JOURNAL OF MODERN DRUG DISCOVERY
AND DRUG DELIVERY RESEARCH
Journal homepage: http://scienceq.org/Journals/JMDDR.php

Research Article Open Access

Ethno-botanical survey and Ecological study of Plants resources used in Folk medicine to treat symptoms of Tuberculosis in Kinshasa City, Democratic Republic of the Congo

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Received: June 13, 2014, Accepted: July 9, 2014, Published: July 10, 2014.

ABSTRACT

Medicinal plants represent the key product for the Congolese population. In order to preserve the ethno-medical cultural heritage of the Democratic Republic of the Congo, the present study was undertaken with the aim of identifying and characterizing ecological status of plant species used to treat symptoms of tuberculosis in Kinshasa city. The ethno-botanical study was conducted in Kinshasa city in January-March 2013 through questionnaire and personal interviews and their responses were documented.

Twenty-six plant species found in 20 families and 25 genera which belong to the Magnoliophyta taxonomic group were identified out of which phanerophytes predominate. The family of Apocynaceae, Fabaceae, Lamiaceae, Myrtaceae and Rubiaceae are represented each one by two species and the remainders with only one species each one. 88.46% of herbal remedies used to treat symptoms of TB in Kinshasa city are prepared by aqueous decoction. All recipes are administered to patients by oral route. 26.92% of used medicinal plants are Guinea-Congolese species. Leaves are the most used part (69.23%). The large distribution of inventoried medicinal flora in Africa means that the protection of their ecosystems should be a common effort at national, sub-regional and regional levels. Advanced phytochemical, pharmacological and toxicological investigations of some inventoried plants are in progress and might lead to the development and standardization of interesting anti-TB remedies.

Keywords: Tuberculosis, ethno-pharmacology, medicinal plants, Floristical characterization, Democratic Republic of the Congo.

INTRODUCTION

Tuberculosis (TB) is one of the leading causes of morbidity and mortality in the third world [1-3]. According to Chaisson and Martinson [4], Africa carries 29% of the world's disease burden and 34% of the world's total death rate. The Democratic Republic of Congo with an estimated incidence smear over 150 cases per 100 000 inhabitants, is one of the 22 most affected countries in the world. It ranks the 5th place in Africa and 11th in the world [5, 6]. The situation is made worse by co-infection with HIV among TB patients. Indeed, autopsy studies have shown that 50% of the 40 million HIV-infected individuals die of tuberculosis [7]. Treatment of TB patients co-infected with HIV/AIDS has been associated with treatment failure, relapses, and acquires drug resistance in addition to drug interactions that increase the risk of toxicity [8, 9].

Medicinal plants have been used since time immemorial as source of medicine to combat various ailments including TB [10]. According to the WHO report, about 80% of African people rely on traditional medicine for primary health care because they cannot afford access to quality medical care. It is therefore necessary to investigate and document information on plants traditionally used in folk medicine in order to insure their rational use. The Democratic Republic of Congo is reputed for the extraordinary richness of it biodiversity [11]. These plants have found to have therapeutic value for fighting major health problems [12-20]. This explains the need to document information on the use of plants in folk medicine and their ecological status.

The present study was performed with the aim of documenting information on medicinal plants and recipes traditionally used to treat tuberculosis in Kinshasa city and to analyze their relative

importance. Scientists in the ethno-pharmacology field may find information which could stimulate them to undertake further studies.

MATERIALS AND METHODS

Study area

The ethno-pharmacological investigations were conducted in Kinshasa, the capital of the Democratic Republic of Congo (Fig 1). Kinshasa is a city located between 4°18 ' and 4°25 'S latitude and between 15°19' and 15°22'E longitude. Its average altitude is 360 m above sea level. Kinshasa is limited in the north by left bank of the Congo River, in the East by Bateke plate, in the South by the Lukaya River and in the West by the Mfuti River. This city covers a surface of 9.965,2 square kilometer and is located in the low altitude climate, characterized by AW4 climate type according to the classification of Koppen. Considering the chorologic subdivisions of the Democratic Republic of Congo as previously reported [21], Kinshasa is located in the Guineo-congolian region and belongs to the Congolo-zambezean transition sector. It is a town with heterogeneous population inhabitants originating from different ethnic groups (450 tribes grouped into four predominant linguistic groups: Lingala, Tshiluba, Swahili and Kikongo). However, the indigenous population of Kinshasa consists of Teke and Humbu.

