

# Ethnobotanical survey on anti-tuberculosis plants in Mbuji-Mayi, Democratic Republic of the Congo

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## ABSTRACT

### Introduction

Tuberculosis (TB) is a serious public health issue in the Democratic Republic of Congo (DRC). However, the lack of appropriate treatment has led to the emergence of multidrug-resistant tuberculosis (MDR-TB), which poses a significant public health challenge and complicates the management of the disease.

### Purpose

This ethnobotanical survey, conducted in the city of Mbuji-Mayi, DRC, aimed to identify traditional remedies used to treat tuberculosis.

### Methods

An ethnobotanical survey was conducted through interviews using a structured questionnaire with 46 resource persons, including household members, herbalists, and traditional practitioners. Information was collected on plant species considered to have anti-tuberculosis properties, the plant parts used, preparation methods, administration routes, and dosage of medicinal recipes. Data were analysed using R software, with results presented as frequencies and percentages.

### Results

The survey identified 56 plant species belonging to 25 botanical families, with Rubiaceae (10.7%), Asteraceae (10.7%), Phyllanthaceae (8.9%), and Fabaceae (7.2%) being the most represented. The identified species were categorized as shrubs (37.50%), grasses (37.50%), trees (21.43%), and lianas (3.57%). These plants were reported to treat 40 conditions, including nine tuberculosis-related symptoms, with fever being the most cited symptom (quoted 80 times out of 253 mentions, 31.62%). Leaves were the most commonly used plant part (36.06%), and decoction (64.82%) was the predominant preparation method. The majority of traditional remedies were administered orally (78.47%). The findings indicate that in the face of limited access to anti-tuberculosis drugs, residents of Mbuji-Mayi rely on medicinal plants to manage tuberculosis, one of the DRC's critical public health issues. These results highlight the potential of medicinal plants in the fight against tuberculosis and suggest avenues for further research into their therapeutic properties.

### Conclusion

This study represents the first ethnobotanical investigation of plants used for tuberculosis treatment in Mbuji-Mayi, DRC. It provides valuable insights into the knowledge of resource persons and traditional practitioners. Further research, particularly chemical screening, ethnopharmacological studies, and evaluations of biological activity, is essential to isolate and characterize promising anti-tuberculosis compounds.

## INTRODUCTION

Tuberculosis (TB) is an endemic-epidemic infectious disease with direct transmission, primarily inter-human, caused by the *Mycobacterium tuberculosis* complex, also known as the Koch bacillus (BK) in 99% of cases (Ballo, 2013; Laborde, 2016; Zahir et al., 2018; Eddouks et al., 2020; Hamidou, 2021; Kazadisha et al., 2023; Navoizat & Limonet, 2023; Bolisomi et al., 2024). With an estimated incidence of more than 150 cases per 100,000 inhabitants worldwide (Eddouks et al., 2020; Ekono et al., 2021), TB has been declared by the World Health Organization (WHO, 2021) as the second deadliest infectious disease after COVID-19 (Hamidou, 2021).

According to the WHO, the countries most affected by this pandemic are India, Indonesia, China, the Philippines, Pakistan, Nigeria, Bangladesh, and the Democratic Republic of Congo (DRC), which collectively account for over 75% of all TB cases (Hengliang et al., 2021). In 2023, the WHO reported that 1.5 million people died from TB, with most cases occurring in adults. That year, 56% of the cases were in men, 33% in women, and 11% in children, with 90% of the cases concentrated in 30 countries, primarily in Africa and Asia, including the DRC (WHO, 2023).

TB remains a significant public health issue in the DRC (PNLT, 2023). With an incidence of approximately 327 cases per 100,000 inhabitants, the country ranks ninth globally according to the WHO and is classified among the high-burden TB countries (Kabedi et al., 2023a; Kabedi et al., 2023b; PNL, 2023; Akilimali et al., 2024; Chauffour et al., 2024). Statistics from the past four years indicate a steady increase in reported cases (PNLT, 2023). This trend is also observed in the Kasai Oriental Province, with its capital city, Mbuji-Mayi, reporting similar increases according to the Provincial Health Division (DPS, 2023).

In Mbuji-Mayi, as in most rural and urban areas of the DRC, a significant portion of the population relies on traditional medicine for healthcare, including TB treatment and other conditions (Ngoy, 2013; Bashige et al., 2017; Bashige et al., 2018; Manya, 2020; Kalunga, 2021; Manya, 2021; Mbuyi, 2022; Muamba, 2022). The plant kingdom provides an almost inexhaustible and diverse source of natural substances utilized by traditional medicine and

biomedicine to treat numerous diseases, including TB. These natural substances represent an essential source of active ingredients for medicinal use (Memvanga et al., 2015; Newman & Cragg, 2016).

Medicinal plants have historically been used to treat a range of diseases, including cancer, TB, malaria, sickle cell anaemia, intestinal worms, and skin diseases. Ethnobotanical surveys can catalogue these plants, forming a global database of therapeutic species accessible to scientists worldwide. Since antiquity, medicinal plants have played a central role in healthcare, with research confirming their efficacy and leading to the development of plant-based drugs such as vinblastine, vincristine, artemisinin, strychnine, quinine, morphine, codeine, and colchicine (Lautié et al., 2020). Certain natural products identified from plants have served as models for the organic synthesis of new drugs. Surveys of anti-tuberculosis plants underscore the role of medicinal plants in combating TB and improving public health. The findings of such surveys contribute to creating databases of anti-tuberculosis medicinal plants, including those in Mbuji-Mayi and its environs.

This study aimed to inventory the medicinal plant species known for their anti-tuberculosis properties in Mbuji-Mayi and its surrounding areas.

## METHODS

### *Description of the Study Environment*

The city of Mbuji-Mayi, the capital of the province of Kasai Oriental (Figure 1), covers an area of 136 km<sup>2</sup>. It lies between the geographical coordinates of 6°5' and 6°10' south latitude, and 23°27' and 23°40' east longitude. It is, therefore, a horizontal city—i.e., a spread-out city—that extends 15 km from east to west and 9 km from north to south (Bukome & Tshimanga, 2011; Kambi, 2010; Omasombo et al., 2014; Tshimanga, 2009).

The city is bounded to the north by the Muya River, to the south by the Kanshi River, to the west by the artificial line joining the Kanshi-Nzaba confluence to that of the Muya-Bipemba, and to the east by the Mbuji-Mayi River. Within the province of Kasai Oriental, Mbuji-Mayi is bordered to the north, west, and south by the territory of Lupatapata; to the northeast by the territory of Katanda; and to the

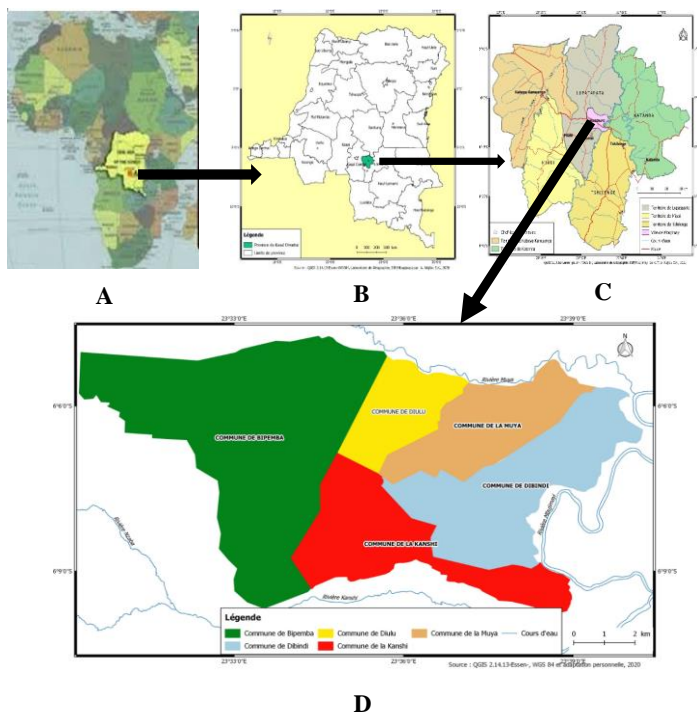
southeast by the territory of Tshilenge. It is located 666 km south of the Equator, 950 km east of Kinshasa, 1,000 km north of Lubumbashi, 243 km east of Kananga, 132 km north of Mwene-Ditu, 850 km southwest of Bukavu, and 400 km from Lodja (Tshimanga, 2009; Kambi, 2010).

