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# Medicinal plants used by women from Agnalazaha littoral forest (Southeastern Madagascar)

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## Abstract

**Background:** The country of Madagascar is renowned for its high level of biodiversity and endemism, as well as the overwhelming pressures and threats placed on the natural resources by a growing population and climate change. Traditional medicine plays an important role in the daily lives of the Malagasy for various reasons including limited access to healthcare, limited markets and traditional values. The objective of this study was to assess the modern utitilization of the Agnalazaha Forest by the local population in Mahabo-Mananivo, Madagascar, for medicinal plants used by women, and to establish a list of medicinal plants used by women sourced from Agnalazaha Forest.

**Methods:** Ethnobotanical studies were conducted over a period of five months in 2010 to determine the diversity of medicinal plants used by women in the commune of Mahabo-Mananivo. In all, 498 people were interviewed, both male and female ranging age from 15 to over 60 years old.

**Results:** 152 medicinal plants used by local people were collected during the ethnobotanical studies. Among the recorded species, eight native species are widely used by women. These species are known for their therapeutic properties in treating placental apposition and complications during childbirth as well as tropical illnesses such as malaria, filariasis, and sexual diseases like gonorrhea and syphilis.

**Conclusions:** Littoral forests are rare ecosystems that are highly threatened on the island nation of Madagascar. Our investigation into the use of medicinal plants sourced from and around the Agnalazaha Forest by the women of Mahabo-Mananivo reinforces the need for this natural resource as a first line of health care for rural families.

**Keywords:** Medicinal plants, Madagascar, Littoral forest, Traditional medicine, Women's traditional knowledge

## Background

Traditional medicine is a term used to describe the use of natural resources, often in concert with ritual and spirituality, to prevent, treat and heal human diseases and ailments [1]. While the use of plant species for healing dates back further than the written record, with evidence the Neanderthals practiced plant medicine [2], it is still being used by many in our modern era. Eighty (80) percent of the world's population depends on traditional medicine for the treatment of pain [3]. And in developing countries such as Madagascar medicinal plants remain a primary source of medical care [4] especially in very remote areas or in case of limited health resources.

Medicinal plant use in Madagascar has the added concern of biodiversity loss, environmental degradation, and sustainability. The island nation of Madagascar separated from Africa some 170 million years and the Indian subcontinent nearly 88 million years ago and the isolated flora and fauna have evolved with a high degree of microendemism [5]. Current floristic calculations indicate Madagascar houses between 12,000 and 14,000

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vascular plant species, of which 90% are endemic [6] and 96% endemism in tree species [7]. However, the increasingly intense population growth has led to rapid deforestation as land is cleared for agricultural fields and for fuel [8]. Biodiversity loss, in general, has severe implications on environmental stability which in turn affects human health [9]. When biodiversity directly adds to the wellness of a community as a resource for medicine, biodiversity loss can have even deeper consequences as medicinal plant species are lost or are no longer available [10,11].

Within Madagascar, one of the most threatened ecosystems is the littoral forest [12]. Although the littoral forests of Madagascar once stretched 1600-km along the eastern coast as one single biological corridor, there is only 10% of the original forest remaining [13]. One such littoral forest, the Agnalazaha Forest, is located in the rural commune of Mahabo-Mananivo, 750 km southeast of the capitol city of Antananarivo. Approximately 72.3% of the flora of Agnalazaha is endemic to Madagascar [14].

The villages of Mahabo-Mananivo source timber and non-timber forest products from Agnalazaha Forest littoral forest. Furthermore, the community of Mahabo-Mananivo still practice and often prefers traditional medicine, especially for common diseases and infectious diseases [15]. As is the case with most familial systems, the first line of healthcare decisions and action is often administered by female household members [16]. The purpose of this study was to assess the modern utilization of this forest by the local population with a focus on the plants known and utilized by women in their everyday care giving. We focused on the women for this study while a study on the use of medicinal plants by men was carried out simultaneously. At times men were present during the interview process and would add information about plants used by women which we allowed.

## Methods

Research was coordinated by and supported in large part by the staff at the Missouri Botanical Garden Mahabo-Mananivo Conservation research site. Field research was conducted over a period of five months (January – May) in 2010 with three field trips to the community. A ten day preliminary exploration was used to become familiar with the community and introduce ourselves, make contact with local officials and present the topic of our research. A hired local guide acted as our translator, introduced us to interview prospects and coordinated interview schedules. Consent was given by the tribal leaders, local government officials and by each individual we interviewed.

### Study site

Agnalazaha Forest is located within the district of Farafangana, Atsimo Atsinanana region in southeastern Madagascar, in the Commune Rural Mahabo-Mananivo (Figure 1). The National Road 12, a paved highway connecting Farafangana and Vangaindrano borders the forest to the west while the Indian Ocean borders it to the east. It is between 47° 41′and 47° 45′ E, and 23° 09′and 23° 14′ S with an altitude of less than 50 m [14]. In 2003, it was measured that this coastal forest covered an area of 1,565 ha and represents approximately 17% land coverage of the rural area of the commune Mahabo-Mananivo. Agnalazaha Forest has the status of Forest Reserve under article number 129-SF/EF/CG since May 17, 1954, but has been under the management of the Missouri Botanical Garden (MBG) since 2002.

