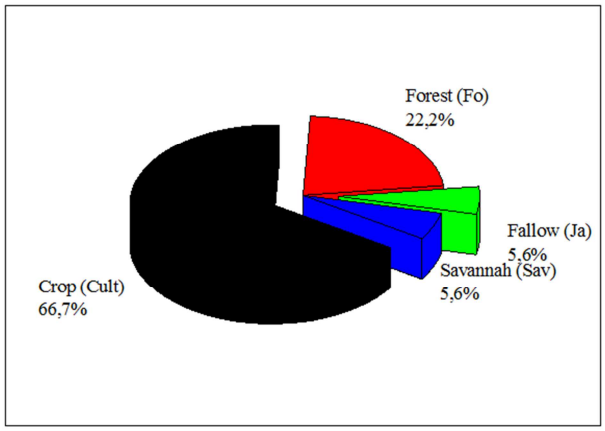

Figure 6. Types of biotope.

It is observed from figure 5 that different species identified in Yakoma territory present five morphological types of which trees are predominant (28%) followed respectively by herbs and shrubs (22% each), lianas (17%) and under shrubs (11%). These morphological types belong to four biotopes were.

Crops were the most predominant biotope (66.7%) followed by the forest (22.2%), fallow and savannah (5.6% each) respectively. The predominance of forest plants would be justified by the fact that the study area is located in a forest ecosystem of the tropical region (humid tropical zone). The same results were reported by Ngbolua et *al.* [8] in Gbado-Lite city in Nord Ubangi province.

The results on the biological types and phytogeographic distribution of the plants surveyed are shown in the figures below

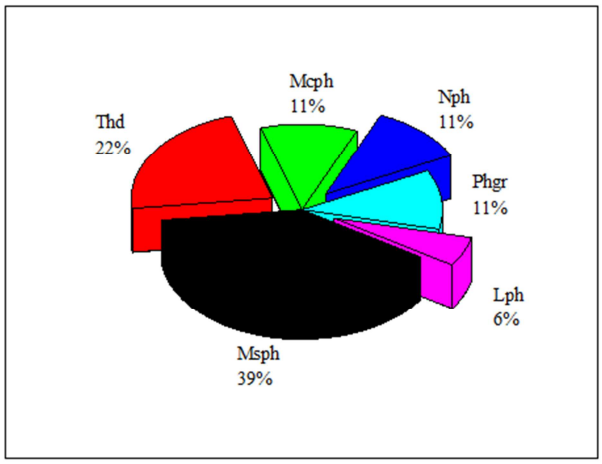

Figure 7. Biological types.

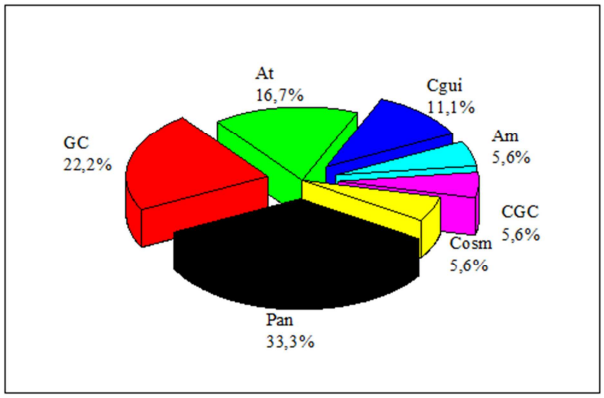

Figure 8. Phytogeographic distribution.

Figure 6 shows that the listed species are divided into 6 biological types as follow: mesophanerophytes (Msph, 39%); dressed therophytes (Thd, 22%); microphanerophytes (Mcph, 11%); nanophanerophytes (Nph, 11%); climbing phanerophytes (Phgr, 11%) and lianous phanerophytes (Lph, 6%). From a chorological point of view, these listed species are mainly pantropical (Pan, 33.3%) followed by Guineo-Congolian (GC, 22.2%); Afro-tropical (At, 16.7%); Centro-Guinean species (Cguin, 11.1%) and American species (Am, 5.6%); Centro-Guinean Congolese species (CGC, 5.6%) and Cosmopolitan species (Cosm, 5.6%). The predominance of pantropical species has also been reported in several studies, of which Ngbolua et al. [14], Masunda et al. [16] and Ipona et al. [5]. The predominance of phanerophytes among the reported plant species is a characteristic of tropical regions and may also correlate to the ease with which their tissues synthesize bioactive secondary metabolites. In addition, the perennial character of the reported species supports their high availability and usage by the communities for the management of Sickle cell disease (SCD).

SCD is a life-long blood disorder characterized by red blood cells that assume an abnormal, rigid and sickle shape. It is a genetic disease in which a single base substitution in the gene encoding the human β-globin subunit results in replacement of β6 glutamic acid by valine [27]. In recent years bone marrow transplantation and gene therapy have been proposed as an efficient way of treating SCD. However the cost implications, availability of necessary expertise, problem of finding suitable donors, inadequate transfusion and transfusion related infections constituted a major setback to this approach in developing countries. Currently, drugs such as hydroxyurea and erythropoietin are used as disease modifier agents. Cost and side effects of these drugs limit their clinical use [28]. In Democratic Republic of the Congo (DRC), it was reported that 12% of the hospitalized children are sicklers and that the annual cost of the treatment of this hemoglobinopathy is higher than 1.000,00 USD per patient. This cost is hard to bear for the majority of the population whose average income is lower than 2 USD per day and who for the needs for primary health care turns mainly to medicinal plants for the treatment of SCD and associated bacteria [29].

These medicinal plant species contain bioactive compounds that are capable of modulating metabolic processes which can result in the promotion of better health. Some of these plants act therefore as functional foods and could serve as valuable sources of nutraceuticals. The use of edible medicinal plants is an interesting approach since these plants can be integrated into the daily diet of patients suffering from SCD. Eight medicinal foods namely *Alchornea cordifolia*, *Basella alba, Coffea canephora, Hibiscus acetosella, H. sabdariffa, Phytolacca dodecandra* and *Psophocarpus scandens* were identified in this study. Four plant species among 18 were scientifically validated for their antisickling activity *in vitro*.

These plants are *Alchornea cordifolia* [30], *Anthocleista schweinfurthii* [31], *Morinda lucida* [32] and *Psophocarpus scandens* [33]. This activity is mainly due to anthocyanins [34-36] and organic acids [37-40].

4. Conclusion and Suggestions

The aim of the present study was to carried out an ethnobotanical survey of antisickling plants used in Traditional Medicine by Traditional Healers in Yakoma territory for scientific validation in subsequent work. The results obtained in this study show that 18 plant species belonging to 15 families and 17 genera have been recorded in the medicinal flora of the Ngbandi people in Yakoma territory, Nord Ubangi Province, DRC; Malvaceae family was the most represented botanical family in terms of species. While

leaves were the most used part and the decoction and infusion were the most common modes of preparation used and the oral route was the most commonly used for drug administration. Eight medicinal foods (*Alchornea cordifolia*, *Basella alba, Coffea canephora, Hibiscus acetosella, H. sabdariffa, Phytolacca dodecandra* and *Psophocarpus scandens*) were identified in this study and four plant species *(Alchornea cordifolia, Anthocleista schweinfurthii, Morinda lucida* and *Psophocarpus scandens*) were scientifically validated for their antisickling activity *in vitro*. Advanced pharmacological and phytochemical studies will evaluate the therapeutic efficacy and safety of these plants and their isolates in order to formulate a suitable phytomedicine.

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