Mbujimayi experiences two seasons: the rainy season, lasting eight months from September to April, and the dry season, lasting two months—June and July. May and August are transitional months.

During the rainy season, maximum rainfall peaks occur in March and November. Although November brings the most rainfall, December has more rainy days, with an average monthly rainfall of 185.5 mm. The ambient temperature varies between 20°C and 30°C, with an annual average of 25.2°C (Kambi, 2010).

In terms of vegetation, Mbujimayi, with its humid tropical climate, is located in a wooded savannah zone. This consists of a dense carpet of tall grasses, exceeding 2 meters during the rainy season, and trees forming gallery forests along watercourses (Mulamba, 2017).

**Figure 1:** Mbujimayi City D in Kasai Oriental C, one of the 26 provinces of the DR Congo B, in Africa A



### *Ethnobotanical Survey by Interview*

Using a guided questionnaire, a survey was conducted through interviews with 46 resource persons, selected from households, herbalists, and traditional practitioners based on their reputation for using plants in Mbujimayi and its surrounding areas. The survey was conducted between October and December 2019. Participants were included or excluded based on two criteria. Inclusion criteria required individuals to be at least 18 years old, work as traditional practitioners, or possess knowledge of plant use in treating diseases. Exclusion criteria applied to minors or those without relevant knowledge.

The questionnaire was developed by the head of the medicinal plant research team (a professor) in collaboration with interviewers (PhD students) from the Department of Chemistry and Industries within the Faculty of Science and Technology and the Department of Pharmaceutical Sciences. Teachers from the Department of Psychology and Educational Sciences at the University of Lubumbashi reviewed and corrected the questionnaire.

The survey collected information on the pathologies treated by plants, the preparation and administration methods of traditional recipes, and the dosage of herbal remedies. Data collection adhered to the principle of anonymity as outlined in the Declaration of Helsinki (World Medical Association, 2013).

During the ethnobotanical survey, the vernacular names of plants, the parts used (e.g., root [R], root bark [RB], stem [S], stem bark [SB], leaf [L], or whole plant [WP]), preparation methods, administration methods, and dosages of traditional medicines were documented.

### *Harvesting and Identification of Plant Species*

The survey identified 56 plants known to have anti-tuberculosis properties based on responses from the 46 resource persons. The plant species were collected in various communes of Mbujimayi and its surrounding areas, with resource persons accompanying the research team to the collection sites.

Plant identification was conducted by botanical systematists at the Biology Laboratory of ISP/Mbujimayi. Identification methods included document-based approaches, descriptive comparisons with bibliographic

data, and species comparison with reference herbaria (Mulamba, 2017).

#### Data Processing and Analysis

Data on the frequency and percentage of pathologies treated by plants, plant parts used, and preparation and administration methods were entered into Microsoft Excel 2019. The data were then analysed using R software (version 4.0.1).

**Table 1:**  
Identification of plant species studied, their morphological characteristics, and their medicinal properties

N°	Plant species (Famille)	Vernacular names	MC	RA	Reference
1	<i>Albizia adianthifolia</i> (Schum.) W.F. Wight ( <b>Fabaceae</b> )	Musesa mukunza (tshiluba), Tumbili (swahili), Kapeta nzovu (luba)	Tree	NR	Mulamba, 2017, Wa Ilunga, 2017, Kalunga, 2021 ; Bakari, 2011, Ngoy, 2013
2	<i>Alchornea cordifolia</i> (Schum. et Thonn.) Müll. Arg. ( <b>Euphorbiaceae</b> )	Ditolu difika (tshiluba)	Shrub	NR	Konda et al., 2015
3	<i>Antidesma membranaceum</i> Mull. Arg. ( <b>Phyllanthaceae</b> )	Tshifuba (tshiluba), Kifumbya (bemba)	Tree	NR	Wa Ilunga, 2017 ; Mbayo, 2019
4	<i>Aspilia kotschyi</i> (Sch. Bip. ex Hochst.) Oliv. ( <b>Asteraceae</b> )	Nyinyatshisonga (tshiluba), Nyinyi wa tshisanga (tshiluba)	Grass	NR	Konda et al., 2015 ; Al-Khulaidi, 2021 ; <a href="http://www.science.mnhn.fr">www.science.mnhn.fr</a>
5	<i>Bauhinia thonningii</i> Schumach. (Caesalpinaceae)	Tshifumba tshia mpata tshia bilongu bia kalabi (tshiluba); Kifumbe (luba), Hifumbe (hemba)	Shrub	AR	Wa Ilunga, 2017 ; Yemoa et al., 2008
6	<i>Bixa orellana</i> L. ( <b>Bixaceae</b> )	Kamuma ka kasumbi (tshiluba) Kakula (tshiluba) Ndinga (tshiluba)	Shrub	NR	<a href="http://www.tramil.net">www.tramil.net</a>
7	<i>Boerhavia diffusa</i> L. ( <b>Nyctaginaceae</b> )	Tshidiatambemba (tshiluba); Kidiatambemba (kanyok)	Grass	NR	Mulamba, 2017
8	<i>Borreria ocymoides</i> (Burm.F.) DC. ( <b>Rubiaceae</b> )	Kafuankusu (tshiluba)	Grass	NR	<a href="http://www.ipni.org">www.ipni.org</a>
9	<i>Bridelia atroviridis</i> Müll. Arg. ( <b>Phyllanthaceae</b> )	Mufulu (tshiluba) Tshifuba (tshiluba) Tshinkandinkandi (tshiluba)	Tree	NR	Mulamba, 2017
10	<i>Bridelia ferruginea</i> Benth. ( <b>Phyllanthaceae</b> )	Tshinkunku (tshiluba)	Shrub	AR	Konda et al., 2015
11	<i>Carica papaya</i> L. ( <b>Caricaceae</b> )	Tshinkuenda, Tshihahayi (tshiluba), Kipapayi (swahili)	Tree	AR	Mulamba, 2017
12	<i>Cassia occidentalis</i> L. ( <b>Caesalpinaceae</b> )	Lukunda bajangi (tshiluba)	Grass	AR	Mbuyi, 2022 ; Mulamba, 2017
13	<i>Cassia siamea</i> Lam. ( <b>Caesalpinaceae</b> )	Ndunda mukunza (tshiluba)	Tree	NR	Mulamba, 2017
14	<i>Catharanthus roseus</i> (L.) G.Don ( <b>Apocynaceae</b> )	Kalangu ka bena Sanku (tshiluba)	Grass	NR	Konda et al., 2015
15	<i>Celosia trigyna</i> L. ( <b>Amaranthaceae</b> )	Dipukapuka difika (tshiluba)	Grass	NR	Konda et al., 2015
16	<i>Cenchrus biflorus</i> Roxb. ( <b>Poaceae</b> )	Ntambua dishinda (tshiluba)	Grass	NR	Mulamba, 2017
17	<i>Coleus hybridus</i> Hort. ( <b>Lamiaceae</b> )	Mulafuma (tshiluba), Mulavuma (tshiluba)	Grass	NR	Mulamba, 2017
18	<i>Costus afer</i> Ker Gawl. ( <b>Costaceae</b> )	Tshitateteta tshia tubeji tukese (tshiluba)	Grass	NR	Konda et al., 2015
19	<i>Crassocephalum bojeri</i> (DC.) Robyns ( <b>Asteraceae</b> )	Nsenu (tshiluba)	Grass	NR	<a href="http://www.ipni.org">www.ipni.org</a>
20	<i>Craterispermum cerinanthum</i> Hiern ( <b>Rubiaceae</b> )	Tshisaasa (tshiluba), Tshinsansa (tshiluba)	Shrub	NR	<a href="http://www.ipni.org">www.ipni.org</a>
21	<i>Crossopteryx febrifuga</i> (G.Don.) Benth. ( <b>Rubiaceae</b> )	Mutotshi (tshiluba), Mzwale (swahili) Mutambelungu (lala), Kububa (luba)	Shrub	NR	Konda, 2015; Mulamba, 2017
22	<i>Cymbopogon citratus</i> (D.C.) Stapf ( <b>Poaceae</b> )	Disela dia mputu (tshiluba), Lubishi lua mputu (songye)	Grass	NR	Mulamba, 2017
23	<i>Cymbopogon densiflorus</i> (Steud.) Stapf. ( <b>Poaceae</b> )	Tshikota (tshiluba), Tshikotshi (songye)	Grass	NR	Mulamba, 2017
24	<i>Cyphostemma vanmeelii</i> (Lawalrée) Wild & R.B. Drumm. ( <b>Vitaceae</b> )	Kabonzu (tshiluba)	Liana	NR	Mulamba, 2017

## RESULTS

### Identification and Nature of Plant Species Studied

The identification of the plants inventoried by scientific name, vernacular name, and morphological type is presented in **Table 1** below. The table also indicates whether each species is already known as a medicinal plant.