The southeast region of Madagascar is characterized as the eastern coastal plain and has a climate of high rainfall and high average temperature [17]. The Agnalazaha Forest experiences two seasons: the hot rainy season from December to April, and the cool season from May to November. The average annual rainfall in Agnalazaha Forest is 2,706 mm. The average annual temperature varies between 21°C - 24°C (69 °F – 75 °F). According to the bioclimatic division of Madagascar, this region belongs to the humid tropics and part of the humid warm bioclimatic type [18]. Agnalazaha Forest is classifed as a littoral forest, characterized by an open canopy and sandy soils [12], seasonally flooded wooded swamps, open marshes with *Nepenthes madagascariensis* and *Lepironia articulata*, savannas, remnants of secondary forest on lateritic soils and reforestation forests of *Eucalyptus robusta* and *Acacia mangeum*. There are 275 species of plants in Agnalazaha Forest [14] distributed within 188 genera and 82 families. The site contains species belonging to three endemic families, Asteropeiaceae (2 species), Sarcolaenaceae (6 species) and Sphaerosepalaceae (1 species). Furthermore, 199 species present in Agnalazaha Forest are determined to be endemic to Madagascar (72.3%).

An inventory of primates [19] conducted in Agnalazaha Forest identified four species of lemur all of which are considered to at least be threatened, including the critically endangered *Eulemur albocollaris* [20]. All are known to be hunted locally. A similar study identified seven species of endemic small mammals found in Agnalazaha Forest including *Pteropus rufus, Hemicentetes semispinosus, Setifer setosus and Tenrec caudatus, Hova oryzorictes*, all of which are also locally hunted [21].

### Surrounding community

Commune Rural Mahabo-Mananivo surrounds Agnalazaha Forest to the west, north and south. There are 6,998 residents according to the 2009 census. Mahabo-Mananivo is primarily comprised of residents identifying with the Antesaka ethnic group, while Antefasy, Merina and Betsileo members have migrated to this area as well. The municipality of Mahabo-Mananivo consists of ten fokontany surrounding the Agnalazaha Forest; Mahabo,