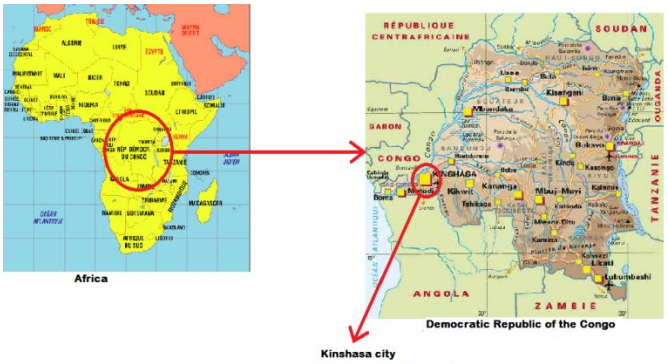

Figure 1: Localization of the study area (Kinshasa city)

Ethno-botanical surveys

Ethno-botanical surveys were conducted in January-March 2013 in Kinshasa City. A total of 15 traditional healers were interviewed. Informants were selected for their authentic knowledge on the utilization of anti-TB plants. Traditional healers were interviewed on a voluntary basis. The study followed principles laid out in the Declaration of Helsinki as previously reported [21]. The questionnaires were divided into three sections: (i) personal information such as name, age, sex, marital status, ethnic group of informant and studies level; (ii) traditional medicine practice; (iii) plant part used, preparation methods, administration route of remedies. Informed consent was obtained from the respondents to divulge information.

Floristical study

Medicinalplants selected for this study are characterized by their morphological type, biological types, habitat types and phytogeographic distribution.

Morphological type

The morphological type's classification of medicinal plant species was carried out according to Pauwels' classification [22]. These plants were classified as following: trees (T), shrubs (Shr), under shrubs (U/shr), liana (L), annual herb (Anh), and perennial herb (Perh).

Biological types

The biological types adopted in this study are those definite according to the Raunkiaer's classification, applicable for the tropical regions [23]. They have been classified as follows: megaphanerophytes (MgPh), mesophanero-phytes (MsPh), microphanerophytes (McPh), nanophanerophytes (NPh), lianous phanerophytes (Lph), dressed therophytes (Thd), climbing therophytes (Thg) or dressed chamephytes (Chd).

Habitat types

The identification of the inventoried plant species habitat/biotope types was carried out using some Congolese flora books as previous reported [21]. The biotopes have been classified as follows: Primary forest (PF), Secondary forest (SF), Savanna (Sav), Ruderal (Rud), Cultured plant/crop (Cult) and bush fallow (Buf).

Phytogeographic distribution

Phytogeographic distribution of species has been recorded according to Central Africa's chorographic subdivisions [24-26] as follows: Afro-tropical (At), Pan-tropical (Pan), Guinean (Guin) Paleo-tropical (Pal), and Cosmopolitan (Cosm), Afro-Malagasy (AM), Guinea-Congolese (GC) and Afro-American (AA) plant species.

RESULTS AND DISCUSSION

The ethno-botanical surveys have led to the identification of 26 medicinal plant species presented in Tables 1. These plants are listed in alphabetical order of their scientific accepted names in italic and ecological characteristics, the ethno-botanical information concerning these plants, followed by Congolese vernacular names, families, used part and mode of preparation.