25	<i>Emilia fosbergii</i> Nicholson ( <b>Asteraceae</b> )	Tshibuibua (tshiluba)	Grass	NR	<a href="http://www.ipni.org">www.ipni.org</a>
26	<i>Entada abyssinica</i> Steud. Ex A. Rich. ( <b>Mimosaceae</b> )	Tshingeja (tshiluba), Tshitifu (tshiluba)	Shrub	NR	Mulamba, 2017; Mbuyi, (2022)
27	<i>Gaertnera parvipaniculata</i> E.M.A.Petit ( <b>Rubiaceae</b> )	Kampanganzevu (tshiluba)	Shrub	NR	Mulamba, 2017
28	<i>Harungana madagascariensis</i> Lam ex Poir ( <b>Hypericaceae</b> )	Mutondo mashi (tshiluba), Muvula mputa (tshiluba), Mukuta (luba), kafifi (bemba)	Shrub	AR	Wa Ilunga, 2017 ; Kalunga, 2021
29	<i>Hymenocardia acida</i> Tul ( <b>Phyllanthaceae</b> )	Lukuanga (tshiluba), Muheta (tshiluba), Lokonga (tetela), Kape (songye)	Shrub	NR	<a href="http://www.naturalist.org">www.naturalist.org</a>
30	<i>Jatropha curcas</i> L. ( <b>Euphorbiaceae</b> )	Nkambua (tshiluba) Mvidie (tshiluba) Kapuluayi (tshiluba), Tshinkambuankambua (tshiluba) Kabuwabuwa (songye)	Shrub	NR	Mulamba, 2017
31	<i>Kalaharia uncinata</i> ( <b>Verbenaceae</b> )	Keba ka nyoka (tshiluba)	Grass	NR	Mulamba, 2017
32	<i>Lycopersicum cerasiforme</i> Donal ( <b>Solanaceae</b> )	Kamata ka tumuma tukesa (tshiluba)	Grass	NR	Mulamba, 2017
33	<i>Maytenus senegalensis</i> (Lam.) Exell ( <b>Celastraceae</b> )	Tshikela mutshi (tshiluba)	Shrub	NR	<a href="http://www.plantes-botanique">www.plantes-botanique</a>
34	<i>Millettia drastica</i> Welw. ex Baker ( <b>Fabaceae</b> )	Kabukola (tshiluba) Kajita (tshiluba) Selemonji (tshiluba)	Tree	AR	Mulamba, 2017
35	<i>Morinda lucida</i> Benth. ( <b>Rubiaceae</b> )	Mulalambua (tshiluba), Nkusu mutshi (tshiluba)	Tree	NR	Mulamba 2017 <a href="http://www.ethnopharmacologia.org">www.ethnopharmacologia.org</a> ,
36	<i>Morinda morindoides</i> (Baker) Milne-Redh. ( <b>Rubiaceae</b> )	Nkongabululu (tshiluba) Kongobololo (lingala)	Liana	NR	Mulamba 2017
37	<i>Nicotiana tabacum</i> L. ( <b>Solanaceae</b> )	Mfuanka (tshiluba), Makanya (tshiluba), Kahonda (tshiluba)	Grass	NR	Konda et al., 2015
38	<i>Ocimum canum</i> Sims (Lamiaceae)	Disulu (tshiluba)	Grass	NR	<a href="http://www.ipni.org">www.ipni.org</a>
39	<i>Ocimum basilicum</i> L. ( <b>Lamiaceae</b> )	Luenyi (tshiluba)	Grass	NR	Mulamba, 2017; <a href="http://www.prota4u.org">www.prota4u.org</a>
40	<i>Parinari mobola</i> Oliv. ( <b>Chrysobalanaceae</b> )	Muhenga (tshiluba)	Shrub	NR	Mulamba, 2017; <a href="http://www.prota4u.org">www.prota4u.org</a>
41	<i>Phyllanthus muellerianus</i> (Kuntze) Exell ( <b>Phyllanthaceae</b> )	Luangandindi (tshiluba) Mupetwalupe (bemba), Lweya manfume (luba) Mulembalemba (luba)	Shrub	AR	Wa Ilunga, 2017, Kalunga, 2021 ; Mbayo et al., 2016
42	<i>Psorospermum febrifugum</i> Spach ( <b>Hypericaceae</b> )	Mpandanganga (tshiluba), Mukuta (luba), Kafifi (tabwa)	Shrub	NR	Wa Ilunga, 2017
43	<i>Pterocarpus tinctorius</i> Welw. ( <b>Fabaceae</b> )	Mutondo mashi (tshiluba)	Tree	NR	Mulamba, 2017
44	<i>Rauwolfia vomitoria</i> Wennberg. ( <b>Apocynaceae</b> )	Kampondampanda (tshiluba)	Shrub	AR	Konda et al., 2015
45	<i>Ricinus cummunis</i> L. ( <b>Euphorbiaceae</b> )	Mudiantondu (tshiluba), Dikulakula (tshiluba), Mumono (bemba), Tutu njimba (luba)	Shrub	NR	Wa Ilunga, 2017 ; Mbayo, 2019
46	<i>Sida rhombifolia</i> L. ( <b>Malvaceae</b> )	Mumvumvu (tshiluba)	Grass	NR	Mulamba, 2017
47	<i>Solanum aculeastrum</i> Jacq ( <b>Solanaceae</b> )	Nkulanyi (tshiluba)	Shrub	NR	<a href="http://www.tramil.net">www.tramil.net</a>
48	<i>Sonchus oleraceus</i> L. ( <b>Asteraceae</b> )	Mbata wa ku mukuna (tshiluba)	Grass	NR	<a href="http://www.rhs.org.uk">www.rhs.org.uk</a> ; <a href="http://www.tropicos.org">www.tropicos.org</a>
49	<i>Sterculia quinqueloba</i> K.Scum. (Malvaceae)	Muabi (tshiluba)	Tree	NR	<a href="http://www.ipni.org">www.ipni.org</a>
50	<i>Tithonia diversiflora</i> (Hemsl.) A.Gray ( <b>Asteraceae</b> )	Tshilulunkunzu (tshiluba)	Grass	NR	<a href="http://www.ipni.org">www.ipni.org</a>
51	<i>Treculia africana</i> Decne. ex Trecul. ( <b>Moraceae</b> )	Dizaya (tshiluba), Dizeya (tshiluba) Diseya (tshiluba)	Tree	NR	<a href="http://www.ipni.org">www.ipni.org</a>
52	<i>Trema orientalis</i> (L.) Blume ( <b>Ulmaceae</b> )	Kandungandunga (tshiluba), Kandunga mashika (tshiluba), Mukesu (tshiluba)	Shrub	NR	Mulamba, 2017
53	<i>Trichilia prieureana</i> A. Juss. ( <b>Fabaceae</b> )	Mukobakoba (tshiluba)	Tree	NR	<a href="http://www.ipni.org">www.ipni.org</a>
54	<i>Uraria picta</i> (Jacq.) DC. ( <b>Fabaceae</b> )	Mukila wa kabundi (tshiluba)	Shrub	NR	Konda et al., 2015
55	<i>Vernonia amygdalina</i> Défile. Cent. Pl. ( <b>Asteraceae</b> )	Musumbululu (tshiluba), Mtukuta (swahili)	Shrub	NR	Mulamba, 2017; <a href="http://www.plantnet-project.org">www.plantnet-project.org</a>
56	<i>Vitex welwitschii</i> Gürke ( <b>Verbenaceae</b> )	Dihodi dia ditu (tshiluba)	Tree	NR	Konda, 2015 ; <a href="http://www.ipni.org">www.ipni.org</a>

Legend: RA: Remedy as Antituberculosis; AR: Already Reported; NR: Not Reported; MC: morphological characteristics

The fifty-six plant species identified after the ethnobotanical survey belong to 25 botanical families (Table 1; Figure 2). Of these 25 families, nine were represented by at least three species: Rubiaceae (6 species, 10.7%), Asteraceae (6 species, 10.7%), Phyllanthaceae (5 species, 8.9%), Fabaceae (4 species, 7.2%), Caesalpiniaceae (3 species, 5.3%), Euphorbiaceae (3 species, 5.3%), Lamiaceae (3 species, 5.3%), Poaceae (3 species, 5.3%), and Solanaceae (3 species, 5.3%). Four other families were represented by two species each (3.6%): Apocynaceae, Hypericaceae, Malvaceae, and Verbenaceae. The remaining families were represented by one species each (1.8%): Amaranthaceae, Bixaceae, Caricaceae, Celastraceae, Chrysobalanaceae, Costaceae, Meliaceae, Mimosaceae, Moraceae, Nyctaginaceae, Ulmaceae, and Vitaceae.