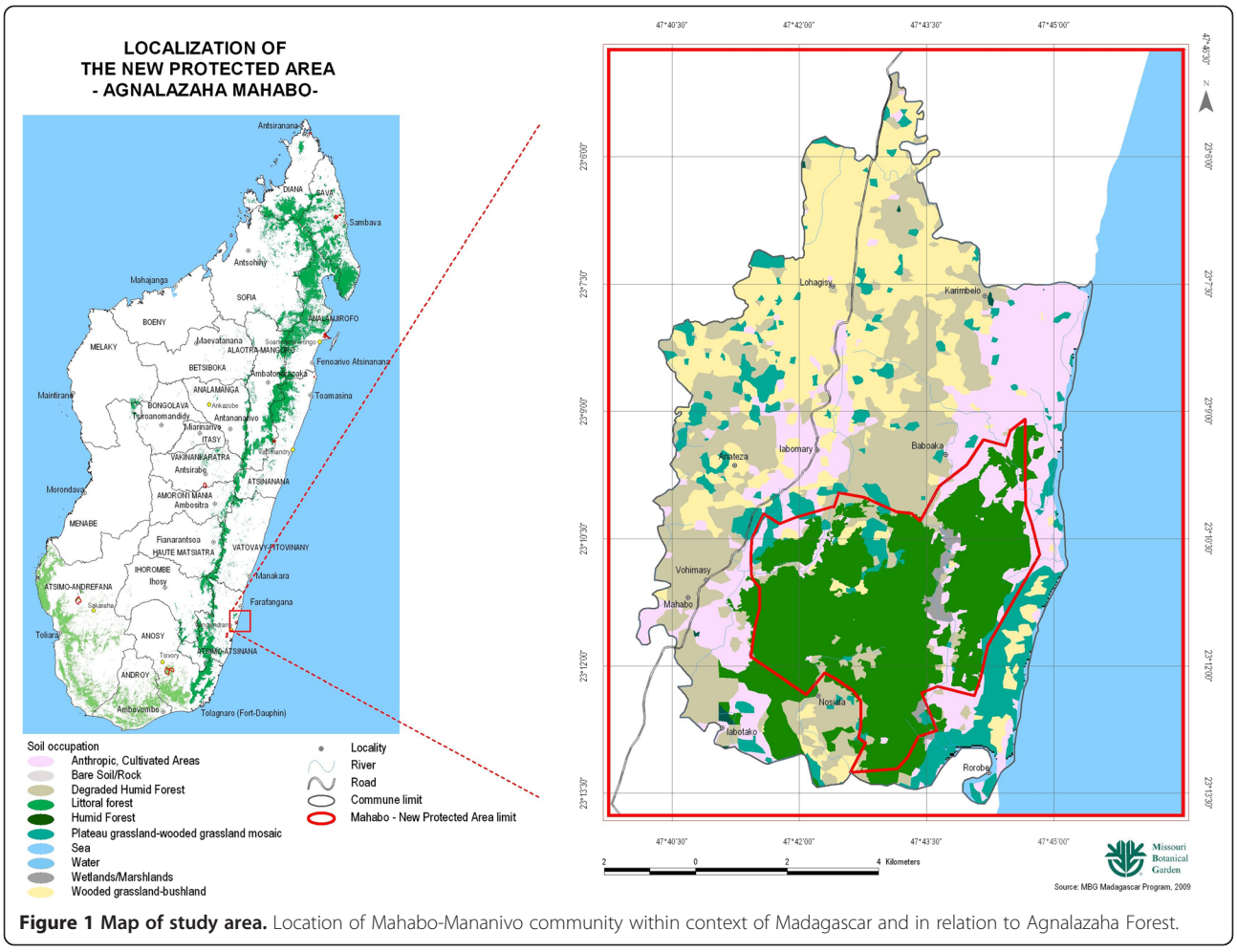


**Figure 1 Map of study area.** Location of Mahabo-Mananivo community within context of Madagascar and in relation to Agnalazaha Forest.

Vohimasy, Iabotako, Nosiala, Iambomary, Baboaka, Lohagisy, Karimbelo, Rorobe, and Agnateza. A "fokontany" is the smallest political distinction recognized by the government. It may compromise several small villages with an average 1,000 people [22]. Mahabo-Manaivo is primarily an agriculture economy. Approximately 99.74% of the population is farmers. Rice fields dominate the landscape with cassava, yams, and manihot as supplementary crops. Additional income is sought through handicraft production, largely basketry weaving. The most popular species used for basketry is *Lepironia articulate*, *Cyperus sp*, and *Pandanus sp*. Monthly income is less than 80,000 Ariary (approximately USD$35) for a majority of the population of Mahabo-Mananivo.

There is a relatively new community health center, built in 2009, in the fokontany Mahabo, located on Road 12. It has 2 rooms and accommodates one doctor and one nurse. However, a majority of the population of Mahabo-Mananivo relies on medicinal plants to cure common diseases. To this end, local people consult traditional healers called *ombiasy* to be treated with medicinal plants. *Ombiasy* can be distinguished into four different types of healers: *tromba* (spiritually possesed) healers, midwives, massage healers and premonition healers.

### Ethnobotanical surveys

The Agnalazaha Forest provides the local population with firewood, timber for home construction, non-timber products and medicinal plants. In order to identify medicinal plants known to be used by and for women in the rural commune of Mahabo-Mananivo, inquiries on the therapeutic use of plants were conducted primarily with women and female healers, although some men were interviewed as well. Due to time limitations, not all fokontany were included in the study. Fokontany were selected using the following criteria: (a) proximity to Agnalazaha Forest (b) Distance to the health center located in Mahabo (c) presence of female healers in the village. Fokontany closest to Agnalazaha Forest were given priority. Field visits to each fokontany selected were scheduled so that the villages furthest from the forest were visited first. The interviews were structured as semi-direct interviews with open questions

[23]. The interviews were conducted with both individuals and in group settings [24]. Interview questions were written with two different approaches, inquiry of plant specific use or through disease-specific and/or symptomatic description plant use. Questionnaires or survey forms were established, first on medicinal plants used by women and healers, then the socio-economic and cultural value for each species (Additional file 1).

Surveys focused on plants used in the treatment of common female diseases in the commune. They were conducted with traditional healers (*ombiasy*), birth attendants, women and men who know the medicinal plants used by and for women. The interviews were interspersed with forest walks with interview participants where species were identified by their vernacular names and photos were taken. Herbarium voucher were made and the identification of these species was then conducted in the national herbarium of Tsimbazaza (TAN).

## Results

### Demographic variables

In the community 498 people were surveyed, 301 (60.44%) were women and 197 (39.56%) were men and 90.56% of those interviewed responded that they utilize medicinal plants. Table 1 compares the number of those who utilize medicinal plants with those who do not use medicinal plants for each age group, level of schooling, marital status and income level.

People aged 40 to 49 years have the highest frequency of use of medicinal plants at 98.29%. This age group was followed by the 50 – 59 year old age bracket (96.15%), the 30 – 39 year old age bracket (94.59%), 60 years and older bracket (89.36%), the 20 – 29 years old bracket (86.91%) and finally the youngest bracket, 15 – 19 years old at 45.73%. We found that people at least 30 years old have increased knowledge in terms of medicinal plants, while lower knowledge levels occur in the younger age groups.