Table 1: List of anti-TB Medicinal plants used in Kinshasa (Democratic Republic of the Congo): their ecological characteristics and ethno-botany

Plant species (Ecological characteristics)	**Vernacular name**	**Family**	**Used part**
Abrus precatorius L. (Lia, LPh, At, Sav)	Sukali sukali (Lingala)	Fabaceae-Faboïdeae	Leaves*
Azadirachta indica A. (T, MsPh, GC, SF)	-	Meliaceae	Stem bark*
Canarium schweinfurthii Engl. (T, MgPh, GC, PF)	Watene (Ngbandi)	Burseraceae	Stem bark**
Catharanthus roseus L. (U/shr, NPh, AM, Sav)	-	Apocynaceae	Leaves*
Citrus limon (L.) Burn.F. (T, MsPh, Pan, Sav)	Kpekpe (Ngbandi)	Rutaceae	Leaves*
Croton sylvaticus Hochst. Ex Krauss (Anh, Thd, GC, Cul)	-	Euphorbiaceae	Stem bark*
Dysphania ambrosioides (L.) Monsyakin (Perh, Thd, Cosm, Sav)	Nkasa kindongo (Kikongo)	Amaranthaceae	Leaves****

Eriosema psoraloides (Lam.) G.Don (U/shr, NPh, AM, Buf)	-	Fabaceae	Stem bark*
Eucalyptus citriodora Hook. (T, McPh, GC, SF)	-	Myrtaceae	Leaves*
Eucalyptus globulus Labil. (T, MsPh, GC, SF)	-	Myrtaceae	Stem bark*
Garcinia huillensis Welw. Ex Oliv. (Shr, McPh, At, Sav)	Kisima (Kikongo)	Clusiaceae	Stem bark*
Gossypium barbadense L. (U/shr, McPh, Pan, Sav)	Tukia (Ngbandi)	Malvaceae	Leaves*
Heinsia crinita (Afzel) G. Taylor (Shr, McPh, GC, PF)	Kita mata (Lingala)	Rubiaceae	Leaves*
Holarrhena floribunda (G. Don) Dur&Schinz. (Shr, McPh, At, PF)	Kinzenze (Kikongo)	Apocynaceae	Leaves*
Hymenocardia acida Tul. (Shr, McPh, At, Sav)	Mvete (Kikongo)	Phyllanthaceae	Leaves*
Lannea welwitschii (Hiern) Engl. (T, MsPh, GC, PF)	Kumbi (Kikongo)	Anacardiaceae	Leaves*
Lippia multiflora L. (U/shr, NPh, GC, Sav)	Bulukutu (Kikongo)	Verbenaceae	Leaves*
Momordica charantia L. (Lia, Thg, Pan, Sav)	Mambunzu (Kikongo)	Cucurbitaceae	Leaves*
Moringa oleifera Lam. (T, McPh, GC, SF)	-	Moringaceae	Leaves***
Myrianthus arboreus P. Beauv. (T, MsPh, G, Buf)	Ngbolo (Ngbandi)	Cecropiaceae	Leaves*
Ocimum gratissimum L. (U/shr, Chd, Pal, Sav)	Lumba lumba (Lingala)	Lamiaceae	Leaves*
Rauvolfia vomitoria Afzel. (Shr, McPh, GC, SF)	Kilungu (Mundayi ndayi)	Apocynaceae	Root bark*
Sarcocephalus latifolius (Sm.) Bruce (Shr, McPh, At, PF)	Nlolo kikwango(Kikongo)	Rubiaceae	Leaves*
Schweinckia americana L. (Anh, Chd, AA, Sav)	Lunzila nzila (Kikongo)	Solanaceae	Leaves*
Vernonia amygdalina Del. (Shr, McPh, At, Buf)	Malulu (Kikongo)	Asteraceae	Leaves*
Vitex madiensis Oliv. (Shr, McPh, At, Sav)	Mfilu (Kikongo)	Lamiaceae	Leaves*

Mode of preparation*: decoction,**: maceration,***: infusion,****: crushing

The inventoried medicinal flora is made up of 26 species found in 20 families and 25 genera which belong to the Magnoliophyta taxonomic group. The family of Apocynaceae, Fabaceae, Lamiaceae, Myrtaceae and Rubiaceae are represented each one by two species and the remainders with only one species each one.