The plant species inventoried are classified into four morphological groups: grasses (37.50%), shrubs (37.50%), trees (21.42%), and lianas (3.57%). The majority of these species (85.71%) have not been reported as plants used in

the treatment of tuberculosis, while 14.28% are known as anti-tuberculosis plants. The species known to be used in the treatment of tuberculosis are:

*Bauhinia thonningii* Schumach (Caesalpiniaceae), *Bridelia ferruginea* Benth (Phyllanthaceae), *Carica papaya* L. (Caricaceae), *Cassia occidentalis* L. (Caesalpiniaceae), *Harungana madagascariensis* Lam ex Poir (Hypericaceae), *Millettia drastica* Welw. ex Baker (Fabaceae), *Phyllanthus muellerianus* (Kuntze) Exell (Phyllanthaceae), and *Rauvolfia vomitoria* Wennberg (Apocynaceae).

#### Ethnobotanical Information

The medicinal uses of the plants inventoried during the survey conducted in Mbujimayi, in relation to the plant part, symptoms or pathologies treated, method of preparation, and administration of medicinal recipes, are listed in Table 2 below.

**Table 2:**  
Medicinal plants used for tuberculosis treatment in Mbujimayi

N°	Plant species (Family)	PU	Pathologies/Symptoms	Method of preparation and administration	T <sub>H</sub>
1	<i>Albizia adianthifolia</i> (Schum.) W.F. Wight (Fabaceae)	L	Fever, convulsions, headache, cough and constipation	Decoction, drink: 2G/d, 21d	T13, T4, T1, T43
		SB	Colic, diarrhea and fatigue	Decoction, drink: 1G/d, 7d	
		RB	Rash Intestinal worms, cough and jaundice	Pounding, local application: until it disappears Decoction, drink: 1G/d, 20d	
2	<i>Alchornea cordifolia</i> (Schum. et Thonn.) Müll. Arg. (Euphorbiaceae)	L	Cough, fever, headache and fatigue	Maceration, drink: 1/4G x 2/d, 10d	T13, T45
3	<i>Antidesma membranaceum</i> Mull. Arg. (Phyllanthaceae)	L	Fever, diarrhea, cough and constipation	Decoction, drink: 1/2G/d, 20d	T7, T35
		SB	Fever and convulsions	Decoction, drink: 1/3G/d, 10d	
		RB	Fever, diarrhea, cough and constipation	Maceration, drink: 1/4G x2/d, 14d	
4	<i>Aspilia kotschyi</i> (Sch. Bip. ex Hochst.) Oliv. (Asteraceae)	L	Cough, fever, headache and fatigue	Maceration, drink: 1/4G x2/d, 10d	T36, T33
5	<i>Bauhinia thonningii</i> Schumach. (Caesalpiniaceae)	L	Cough, fever, headache and fatigue	Decoction, drink: 1/4G x2/d, 21d	T24, T44
		S	Convulsions, fever, and intestinal worms	Decoction, drink: 1G/d, 21d	
6	<i>Bixa orellana</i> L. (Bixaceae)	L	Cough, vomiting, intestinal worms, and fever	Maceration, drink: 1G/d, 5d	T38, T41
		SB	Cough and fever	Decoction, drink: 1/2G/d, 5d	
		RB	Diarrhea, vomiting, intestinal worms, and fever	Decoction, drink: 1G/d, 3d	
7	<i>Boerhavia diffusa</i> L. (Nyctaginaceae)	L	Appendicitis, convulsion, asthma, cough and dysmenorrhea.	Decoction, drink: 1G/d	T36, T34
		S	Diarrhea, constipation, and gastritis.	Decoction, drink, 2G/d, 5d	
		R	Cough, constipation and stomach aches	Decoction, drink: 1G/d 7d	
8	<i>Borreria ocymoides</i> (Burm.F.) DC. (Rubiaceae)	WP	Mycoses	Pounding, application on the attacked part: x1/d	T29, T33
			Cough and intestinal worms	Maceration, drink: 1/3G x2/d, 10d	
9	<i>Bridelia atroviridis</i> Müll. Arg. (Phyllanthaceae)	L	Mycoses	Pounding, local application x1/d	T3, T33
			Fever, cough and constipation	Decoction, drink: 1/2G/d, 3weeks	

	SB	Mycoses and vaginal infections	Decoction, wash and vaginal bath x1/d	
	RB	Mycoses	Pounding + calcination of pilat, application to the infected part x1/d until healing	
10	<i>Bridelia ferruginea</i> Benth. (Phyllanthaceae)	L <b>Fever, intestinal worms and diarrhea</b>	Decoction, drink: 1/2G/d, 5d	T39, T41
	S	Intestinal worms, stomach aches and diarrhea	Decoction, drink: 1/4G x2/d, 10d	
	R	Diarrhea and intestinal worms	Decoction, drink: 1/4G/d, 5d	
11	<i>Carica papaya</i> L. (Caricaceae)	L <b>Fever, convulsions, headache</b> and intestinal worms	Decoction, drink: 2G/d, 10d	T39, T34
	SB	Intestinal worms and <b>fatigue</b>	Decoction, drink: 1G/d, 5d	
	RB	<b>Fever, constipation and headache</b>	Decoction, drink: 2G/d, 7d	
12	<i>Cassia occidentalis</i> L. (Caesalpiniaceae)	WP Intestinal worms, jaundice, <b>vomiting, fatigue, headache, anemia, and fever</b> Wound	Decoction, drink: 1/2G/d, 21d Pounding, local application	T34
13	<i>Cassia siamea</i> Lam. (Caesalpiniaceae)	L Amoebiasis, <b>fever, convulsions</b> and jaundice	Decoction, drink: 1G/d, 21d	T3, T29, T23
	SB	Amoebiasis and <b>cough</b> Mange	Decoction, drink: 1G/d, 15d Pounding, local application until total disappearance	
	RB	<b>Fever, cough, vomiting, fatigue and anemia</b>	Decoction, drink : 1½G/d, 20d	
14	<i>Catharanthus roseus</i> (L.) G.Don (Apocynaceae)	L Intestinal worms, <b>fever and convulsions</b>	Decoction, drink: 1/2G/d, 7d	T7, T36
	S	Diarrhea, <b>constipation, and fever</b>	Decoction, drink 1G/d, 5d	
	R	<b>Fever, constipation and fatigue</b>	Decoction, drink, 1G/d, 14d	
15	<i>Celosia trigyna</i> L. (Amaranthaceae)	WP <b>Cough, fever</b> , intestinal worms and diarrhea Mycoses and redness on children's skin	Maceration, drink: 1/2G x3/d, 7d Pounding+calcination, topical application, nightly	T4, T32
16	<i>Cenchrus biflorus</i> Roxb. (Poaceae)	WP <b>Fever, convulsions</b> , jaundice, <b>fatigue</b> , intestinal worms, and sexually transmitted infections	Decoction, drink: 2G/d, 2weeks	T14, T39
17	<i>Coleus hybridus</i> Hort. (Lamiaceae)	L <b>Fever</b> , diarrhea, gonorrhoea, diabetes, and intestinal worms	Decoction, drink, 1G/d, 30d	T44, T32
	S	Intestinal worms, <b>fever and convulsions</b>	Decoction, drink: 1/2G/d, 7d	
	R	Vaginal infections	Decoction, vaginal bath x1/d	
18	<i>Costus afer</i> Ker Gawl. (Costaceae)	L <b>Fever</b> , diarrhea and <b>cough</b>	Decoction, drink: 1/4G/d, 14d	T39, T45
	S	<b>Fever and convulsions</b>	Decoction, drink: 1/3G/d, 10d	
	R	<b>Fever</b> , diarrhea, <b>cough and constipation</b>	Maceration, drink: 1/4G x2/d, 14d	
19	<i>Crassocephalum bojeri</i> (DC.) Robyns (Asteraceae)	L <b>Headache, fever</b> , body aches and <b>vomiting</b>	Infusion, drink: 1/2G x2/d, 14d	T45
20	<i>Craterispermum cerinanthum</i> Hiern (Rubiaceae)	L Vaginal infections	Maceration, vaginal bath x 2/d, several days	T29, T44
	S	<b>Headache</b>	Maceration, drink: 1/3G x2/d, 14d	
	R	Epilepsy, meningitis, and <b>convulsions</b>	Decoction, drink: 1G x 3/d, 30d	
21	<i>Crossopteryx febrifuga</i> (G.Don.) Benth. (Rubiaceae)	L <b>Fever</b> , intestinal worms and <b>constipation</b>	Decoction, drink: 1/3G/d, 7d	T10, T33, T32
	SB	<b>Fever</b> , intestinal worms, <b>cough</b> and stomachache	Decoction, drink: 1/2G/d, 7d	
	RB	Diarrhea, intestinal worms, and stomach aches	Decoction, drink: 1/4G x 2/d, 5d	
22	<i>Cymbopogon citratus</i> (D.C.) Stapf (Poaceae)	WP <b>Convulsions, fatigue, constipation, fever</b> , diabetes, and stomach aches Hernia	Decoction, drink: 1G/d, 21d Infusion, drink: 1G/d, 30d	
23	<i>Cymbopogon densiflorus</i> (Steud.) Stapf. (Poaceae)	L <b>Fever, constipation and fatigue</b>	Decoction, drink: 1G/d, 2weeks	T12, T39
	S	<b>Fever, convulsions and cough</b>	Decoction, drink: 1G/d, 1week	
	R	<b>Fever, constipation, fatigue</b> , intestinal worms and stomachache	Decoction, drink: 1/2G/d, 2weeks	
24	<i>Cyphostemma vanmeelii</i> (Lawalrée) Wild& R.B. Drumm) (Vitaceae)	L <b>Convulsions, fever</b> , hepatitis and asthma	Decoction, drink: 1G/d, 2weeks	T2, T9, T31
	S	<b>Fever</b> , hepatitis, asthma, diarrhea, and intestinal worms	Decoction, drink: 1/2G/d, 2weeks	
	R	<b>Convulsions, headache, fever</b> , hepatitis, and asthma	Decoction, drink: 1G/d, 1week	
25	<i>Emilia fosbergii</i> Nicholson (Asteraceae)	WP Wound and abscess <b>Cough</b> and asthma	Drying + pounding, local application 1x/ until completely removed Decoction: drink 1/3G x2/d, 30d	T17, T11, T25, T34, T1
26	<i>Entada abyssinica</i> Steud. Ex A. Rich. (Mimosaceae)	L Intestinal worms and <b>headache</b> Mycoses	Decoction, drink: 1/4G x2/d, 1week Pounding, local application x1/d preferably in	T11, T42