Furthermore, the data analysis shows that in the Commune of Mahabo-Mananavio, the majority of women (65.90%) who use were interviewed are illiterate, with 96.34% of them using medicinal plants. This high percentage is directly correlated with the fact that girls receive less education than boys. Persons with at least a primary school level of education made up 28% of our interviewees, and have a significant percentage of use of medicinal plants (82.52%), while those with secondary level of education (4.8% of our respondents) make little use of medicinal plants (66.53%). This percentage decreases again and becomes less significant for those with a university level education (33%).

Married people have a broad knowledge of medicinal plants with a percentage of 77.10%, while persons listed as single use plants at a frequency of 21.10%. Most of these

**Table 1 Demographic information of the ethnobotanical interviewees**

| | | Number of people interviewed | Percentage of total | Utilize medicinal plants (#) | Percentage of total | Do not utilize medicinal plants (#) | Percentage of total |
|---|---|---|---|---|---|---|---|
| **Gender** | Females | 301 | 60.44 | 280 | 93.02 | 21 | 6.98 |
| | Men | 197 | 39.56 | 171 | 86.8 | 26 | 13.2 |
| **Age group** | [15-19] | 35 | 7.03 | 16 | 45.73 | 19 | 54.27 |
| | [20–29] | 84 | 16.87 | 73 | 86.91 | 11 | 13.09 |
| | [30–39] | 111 | 22.29 | 105 | 94.59 | 6 | 5.41 |
| | [40–49] | 117 | 23.49 | 115 | 98.29 | 2 | 1.71 |
| | [50–59] | 104 | 20.88 | 100 | 96.15 | 4 | 3.85 |
| | [60 +] | 47 | 9.44 | 42 | 89.36 | 5 | 10.64 |
| **Level of** | Illiterate | 328 | 65.9 | 316 | 96.34 | 12 | 3.66 |
| **Education** | Primary | 143 | 28.7 | 118 | 82.52 | 25 | 17.48 |
| | Secondary | 24 | 4.8 | 16 | 66.53 | 8 | 33.47 |
| | University | 3 | 0.6 | 1 | 33.33 | 2 | 66.67 |
| **Marital status** | Single | 105 | 21.1 | 80 | 76.21 | 25 | 23.79 |
| | married | 384 | 77.1 | 368 | 95.83 | 16 | 4.17 |
| | widowed | 9 | 1.8 | 3 | 33.07 | 6 | 66.93 |
| **Household** | <80,000 | 371 | 74.5 | 349 | 94.07 | 22 | 5.93 |
| **Education (monthly income in Ariary)** | 80,000-160,000 | 123 | 24.7 | 99 | 80.49 | 24 | 19.51 |
| | >160,000 | 4 | 0.8 | 3 | 74.9 | 1 | 25.1 |

Comparison of age group, level of schooling, marital status and income level of the 498 interview respondents of Mahabo-Mananivo.