Recent findings indicated that Fabaceae and Rubiaceae are two of the six angiosperm families including Asteraceae, Orchidaceae, Poaceae and Euphorbiaceae which are widely represented [27]. In the particular case of Rubiaceae family, literature research revealed that various secondary metabolites are naturally occurring as phytochimical markers in this family. These include terpenoids, anthraquinones and tetracyclic or pentacyclic indole alkaloids [27, 28-31]. Such secondary metabolites with broad-spectrum of biological properties could justify the interest be accorded to this family as a useful tool for anti-TB screening program

Morphological types

Figure 2 gives the weighted morphologic type

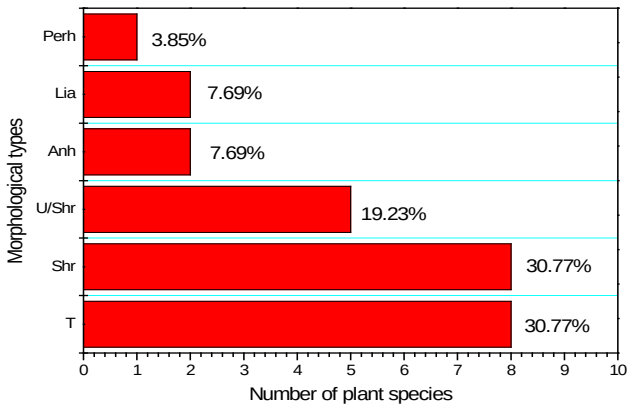

Figure 2: Weighted morphologicical types

This figure shows that inventoried flora used in folk medicine against TB in Kinshasa city is constituted of six main morphological types which are T, Shr, U/Shr, Anh, Peh, and L. Ligneous plants represent about 61.54% of species (30.77% of T and 30.77% of Shr) while herbaceous plants and lianas represent 11.54% and 7.69% of species respectively. Higher plants (woody species) possess anatomical and histological structures that allow them to develop and accumulate medically interesting secondary metabolites responsible of their pharmacological values [32].

Biological types

Figure 3 gives the weighted biological types

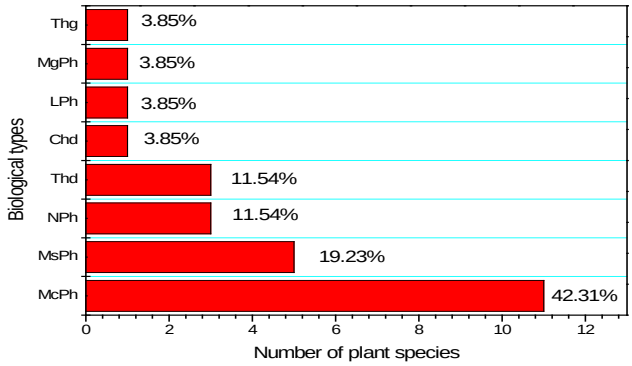

Figure 3: Weighted biological types

The analysis of the biological types of the inventoried flora used in folk medicine against TB in Kinshasa city (Figure 3) indicates the predominance of McPh (42.31%) followed by MsPh (19.23%) and NPh and Thd (11.54% each one). MgPh, LPh, Thg and Chd represent only 3.85% for each biological type. The predominance of phanerophytes (80.78%) in inventoried medicinal plants is a

characteristic of equatorial regions [33]. Indeed, Democratic Republic of the Congo is located in the heart of Africa and 62% of its national territory is covered by forests [11].