				the evening	
		S	<b>Headache and fatigue</b>	Maceration, drink: 1/4V/d, 10d	
		R	Diabetes Mycoses	Maceration, drink: 1/4G/d, 10 d Pounding, local application x1/d preferably in the evening	
27	<i>Gaertnera parvipaniculata</i> E.M.A.Petit ( <b>Rubiaceae</b> )	L	Asthma and <b>cough</b>  Vaginal infections	Pounding + calcination, fumigation: 2x/d, several days Maceration, vaginal bath: x2/day, several days	T20, T35
		SB	Diabetes	Maceration, drink: ½G x2/d, 30d	
		RB	Epilepsy, meningitis, <b>convulsions</b>	Decoction, drink: 1G x3/d, 30d	
28	<i>Harungana madagascariensis</i> Lam ex Poir ( <b>Hypericaceae</b> )	L	<b>Cough, fever, headache, fatigue and constipation</b>	Decoction, drink: 1G x3/d, 14d	T44, T40
29	<i>Hymenocardia acida</i> Tul ( <b>Phyllanthaceae</b> )	L	Hemorrhoids, abscess and mycoses <b>Headache, fever and constipation</b>	Pounding, local application x1/d until total disappearance Decoction, drink: ½G x3/d, 14d	T38
		SB	<b>Cough, fever, headache, fatigue and stomachache</b>	Decoction, drink: 1/4G x2/d, 21d	
		RB	<b>Convulsions, fever and diabetes</b> Hernia	Decoction, drink: 1G/d, 21d Decoction, drink: 1G/d, 30d	
30	<i>Jatropha curcas</i> L. ( <b>Euphorbiaceae</b> )	L	Abdominal pain, <b>fever and fatigue</b>	Decoction, drink: 1G/d, 14d	T23, T15, T40
31	<i>Kalaharia uncinata</i> ( <b>Verbenaceae</b> )	L	Hemorrhoids and mycoses  <b>Headache and fever</b>	Pounding, local application x1/d until total disappearance Decoction, drink: 1/2G x3/d, 14d	T18, T37
32	<i>Lycopersicon cerasiforme</i> Donal ( <b>Solanaceae</b> )	L	<b>Headache, fatigue, fever, abdominal pain and diarrhea</b>	Decoction, drink: 1G/d, 14d	T28, T37
		S	<b>Headache, fever and abdominal pain</b>	Decoction, drink: 1G/d, 7d	
		R	<b>Headache and abdominal pain</b>	Decoction, drink: 1G/d, 5d	
33	<i>Maytenus senegalensis</i> (Lam.) Exell ( <b>Celastraceae</b> )	L	<b>Fever, diarrhea, cough and constipation</b>	Decoction, drink: ½G/d for 20 days	
		S	<b>Fever and convulsions</b>	Decoction, drink: 1/3G/d, 10d	T1
		R	<b>Fever, diarrhea, cough and constipation</b>	Decoction, drink: 1/2G/d for 20d	
34	<i>Millettia drastica</i> Welw. ex Baker ( <b>Fabaceae</b> )	L	<b>Headache, fever, cough and jaundice</b>	Infusion, drink, 1G/d, 12d; Steam bath x1/d, 10d	
		SB	Body aches, colic, hiccups, and <b>fatigue</b>	Maceration, drink: 1G/d, 6d	T24, T27
		RB	Colic and <b>convulsions</b> Haemorrhoids	Maceration, drink: 1G/d, 5d	
35	<i>Morinda lucida</i> Benth. ( <b>Rubiaceae</b> )	L	<b>Fever, constipation, headache, low back pain and body aches</b>	Maceration, drink: 1/2G/d for 25 days	T5, T7, T46
		SB	<b>Constipation, fatigue, fever, anorexia, intestinal worms and headaches</b>	Decoction, drink: 1/2G/d for 20d	
36	<i>Morinda morindoides</i> (Baker) Milne-Redh. ( <b>Rubiaceae</b> )	L	<b>Fever, dizziness, convulsions, headache, fatigue, diabetes and abdominal pain</b>	Decoction, drink: 1/2G/d, 20d	T29, T11, T41
37	<i>Nicotiana tabacum</i> L. ( <b>Solanaceae</b> )	WP	<b>Cough, fever and asthma</b>	Drying + fumigation, smoke extraction, x2/d	T6, T35
38	<i>Ocimum canum</i> Sims ( <b>Lamiaceae</b> )	WP	<b>Fever, cough, flu and constipation</b>	Decoction, drink: 1G x2/d, 15d	T44, T31
39	<i>Ocimum basilicum</i> L. ( <b>Lamiaceae</b> )	WP	<b>Fever, convulsion, headache, dizziness and cough</b>	Maceration, drink: 1G/d, 7d	T35, T40
40	<i>Parinari mobola</i> Oliv. ( <b>Chrysobalanaceae</b> )	L	<b>Cough, fever, headache and fatigue</b>	Decoction, drink: 1/4G x2/d, 21d	
		S	<b>Convulsions, fever, and intestinal worms</b>	Decoction, drink: 1G/d, 21d	T1, T37
41	<i>Phyllanthus muellerianus</i> (Kuntze) Exell ( <b>Phyllanthaceae</b> )	L	Malaria, <b>constipation and fatigue</b>	Decoction, drink, 1G/d, 14d	T34, T39
		S	Haemorrhoids. <b>Fever and diarrhea</b>	Pounding, sitz bath, x2/d Decoction, drink: ½G x3/d, 14d	
		R	Diarrhea	Decoction, drink 1G/d, 7d	
42	<i>Psorospermum febrifugum</i> Spach ( <b>Hypericaceae</b> )	L	Hemorrhoids, abscesses and mycoses <b>Headache and fever</b>	Pounding, local application x1/d until total disappearance Decoction, drink: ½G x3/d, 14d	T5, T28, T42
		SB	Abscess, mycoses and redness on the skin	Drying + pounding, local application x1/d until total disappearance	
		RB	<b>Headache, fever and constipation</b>	Decoction, drink: ½G x2/d, 14d	
43	<i>Pterocarpus tinctorius</i> Welw. ( <b>Rubiaceae</b> )	L	<b>Anemia, fever, jaundice, fatigue and</b>	Maceration, drink: 2G/d, 21d	T31, T42