**Table 2 Species known to be medicinal by women in Mahabo-Mananivo**

| Family | Scientific name | Vernacular name | Part used | Disease treated | Distribution [6,25] |
|---|---|---|---|---|---|
| AMARANTHACEAE | Amaranthus sp | Anampatsa | bark | intestinal parasites | |
| AMARANTHACEAE | *Chenopodium ambrosioides* L. | Taimboritsiloza | Entire plant | Placental apposition - Parasites - Nosebleeds | Naturalized in Madagascar |
| ANACARDIACEAE | *Mangifera indica* L. | Manga | Bark Root | Evacuation of the placenta - Diarrhea - Hemorrhoid - Leucorrhoea - Dental Disease - Gonorrhea | Naturalized in Madagascar |
| ANACARDIACEAE | *Rhus taratana* (Baker) H. Perrier | Taranta | Leaf | Poisoning - Convulsions - Epilepsy - Stomach pain | Endemic to Madagascar |
| ANACARDIACEAE | *Sclerocarya birrea* (A. Rich.) Hochst. | Sakoa | Leaf | Venereal diseases - Sedative - Astringent - Spider Bite | Comoros, Africa |
| ANNONACEAE | *Annona reticulata* L. | Coeur de Boeuf | Leaf | Evacuation of the placenta | |
| ANNONACEAE | Annona sp. | Sarisoky | Leaf | Stomach pain | |
| APHLOIACEAE | *Aphloia theiformis* (Vahl) Benn. | Fandramana | Leaf, Bark | Evacuation of the placenta - Malaria - Tuberculosis - Sore throat - Heartburn | Comoros, Mascarenes, Seychelles, Africa |
| APOCYNACEAE | *Catharanthus roseus* (L.) G. Don | Vonenina | Entire plant, Root | Stomach pain - Pancreas pain - Cancer | Endemic to Madagascar |
| APOCYNACEAE | *Petchia erythrocarpa* (Vatke) Leeuwenb. | Hentona | Bark | Malaria | Comoros |
| APOCYNACEAE | *Petchia madagascariensis* (A. DC.) Leeuwenb. | Kabokala | Leaf | Insect bites | Endemic to Madagascar |
| APOCYNACEAE | *Voacanga thouarsii* Roem. & Schult. | Kaboky | Leaf- Latex - Roots - Bark-seeds | Evacuation of the placenta - Hypertension - Heart problems-wounds - Boils - Gonorrhea-Eczema - Scabies - Fungal Infections - Rheumatism - Stomach pain | Africa |
| AQUIFOLIACEAE | *Ilex mitis* (L.) Radlk. | Hazondrano | Leaf | Bad luck | Africa |
| ARACEAE | *Colocasia esculenta* (L.) Schott | Saonjo | Leaf | Evacuation of the placenta | Naturalized in Madagascar |
| ARACEAE | *Typhonodorum lindleyanum* Schott | Via | Leaf, heart | Evacuation of the placenta - Burn - hip problems | Comoros, Mascarenes, Africa |
| ARALIACEAE | *Schefflera longipedicellata* (Lecomte) Bernardi | Membolo - vatsila | | Epilepsy - Cold - Gonorrhea | Endemic to Madagascar |
| ARALIACEAE | *Schefflera sp.* | Memboloha | Leaf | Albumin - Worms - Plague - Evacuation of placenta | |
| ASCLEPIADACEAE | *Pentopetia* sp | Tandrokosy | Leaf, Stem | Eye disease - Jaundice - Gonorrhea | |
| ASPARAGACEAE | *Dracaena reflexa* Lam. | Hasina | Leaf - stem | Evacuation of the placenta - Malaria - Epilepsy | Mascarenes, Africa |
| ASPARAGACEAE | *Dracaena reflexa* var. *cernua* (Jacq.) Baker | Fananaraha | Leaf - stem | Placental apposition - Thinning | |
| ASPLENIACEAE | *Asplenium sp.* | Apanga malemy | Entire plant | gonorrhea | |
| ASTERACEAE | *Acanthospermum hispidum* DC. | Bakakely | Leaf | Diarrhea | Africa |
| ASTERACEAE | *Ageratum conyzoides* L. | Ananjazavavy | flowers | Stomach pain | Naturalized in Madagascar |
| ASTERACEAE | *Emilia sp.* | Kitsitsona | Leaf | Eczema - Ulcer | |

**Table 2 Species known to be medicinal by women in Mahabo-Mananivo** *(Continued)*

| | | | | | |
|---|---|---|---|---|---|
| ASTERACEAE | *Emilia* sp. | Tsiotsio | Leaf | Apposition of the placenta | |
| ASTERACEAE | *Helichrysum sp.* | Aferombohitra | Leaf | Scabies | |
| ASTERACEAE | *Mimosa pudica* L. | Ramoria | Leaf | Hepatitis - Albumin | Naturalized in Madagascar |
| ASTERACEAE | *Psiadia altissima* (DC.) Drake | Dinga | Leaf | Wounds | Endemic to Madagascar |
| ASTERACEAE | *Sigesbeckia orientalis* L. | Tsindaory | Leaf | Wounds | Naturalized in Madagascar |
| ASTERACEAE | *Vernonia appendiculata* Less. | Asotry | Leaf | tooth decay | Endemic to Madagascar |
| ASTERACEAE | *Vernonia exserta* Baker | Seva | Leaf | Chickenpox - Parasites | Endemic to Madagascar |
| ASTERACEAE | *Vernoniopsis caudata* (Drake) Humbert | Maranitry atoraky | Bark | Chickenpox | Endemic to Madagascar |
| ASTEROPEIACEAE | *Asteropeia micraster* Hallier f. | Manoky mena | Bark, Leaf | Evacuation of the placenta - Diarrhea - Fatigue - Mumps | Endemic to Madagascar |
| ASTEROPEIACEAE | *Asteropeia multiflora* Thouars | Manoky fotsy | Leaf Bark | Evacuation of the placenta - Malaria - Parasites - Dental Disease - Gonorrhea Fatigue | Endemic to Madagascar |
| BIGNONIACEAE | *Phyllarthron madagascariense* K. Schum. | Resiriky/ Zahana | Leaf | Malaria - Breastfeeding-Cough - disease of the hip | Endemic to Madagascar |
| BROMELIACEAE | *Ananas comosus* (L.) Merr. | Mananasy | | Intestinal parasites - diarrhea | Tropics |
| BURSERACEAE | *Protium sp* | Ambihitry | Bark | Abscess - poisoning | |
| CALOHPYLLACEAE | *Calophyllum inophyllum* L. | Vintanina | | trigeminal neuralgia | Comoros, Africa, New World |
| CANELLACEAE | *Cinnamosma fragrans* Baill. | Kanely | Bark | Cold - intestinal parasite - Headaches - Against poison | Endemic to Madagascar |
| CANELLACEAE | *Cinnamosma madagascariensis* Danguy | Fotsinana | Bark, leaf | Evacuation of the placenta - Malaria - Hepatitis - Epilepsy - Intoxication - Dysentery - Carrie dental | Endemic to Madagascar |
| CANNABACEAE | *Cannabis sativa* L. | Rongony | Leaf | Liver disease | |
| CARICACEAE | *Carica papaya* L. | Paza | Leaf, Fruit, seeds, roots | Breastfeeding - Headaches - Wounds - Menstrual Pain - Stomach: Ulcer Constipation - Indigestion - Boil - Cysticercosis - Toxoplasmosis - Cough - Yellow Fever - Tooth Decay | Tropics |
| COMBRETACEAE | *Terminalia catappa* L. | Atafa | Leaf | Ovarian cycle disruption - Albumin - Tension - Stomach pain | Madagascar, Comoros, Seychelles, Africa |
| CONNARACEAE | *Agelaea pentagyna* (Lam.) Baill. | Rangahtsara | Bark | Gonorrhea - Aphrodisiac - Stomach ache | Comoros, Mascarenes, Africa |
| CONVOLVULACEAE | *Ipomoea batatas* (L.) Lam. | Vomanga | Leaf | Pregnancy - Evacuation of the placenta - Insect stings | Naturalized in Madagascar |
| CRASSULACEAE | *Kalanchoe prolifera* (Bowie ex Hook.) Hamet | Silafafa | Leaf | Asthma - Cough - Rheumatism | Endemic to Madagascar |
| CUCURBITACEAE | *Cucurbita maxima* Duchesne | Voatavo | Leaf | Fever - colic | Naturalized in Madagascar |
| CYPERACEAE | *Cyperus papyrus* subsp. *madagascariensis* (Willd.) Kük. | Zozoro | | Difficulty after childbirth - painful spasms | |
| CYPERACEAE | | Ahibita | | Evacuation of placenta-Malaria - Tuberculosis | |