Biotope types

Figure 4 gives weighted habitat types

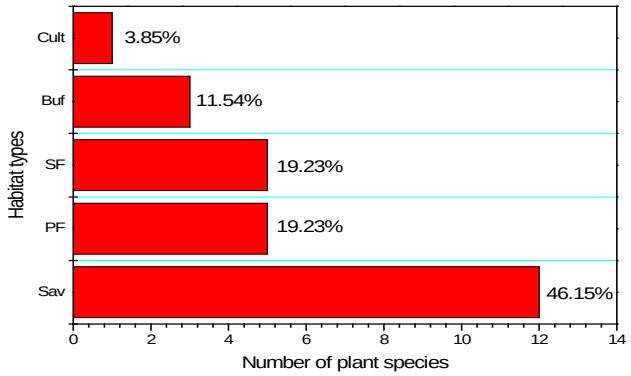

Figure 4: Weighted habitat types

The plant species used in traditional medicine against TB in Kinshasa city (Figure 4) are found in different biotopes. Sav is the main habitat type with 46.15% of used plant species followed by PF and SF (19.230% each one) and Buf (11.54%). Cult with 3.85% is the less represented. The relative importance of savanna plant species in the composition of traditional recipes is due to the fact that they have the advantage of having a relatively high content of active [32].

Phytogeographic distribution

Figure 5 gives the phytogeographic distribution.

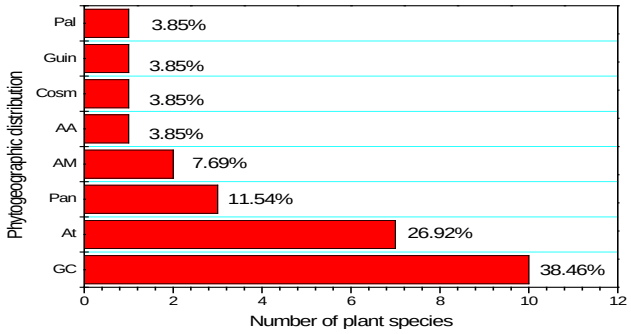

Figure 5: Phytogeographic distribution

As it can be seen from Figure 5, the plant species GC are the most represented (38.46%) followed by the species At (26.92%), Pan (11.54%) and AM (7.69%). The species Pal, Cosm, Guin and AA have weakest abundance with 3.85% each.

Taking into account of the phytogeographical distribution of inventoried medicinal flora, the protection of the forest as reservoir of medicinal plants should be a common effort at national, sub-regional and regional levels. Indeed, inventoried anti-TB plant species have a large spectrum of distribution in Africa [33].

Floristic analysis

The floristic analysis revealed that, there exists among the inventoried medicinal plants: eight trees (30.77), eight shrubs (30.77%), one perennial herb (3.85%), two annual herbs (7.69%), five under-shrubs (19.23%) and two lianas (7.69%). The trees and shrubs are predominant. The majority of these plants are found in the savanna and forest. This result is explained by the fact that the vegetation of the surroundings of Kinshasa is consisted of savannas and the forest scraps along the rivers.