(Fabaceae)		constipation			
	SB	<b>Fever</b> Jaundice	Infusion, drink 1/2G/d, 20d Decoction, steam bath: every evening until the jaundice disappears		
	RB	<b>Fever and jaundice</b>	Infusion, drink: 1G/d, 15d		
44	<i>Rauwolfia vomitoria</i> Wennberg. (Apocynaceae)	L	Gonorrhoea  Convulsion	Maceration, vaginal bath: every evening for 1 hour for 30 days Decoction, drink: 1/2G shortly before the crisis	T39, T 41
	SB	<b>Cough, fever and fatigue</b>	Decoction, drink: 1G/d for 30d		
	RB	Intestinal worms, <b>cough</b> and <b>fever</b>	Decoction, drink: 1/2G/d, 10d		
45	<i>Ricinus cummunis</i> L. (Euphorbiaceae)	L	<b>Fever and headache</b>	Decoction, drink: 1/2G/d, 10d	T34
46	<i>Sida rhombifolia</i> L. (Malvaceae)	WP	Hemorrhoids, rashes, abscess, and mycoses <b>Headache, fever, constipation, convulsions,</b> colic, and jaundice	Pounding, local application x1/d until total disappearance Decoction, drink: ½G x3/d, one week	T15, T18, T31
47	<i>Solanum aculeastrum</i> Jacq (Solanaceae)	WP	<b>Cough, fever, headache and fatigue</b>	Decoction, drink: ½G x2/d, 21 d	T43, T36
48	<i>Sonchus oleraceus</i> L.(Asteraceae)	WP	<b>Cough, fever, fatigue, vomiting,</b> and intestinal worms	Decoction, drink: 1/2G/d pour 1 week	T13, T39, T46
49	<i>Sterculia quinqueloba</i> K.Scum. (Malvaceae)	L	<b>Fever</b> and intestinal worms	Maceration, drink: 1/3G/d, 5d	T12, T39
	SB	Intestinal worms, <b>fatigue</b> and stomachaches	Decoction, drink: 1/2G/d, 7d		
	RB	Diarrhea, intestinal worms, and stomachaches	Decoction, drink: 1/4G x2/d, 5d		
50	<i>Tithonia diversiflora</i> (Hemsl.) A.Gray (Asteraceae)	L	Mycoses	Pounding, local application: x1/d	T23, T11, T45, T34
	S	<b>Fever and cough</b>	Decoction, drink: 1/2G/d, 7 d		
	R	Intestinal worms and diarrhea	Decoction, drink: 1/4G/day, 10d		
51	<i>Treulia africana</i> Decne. ex Trecul. (Moraceae)	L	Wound and abscess	Pounding, application to infected part, x1/d	
	SB	<b>Fever, cough, vomiting,</b> and stomachache	Decoction, drink: 1/3G, x3/d, 15 d		T2, T11
	RB	<b>Fever, cough</b> and stomachache	Decoction, drink: 1/4G, x2/d, 20 d		
52	<i>Trema orientalis</i> (L.) Blume (Ulmaceae)	L	Abdominal pain and <b>fever</b>	Decoction, drink: 1/2G/d, 12 d	
	SB	Abdominal pain, lower back pain, and <b>fever</b>	Decoction, drink: 1G/d, 21 d		T27
	RB	Stomachache, intestinal worms, <b>fever,</b> <b>cough, vomiting and constipation</b>	Decoction, drink: 1G/d, 21 d		
53	<i>Trichilia prieureana</i> A. Juss. (Meliaceae)	L	Mycoses <b>Fever, cough and constipation</b>	Pounding, local application x2 / d	T3, T35
	SB	Mycoses and vaginal infections.	Decoction, drink: 1/2G/day, 3 weeks		
	RB	<b>Fever, cough and constipation.</b>	Decoction, wash and vaginal bath x1/day		
54	<i>Uraria picta</i> (Jacq.) DC. (Fabaceae)	L	<b>Cough, fever</b> and asthma	Drying + pounding, smoke extraction: x2/d	T14, T27
55	<i>Vernonia amygdalina</i> Délile. Cent. Pl. (Asteraceae)	L	Diarrhea, abdominal pain, colic, <b>anemia,</b> and <b>headache</b>	Decoction, drink: 1G x2/d, 7 d	T39
	SB	Diarrhea, <b>anemia,</b> and <b>headache</b>	Decoction, drink: 1G x2/d, 7 d		
	RB	Diarrhea, dysmenorrhoea, intestinal worms, <b>anemia,</b> and <b>headache</b>	Decoction, drink: 1G x2/d, 7d		
56	<i>Vitex welwitschii</i> Gürke (Verbenaceae)	L	Intestinal worms and <b>headache</b> Mycoses	Decoction, drink: 1/4G/d, 14d	T19
	S	<b>Headache and fatigue</b>	Pounding, local application: x1/d		

**Legend:** Leaves: L; Stems: S; Stems Bark: SB; Roots: R; Roots Bark: RB; Whole Plant: WP; d: day; G: glass; TH: resource person; d: day

**Figure 2:**  
Botanical Families of the Identified Plant Species



The fifty-six plant species identified (Table 1) each treat at least two pathologies and/or symptoms. *Albizia adianthifolia* and *Hymenocardia acida* treat 11 pathologies and/or symptoms each. Three species (*Senna siamea*, *Milletia drastica*, and *Sida rhombifolia*) each treat 10 pathologies or symptoms. *Boerhaavia diffusa* treats nine pathologies or symptoms, while *Morinda lucida*, *Morinda*

*morindoides*, *Senna occidentalis*, and *Trema orientalis* each Six species treat seven pathologies or symptoms each: *Coleus hybridus*, *Cymbopogon citratus*, *Cymbopogon densiflorus*, *Gaertnera parvipaniculata*, *Psorospermum febrifugum*, and *Vernonia amygdalina*. Nine species (*Bauhinia thonningii*, *Carica papaya*, *Catharanthus roseus*, *Cenchrus biflorus*, *Crossopteryx febrifuga*, *Parinari mobola*, *Phyllanthus muellerianus*, *Rauwolfia vomitoria*, and *Treculia africana*) each treat six pathologies.

Sixteen species treat five pathologies each: *Antidesma membranaceum*, *Bixa orellana*, *Bridelia atroviridis*, *Costus afer*, *Craterispermum cerinanthum*, *Cyphostemma vanmeelii*, *Entada abyssinica*, *Harungana madagascariensis*, *Lycopersicum cerasiforme*, *Maytenus senegalensis*, *Ocimum basilicum*, *Pterocarpus tinctorius*, *Sonchus oleraceus*, *Sterculia quinqueloba*, *Tithonia diversifolia*, and *Trichilia prioreana*.