**Table 2 Species known to be medicinal by women in Mahabo-Mananivo** *(Continued)*

| | | | | | |
|---|---|---|---|---|---|
| | *Pycreus mundtii* Cherm. | | Entire plant | | Mascarenes, Africa, New World |
| EBENACEAE | *Diospyros sp* | Hazominty | Leaf | Malaria | |
| ERICACEAE | *Agauria salicifolia* (Comm. ex Lam.) Hook. f. ex Oliv. | Haronga-panihy | Leaf | Scabies (Adult) - Wounds - Ulcers | Mascarenes, Africa |
| ERICACEAE | *Erica sp.* | Anjavidy | Leaf Stem leaves | Evacuation of placenta-Pneumonia - Syphilis | |
| ERYTHROXYLACEAE | *Erythroxylum ferrugineum* Cav. | Menahihy | Bark Leaf | Evacuation of the placenta - Diarrhea - Anemia | Endemic to Madagascar |
| ERYTHROXYLACEAE | *Erythroxylum gerrardii* Baker | Fanjoana | Leaf Bark | Yellow fever - Epilepsy | Africa |
| EUPHORBIACEAE | *Croton noronhae* Baill. | Tsiavadika | Bark-Leaf | Placental apposition - Malaria - Cough | Endemic to Madagascar |
| EUPHORBIACEAE | *Euphorbia hirta* L. | Jean Robert | Entire plant | Gonorrhea - Dysentery - Albumin | Naturalized in Madagascar |
| EUPHORBIACEAE | *Jatropha curcas* L. | Savoa | Leaf Latex | Evacuation of placenta Asthma - Dental Disease - Pneumonia | Naturalized in Madagascar |
| EUPHORBIACEAE | *Macaranga oblongifolia* Baill. | Mokarana | Leaf | Malaria - Diarrhea | Endemic to Madagascar |
| EUPHORBIACEAE | *Macaranga sp* | Mokarana | Leaf | Diarrhea | |
| EUPHORBIACEAE | *Manihot utilissima* Pohl | Kazaha | Leaf | Gonorrhea - painful spasms - Pneumonia - Boil | |
| EUPHORBIACEAE | *Suregada boiviniana* Baill. | Lelangana | Leaf | Placental apposition - Dysentery - Epilepsy-Malaria | Endemic to Madagascar |
| FABACEAE | *Albizia gummifera* (J.F. Gmel.) C.A. Sm. | Volomborona | Leaf | Fatigue - Cough | Africa |
| FABACEAE | *Cajanus cajan* (L.) Huth | Ambatry | Leaf | Evacuation of the placenta - Tension | Naturalized in Madagascar |
| FABACEAE | *Chamaecrista mimosoides* (L.) Greene | Quatre épingles | Leaf | Thrush - Schistosomiasis | |
| FABACEAE | *Intsia bijuga* (Colebr.) Kuntze | Hintsy | Leaf | Placental apposition - Cough | Mascarenes, Africa |
| FABACEAE | *Mimosa pudica* L. | Ramoria | | Pelvic pain - Nervousness - Diuretic | Naturalized in Madagascar |
| FABACEAE | *Senna alata* (L.) Roxb. | Quatre épingles | Leaf | Hypertension | Naturalized in Madagascar |
| GENTIANACEAE | *Tachiadenus carinatus* (Desr.) Griseb. | Malanilava | Entire plant | Diarrhea | Endemic to Madagascar |
| GLEICHENIACEAE | *Sticherus flagellaris* (Bory ex Willd.) Ching | Ringotra | Leaf | Diarrhea - Measles - Vomiting - Coughing | Mascarenes, Comoros |
| HYPERICACEAE | *Harungana madagascariensis* Lam. ex Poir. | Harongana | Bud Leaf | Gonorrhea - heart disease - Albumin - Asthma - Boil-Diarrhea | Comoros, Mascarenes, Africa |
| ICACINACEAE | *Cassinopsis madagascariensis* Baill. | Valotry | Leaf - Bark | Cough - Itching - Syphilis | Endemic to Madagascar |
| LAMIACEAE | *Ocimum gratissimum* L. | Romba be | Leaf | Placental apposition - Asthma - Albumin - Headache - Dental Disease | Comoros, Mascarenes, Seychelles, Africa, Asia |