Figures 6 and 7 give the weighted medical and pharmaceutical techniques

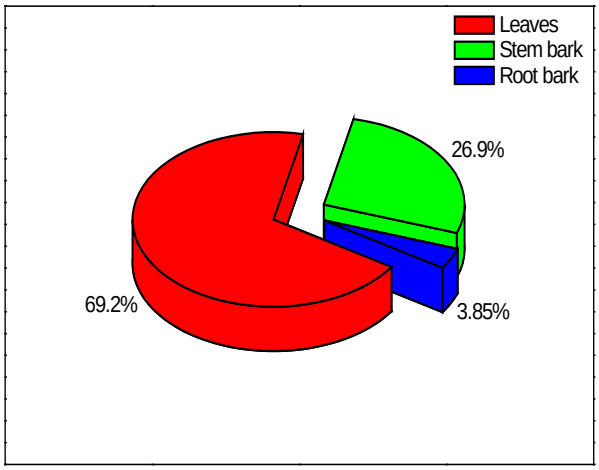

Figure 6: Weighted used part

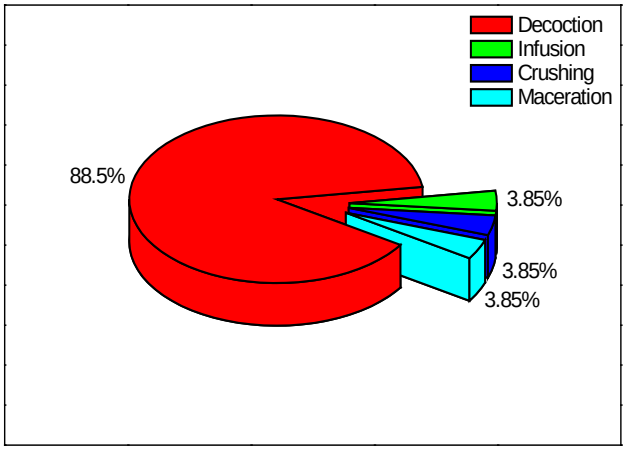

Figure 7: Weighted preparation mode

Medico-pharmaceutical analysis revealed that, leaves are the most used part (69.23%) followed by the stem bark (26.92%) and root bark (3.85%) (Fig.6). According to the preparation mode of herbal medicine (Fig.7), decoction is the most used technique (88.46%), followed by crushing, maceration and infusion (3.85% each one). While according to the mode of administration, all recipes are used per os (oral route).

The harvest of the leaves does not involve the extinction of the plant species.

Similarities of use and other considerations

Recent reports indicated that medicinal plants contain pharmacologically active compounds with anti-mycobacterial activity [34]. Indeed, plants and microbial pathogens have been living together for many centuries. During such co-evolution, plants have developed numerous strategies to counter the microorganisms attack by producing specialized secondary metabolites that have toxic effect on the microbes. Indeed, despite the fact that plant pathogenic microorganisms have played a key role in the early evolution of the secondary metabolites diversity, there is little chance for a microbe to gain resistance from a plant as it is known for antibiotic-producing microbes which possess

genes protecting them from the toxic effects of such metabolites. So, plant secondary metabolites could possess anti-TB activity justifying the use of selective plants in folk medicine [35].

The present surveys listed some plant species used by Congolese traditional healers to treat symptoms of TB. Bibliographic research (library and online search: Google scholar, PubMed, PMC, etc.) revealed that these plants are also known to treat various ailments elsewhere [10, 27, 33]. The frequency of citation by both traditional healers and literature is an indication of the ethno-pharmacological relevance of medicinal plants. In fact, some of listed plants were repeatedly cited by the traditional healers in other countries [33]. So, if a plant is employed as remedy in different countries where each people have specific medicinal practices, there is strong evidence that the pharmacological activity should be effective. Plant species such as *Vernonia amygdalina* Del is edible both for man and for great apes. Thus, this plant may not need to be screened for it toxicological effects and may be recommended to TB patients for their primary health care purpose as nutraceuticals. Although, wild plants need to be submitted to phytochemical, pharmacological and toxicological investigations for their standardization and quality control of the derived recipes to ensure their safety. After such evaluations, they may be approved for their use in the anti-TB primary health care.

CONCLUSION

The present surveys revealed that plants used to treat symptoms of TB in Kinshasa city are widely administered as aqueous decoction. The majority of the inventoried plants are found in the savanna and forest. Their large distribution in Africa means that the protection of their ecosystems should be a common effort at national, sub-regional and regional levels. Phytochemical, pharmacological and toxicological investigations of some cited plants are in progress and might lead to interesting anti-TB remedies.

Acknowledgments

This study was partially supported by the International Foundation for Science (Sweden) and the Organization for the Prohibition of Chemical Weapons (IFS research grant N0 F/4921-2 attributed to Dr. NGBOLUA K.N.).

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Citation: Koto-te-Nyiwa Ngbolua, et al (2014), Ethno-botanical survey and Ecological study of Plants resources used in Folk medicine to treat symptoms of Tuberculosis in Kinshasa City, Democratic Republic of the Congo J. of Modern Drug Discovery and Drug Delivery Research. V1I4. DOI: 10.15297/JMDDR.V1I4.01