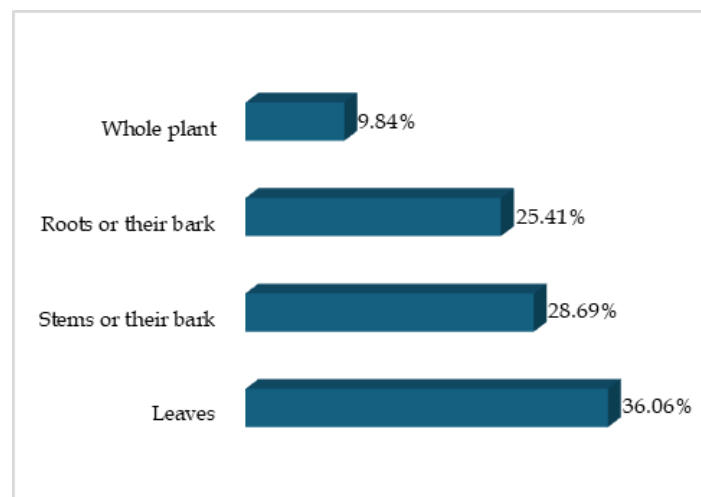
The nine species that treat four pathologies each are: *Alchornea cordifolia*, *Aspilia kotschyi*, *Bridelia ferruginea*, *Crassocephalum bojeri*, *Emilia forsbergii*, *Kalaharia uncinata*, *Ocimum canum*, *Solanum acculeastrum*, and *Vitex welwitschii*. The five species that treat three pathologies each are: *Borreria ocymoides*, *Celosia trigyna*, *Jathropha curcas*, *Nicotiana tabacum*, and *Uraria picta*. Finally, *Ricinus communis* treats two pathologies.

The information collected indicates that these species (Table 1) generally treat approximately 40 pathologies and/or symptoms. These conditions include sexually transmitted infections (e.g., gonorrhoea), hereditary diseases (e.g., diabetes), diseases caused by bacteria, fungi, or viruses (e.g., diarrhoea, mycoses, hepatitis), gynaecological diseases (e.g., dysmenorrhoea), and neurological dysfunction (e.g., epilepsy).

#### Parts of Plants Used and Preparation Methods

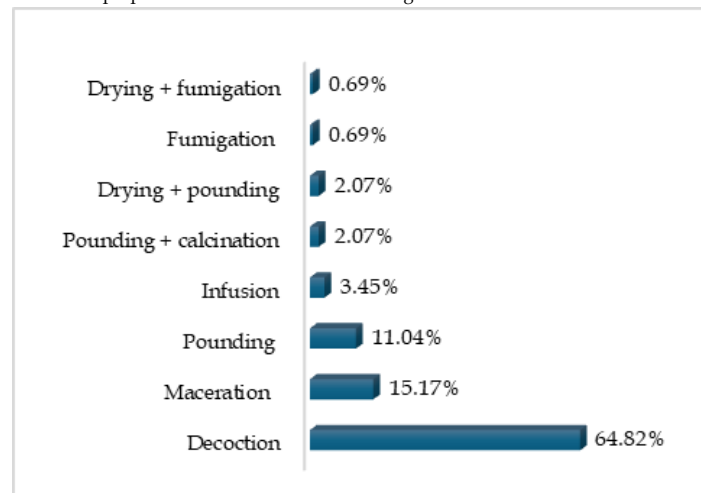
The plant organs most commonly used in the treatment of tuberculosis (Figure 3) are the leaves (36.06%), stems or their bark (28.69%), and roots or their bark (25.41%). The whole plant is used in 9.84% of cases.

**Figure 3:**  
Plant parts used in the treatment of tuberculosis



Decoction is the most common preparation method (64.82%) (Figure 4), followed by maceration (15.17%), pounding (11.04%), and infusion (3.45%). Other methods include pounding plus calcination (2.07%), drying plus pounding (2.07%), fumigation (0.69%), and drying plus fumigation (0.69%).

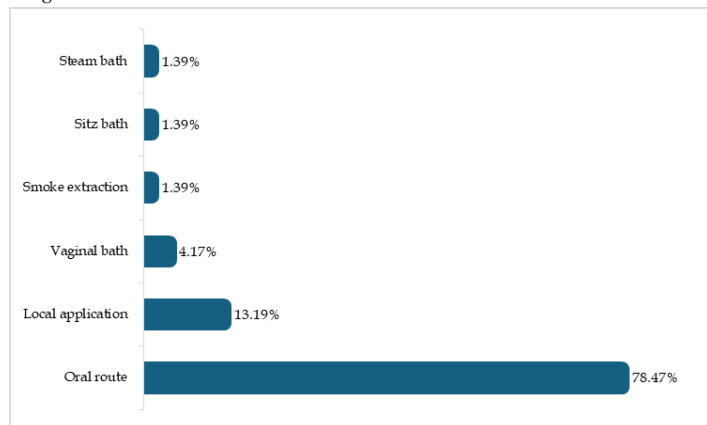
**Figure 4:**  
Method of preparation of remedies in the management of antituberculosis



#### Drug Administration Methods

For drug administration (Figure 5), the oral route, in the form of a drink, is the most commonly used method (78.47%). Other methods include local application (13.19%), vaginal bath (4.17%), smoke extraction (1.39%), sitz bath (1.39%), and steam bath (1.39%).

**Figure 5:**  
Drug administration methods



## DISCUSSION

This study has created a database of plants used to treat tuberculosis (TB) or its symptoms in Mbuji mayi and the surrounding areas. These plants are a vital resource for people living in rural areas due to their socio-cultural and socio-economic importance. They also possess undeniable medicinal properties (Effoe et al., 2020), making them a precious alternative to conventional medicines, which are relatively expensive for the people in the study area. Plants contain thousands of chemical substances that deserve attention after their chemical characterisation, coupled with in-depth in vitro, in silico, and in vivo biological studies (Taylor et al., 2001).

Plants play a critical role in rural areas of the Democratic Republic of the Congo (DRC), where hospitals and medicines are often unavailable. Medicinal plants are used for nutritional, curative, and preventive purposes. Their use prevents the spread of disease, and some plants are even more effective than pharmaceutical products, as demonstrated by biological tests on plant extracts or natural products derived from plants. However, synthetic drugs are standardised compared to traditional recipes. Synthetic drugs are produced under strict standard operating procedures, ensuring consistent quality across batches. In contrast, traditional recipes often lack standardisation, leading to potential overdosing or underdosing. Overdosing may result in poisoning, with serious consequences that could even lead to death. Thus, while plants offer solutions to public health challenges in rural areas, they can also pose risks of toxicity (Ngubane et al., 2024).

This study is based on interviews conducted with resource persons who use plants to treat various pathologies and symptoms, particularly those of TB. It highlights that Rubiaceae and Asteraceae families dominate the plant species identified. Ethnobotanical surveys in the DRC, however, typically indicate that Fabaceae and Euphorbiaceae are among the most utilised plant families in traditional medicine (Kahumba, 2000; Lumbu et al., 2005; Muya et al., 2014; Ngoy, 2013; Mulamba, 2017; Kanangila, 2018; Many et al., 2019; Many, 2020; Mbuyi, 2022). Similar findings have been reported in other African countries, including Cameroon (Titanji et al., 2008), Namibia (Cheikhyoussef et al., 2011), and Zimbabwe (Ngarivhume et al., 2015). However, these patterns are not universal. In Morocco, for example, Lamiaceae are the most frequently cited family, as shown in a study of 57 plants used to treat respiratory diseases (Fatima et al., 2015). Another Moroccan study by Eddouks et al. (2020) of 48 species reputed to be anti-tuberculosis also identified Lamiaceae as the leading family.

The 56 plant species identified as being anti-tuberculosis (Figure 6) are classified into four categories: shrubs (21 species, 37.50%), grasses (21 species, 37.50%), trees (12 species, 21.43%), and lianas (2 species, 3.57%). In this study, grasses and shrubs are equally represented as the primary plants used to treat TB in this region of the DRC. Herbs were similarly found to dominate (40%) in a study on medicinal plants used by traditional healers to treat malaria in Kenya (Muthaura et al., 2015). Herbs have also been reported as the most utilised plants in similar studies, such as those conducted in South Kivu (Kasali et al., 2014; Many et al., 2019) and Mbuji mayi, Kasai Oriental (Mulamba, 2017), as well as in Namibia (Cheikhyoussef et al., 2011).

Clinical diagnosis of tuberculosis involves symptoms such as a cough lasting more than two weeks, chest pain, weight loss, shortness of breath, intermittent fever, night sweats, loss of appetite, fatigue, malaise, and sputum production with or without traces of blood. Biomedicine utilises clinical and paraclinical diagnostic methods, with diagnostic tools unavailable in traditional medicine. However, there are overlaps between the symptoms considered in traditional medicine and those used in clinical diagnoses. In some cases, patients turn to

traditional practitioners after experiencing failure with biological treatments, often for a variety of reasons (Bezawit et al., 2024).