**Table 2 Species known to be medicinal by women in Mahabo-Mananivo** *(Continued)*

| | | | | | |
|---|---|---|---|---|---|
| LAMIACEAE | *Salvia coccinea* Buc'hoz ex Etl. | Romba madinika | Leaf | parasites | Naturalized in Madagascar |
| LAURACEAE | *Persea americana* Mill. | Zavoka | Leaf | Diarrhea - Apposition of placental - Cough | Naturalized in Madagascar |
| LECYTHIDACEAE | *Barringtonia racemosa* (L.) Spreng. | Fotatry | Leaf | Placental apposition - Scabies - Tetanus | Comoros, Australiasia, Africa |
| LILIACEAE | *Asparagus simulans* Baker | Ahitsifantatry | Entire plant | Epilepsy - Stomach pain | Endemic to Madagascar |
| LOMARIOPSIDACEAE | *Nephrolepis cordifolia* (L.) C. Presl | Mitsisiloha | Entire plant | Malaria | Mascarenes, Australasia, Seychelle, Afria, Asia, New World |
| LORANTHACEAE | *Bakerella sp* | Velomiato | Entire plant | Convulsion - Cough - Boil | |
| LYCOPODIACEAE | *Lycopodiella cernua* (L.) Pic. Serm. | Tongotsokina | Entire plant | Asthma - Epilepsy - Pelvic Pain - Gonorrhea - Cough - Hypertension | Mascarenes, Africa, Asia, New World |
| LYCOPODIACEAE | *Lycopodium clavatum* L. | Dito | Leaf | Pregnant - Placental apposition - Gonorrhea - Filariasis - Malaria | Comoros, Mascarenes, Africa |
| MELASTOMACEAE | *Clidemia hirta* (L.) D. Don | Voatrotrokala | Leaf | Wounds | Naturalized in Madagascar |
| MELASTOMACEAE | *Dichaetanthera sp* | Felabarika | Leaf | diarrhea | |
| MELASTOMACEAE | *Medinilla* | Takasina | | Cough | |
| MELIACEAE | *Melia azedarach* L. | Voandelaka | Leaf | Fatigue | Naturalized in Madagascar |
| MENIPERMACEAE | *Burasaia australis* Scott-Elliot | Sompatry | Leaf | Intoxication - Convulsion - Dental Disease - Malaria - Medicinal plant magic | Endemic to Madagascar |
| MOLLUGINACEAE | *Mollugo nudicaulis* Lam. | Aferotany | Entire plant | Malaria - Albumin - Convulsion - Cough - Diarrhea - Diarrhea - Blood loss - Scabies | Australasia, Africa, New World |
| MONIMIACEAE | *Tambourissa castri-delphinii* Cavaco | Amborabe | Leaf | Placental apposition - Dysentery | Endemic to Madagascar |
| MONIMIACEAE | *Tambourissa parvifolia* Baker | Ambora | Leaf | Filariasis - Loss of blood | Endemic to Madagascar |
| MORACEAE | *Artocarpus altilis* (Parkinson) Fosberg | Soanambo | Leaf | Diarrhea | |
| MORACEAE | *Ficus polita* subsp. *polita* | Mandresy | Leaf | Placental apposition - bilious - Gonorrhea - Syphilis | |
| MORACEAE | *Ficus reflexa* Thunb. | Laza | Leaf | Pelvic pain - Gonorrhea | Comoros, Mascarenes, Seychelles |
| MUSACEAE | *Musa* × *paradisiaca* L. | Akondro | Leaf - fruit | Placental apposition - Diabetes - Prevents tooth decay - Diarrhea - Wounds | Naturalized in Madagascar |
| MYRICACEAE | *Morella spathulata* (Mirb.) Verdc. & Polhill | Hazosiay | Leaf | Placental apposition - Malaria - Cough - Stomach Pain - Dental Disease- Injury | Africa |
| MYRISTICACEAE | *Brochoneura acuminata* (Lam.) Warb. | Raraha | Leaf | Injury - Scabies - Abscess | Endemic to Madagascar |
| MYRTACEAE | *Melaleuca* | Kininy bonaky | Leaf | Placental apposition - Cold | Naturalized in Madagascar |
| MYRTACEAE | *Psidium cattleyanum* Sabine | Angavombazaha | Leaf | Diarrhea | Naturalized in Madagascar |