Tuberculosis (TB) as a pathology was not well understood by the resource persons consulted in this study. Notably, it was not explicitly mentioned as a disease by the interviewees. To address this challenge, the study focused on identifying related symptoms. This observation aligns with findings in the literature, as reported in countries such as Malawi (Brouwer et al., 1998), Malaysia (Mohamad et al., 2010), Uganda (Bunalema et al., 2014), and Senegal (Diop, 2018). Similar observations have been documented by researchers investigating other pathologies, including Mulamba (2017) in Mbuji-Mayi, Manyá (2020) in Bukavu and Uvira, and Mbuyi (2022) in Lubumbashi, particularly in relation to malaria treatment in the Democratic Republic of the Congo (DRC).

Traditional healers used symptoms such as fever, headache, convulsions, disorientation, coughing, fatigue, and constipation to diagnose TB. However, as Alemu (2024) notes, these symptoms are not exclusive to TB and may overlap with other conditions such as cancer, COVID-19, asthma, or pneumonia (Give et al., 2024). This overlap complicates accurate diagnosis and differentiation.

Given the above, we consider the plants studied to be anti-tuberculosis based on their ability to address TB symptoms. In traditional medicine, plants are known to treat multiple ailments rather than a single pathology (Kalunga, 2021; Kumwimba et al., 2017; Mbuyi, 2022; Mulamba, 2017; Muya et al., 2014; Ngoy, 2013). The species studied in this research addressed nine TB-related symptoms identified by respondents, with six symptoms reported most frequently: fever (31.62%), cough (16.60%), headache (13.83%), constipation (11.07%), fatigue (11.07%), and convulsions (9.49%), collectively accounting for 93.68% of the symptoms. Other less frequently reported symptoms included vomiting (3.16%), anemia (2.3%), and dizziness (0.79%).

As traditional healers often rely on symptom-based treatment, it is understandable that some patients return with recurring symptoms and complaints. This situation likely occurs when resource persons unknowingly treat TB

cases co-occurring with HIV/AIDS or vice versa, relying solely on symptomatology.

In ethnobotanical surveys, leaves, roots (or bark), and stems (or bark) are commonly used plant parts for preparing traditional medicines, largely due to their year-round availability, unlike other parts such as flowers, fruits, and seeds (Eddouks et al., 2020; Zofou et al., 2011). In this study, leaves were identified as the most commonly used plant part because they are accessible throughout the year and can be harvested with minimal effort. Recipes using other plant parts, such as flowers, fruits, and seeds, were not recorded, even though such practices have been noted in other studies (Mbayo, 2019; Mbayo et al., 2016; Mulamba, 2017; Wa Ilunga, 2017). The choice of plant parts also depends on the specific pathology being treated and their empirically observed effectiveness in traditional healing practices. Each traditional healer adopts a unique approach, informed by their experience and methods, to achieve the desired results.

The preparation methods for medicinal recipes identified in this study were predominantly decoction (64.82%), followed by maceration (15.17%) and pounding (11.04%) (Figure 4). Similar findings have been reported in studies conducted in the DRC and other countries, where decoction is the primary method. For instance, decoction accounted for 53.5% in Ngoy's (2013) study, 47.3% in Mulamba's (2017) study, 59.09% in Wa Ilunga's (2017) study, 61% in Manyá's (2020) study, 41.5% in Kalunga's (2021) study, and 65.3% in Mbuyi's (2022) study, all in the DRC. Additionally, Muthaura et al. (2015) reported 52.8% in Kenya, while Eddouks et al. (2020) observed 30% in Morocco.

The advantage of decoction in the preparation of medicines lies in its ability to rapidly extract all active substances soluble in aqueous media. This technique also facilitates the elimination of hydrocyanic acid released by cyanogenic glycosides, as well as other volatile and/or heat-labile toxic substances (Kahumba, 2000; Kalunga, 2021). Additionally, it contributes to the removal of useful volatile products, such as essential oils contained in plant species, which are substances with several therapeutic virtues (Kalunga, 2021; Zengin et al., 2018).

In terms of administering medicinal recipes, the oral route (78.47% in the present study) is the most widely used method (Figure 7) in both modern and traditional medicine. This finding is supported by almost all studies of a similar nature (Eddouks et al., 2020; Kalunga, 2021; Many, 2020; Mbuyi, 2022).

Of the 56 plant species studied, only eight (14%) are documented as anti-tuberculosis drugs in the literature. These include *Bauhinia thonningii*, *Bridelia ferruginea*, *Carica papaya*, *Cassia occidentalis*, *Harungana madagascariensis*, *Millettia drastica*, *Phyllanthus muellerianus*, and *Rauvolfia vomitoria* (Bakari, 2015; Kalunga, 2021; Konda et al., 2015; Mbayo, 2019; Mpiana et al., 2008; Muya et al., 2014; Nwandjo, 2005; Oyedeji et al., 2013; Wa Ilunga, 2017). Conversely, the other 48 species (86%) are plants used in traditional medicine to treat various pathologies, indications, and symptoms, including those of tuberculosis.

In light of the survey results on anti-tuberculosis plants in Mbujimayi and its surroundings, several questions arise: What type of tuberculosis are traditional practitioners treating—pulmonary or extra-pulmonary? What are the active compounds in the plants used? Do these compounds act independently or in synergy? Is the dosage of the medicinal recipes adequate, and for how long? Since tuberculosis is highly contagious, how do traditional healers protect themselves?

The survey findings highlight numerous issues. For instance, without a paraclinical diagnosis, do traditional healers genuinely treat tuberculosis? What specific kind of tuberculosis—pulmonary or extra-pulmonary—are they addressing? What are the active compounds in the plants, and do they function synergistically? Is the dosage of the pharmaceutical recipes adequate, and what is the appropriate treatment duration? Furthermore, how do traditional healers safeguard themselves against this highly dangerous disease? Traditional medicine currently provides no concrete answers to these questions, based on the survey results.

Ethnopharmacological, biochemical, and phytochemical studies are essential to evaluate the efficacy of plant extracts and the natural substances they contain. Such studies are also needed to assess their toxicity and

cytotoxic potential, as well as to characterize bioactive compounds, thereby enhancing the value of traditional medicine and demonstrating the efficacy of the treatments used (Obakiro et al., 2020). This approach typically leads to the development of improved traditional medicines (ITMs) and the identification and characterization of bioactive compounds, which may, in turn, result in the discovery of new drugs. Identifying bioactive plants among those inventoried during this study will help demonstrate the efficacy of traditional anti-tuberculosis treatments used in Mbujimayi and its surroundings.

## CONCLUSION

Following the ethnobotanical study, 56 plant species were identified using both scientific and vernacular names. These species were classified into 25 families, with the most common being Phyllanthaceae, Asteraceae, Rubiaceae, and Fabaceae. Due to limited knowledge of tuberculosis (TB) among some traditional practitioners, treatments for the disease—which primarily presents with symptoms such as fever, cough, headache, constipation, exhaustion, and convulsions—have often been mistaken for treatments of its individual symptoms. The plant parts used for TB treatment include leaves, stems or their bark, and roots or bark. The main methods for preparing traditional anti-tuberculosis medicines are decoction, maceration, and infusion, with nearly all remedies administered as beverages.

The findings of this survey indicate that some people in Mbujimayi are knowledgeable about plants used to treat tuberculosis. To validate the effectiveness of these traditional treatments, comprehensive ethnopharmacological, biochemical, and phytochemical studies will be conducted *in vitro*, *in vivo*, and *in silico* on the plants identified to establish their scientific merit and confirm their traditional use. This constitutes the next phase of the project.

## Authors' Contributions

1. **Muamba Malangu Lambert:** Study design, survey, data acquisition and analysis, draft production.
2. **Mbayo Kitambala Marsi:** Data processing, manuscript writing.
3. **Wa Ilunga Numbi Evodie, Mbuyu Ilunga Eddy, Kanda Kabeya Justin, Dikala Otete François, Munakongo Ebalantshim Daniel, Maloba Mwinensenge James:** Fieldwork and additional data collection.

4. **Muyumba Nonga Welcome, Ngoy Kihuya Eddy, Kalonda Mutombo Emery, Mbuyi Kalonji Serge, Many Tsheko, Kalunga Muya Richard:** Data processing and draft revision.
5. **Kalanda Kankenza Léonard:** Plant species identification.
6. **Lumbu Simbi Jean-Baptiste:** Study supervision and manuscript correction.

**Ethics Approval:** Not applicable.

**Conflicts of Interest:** None declared.

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