**Table 2 Species known to be medicinal by women in Mahabo-Mananivo** *(Continued)*

| | | | | | |
|---|---|---|---|---|---|
| MYRTACEAE | *Psidium guajava* L. | Angavogasy | Leaf | Malaria - Colic stomach - diarrhea - dysentery | Naturalized in Madagascar |
| MYRTACEAE | *Psidium guajava* L. | Angavofotsy | Leafs Roots | Diarrhea - Vomiting Boil | Naturalized in Madagascar |
| MYRTACEAE | *Syzygium aromaticum* (L.) Merr. & L.M. Perry | Jirofo | Leaf | Placental apposition - Dental Disease - Malaria | |
| MYRTACEAE | *Syzygium bernieri* (Drake) Labat & G. E. Schatz | Rotry | Bark-Leaf | Placental apposition - diarrhea - Dentistry Diseases - Scabies | Endemic to Madagascar |
| MYRTACEAE | *Syzygium emirnense* (Baker) Labat & G.E. Schatz | Rotry | Bark-Leaf | Placental apposition - Dentistry Diseases - Scabies | Mascarenes |
| NEPENTHACEAE | *Nepenthes madagascariensis* Poir. | Kapilanomba | Entire plantEau dans l'urne | Adhesion of placental-malaria-Albumin - Filariasis - Gonorrhea Syphilis-ear disease | Endemic to Madagascar |
| NYMPHEACEAE | *Nymphaea nouchali* Burm. f. | Tatamo | Tubers | Hemorrhoids - Pelvic Pain | Comoros, Mascarenes, Africa, Asia |
| OLACACEAE | *Olax emirnensis* Baker | Soazanahary | Leaf | Placental apposition - Malaria - Hepatitis - Epilepsy - Self-defense against witchcraft - Dysentery - Fatigue - Medicinal plant magic | Endemic to Madagascar |
| OPHIOGLOSSACEAE | *Ophioglossum* L. | Tsipanga | Leaf | Childbirth | |
| ORCHIDACEAE | *Angraecum sp.* | Valily | Entire plant | fortifying | |
| PANDANACEAE | *Pandanus sp* | Vakoana | Leaf | Fatigue - Impotence | |
| PASSIFLORACEAE | *Passiflora edulis* Sims | Garana | Leaf | Tension - Parasites | naturalized in Madagascar |
| PHYLLANTHACEAE | *Phyllanthus sp* | Masombero | Leaf | Apposition of the placenta | |
| PHYSENACEAE | *Physena madagascariensis* Thouars ex Tul. | Resojo | Bark | Sore throat - Anemia - Against poison | Endemic to Madagascar |
| PIPERACEAE | *Piper nigrum* L. | Poivre | Seeds | Dental disease - Poultice - Joint pain | |
| PITTOSPORACEAE | *Pittosporum verticillatum* Bojer | Memboloha | Leaf- Bark | Malaria - Adhesion of placental | Endemic to Madagascar |
| POACEAE | *Cymbopogon citratus* (DC.) Stapf | Veromanitra | Entire plant | Fever | Australasia/Pacific, Africa, Asia, New World |
| POACEAE | *Cynodon dactylon* (L.) Pers. | Kindresy | Entire plant | Albumin - Malaria - Liver Disease - Menstrual Pain - Laxative | Australasia, Africa, New World |
| POACEAE | *Eleusine indica* (L.) Gaertn. | Tsipihipihina | Entire plant | Stomach pain | Africa, Asia, New World |
| POACEAE | *Hyparrhenia rufa* (Nees) Stapf | Verofehana | Entire plant | Epilepsy - Cracks skin of the feet | Africa, Asia, New World |
| POACEAE | *Imperata cylindrica* (L.) Raeusch. | Tenina | Leaf | Intoxication - Gonorrhea - Pneumonia - Tonsillitis - Measles - Tension | Naturalized in Madagascar |
| POACEAE | *Oryza sativa L.* | Vary | Bud | birth | cultivated in Madagascar |
| POACEAE | *Panicum maximum* Jacq. | Ahitry | Leafs | Wounds | Madagascar, Africa, New World |
| POACEAE | *Sporobolus africanus* (Poir.) Robyns & Tournay | Ahitry | Entire plant | Allergy | Australasia, Africa, New World |
| POACEAE | *Zea mays* L. | Katsaka | Barbe | gonorrhea | |

**Table 2 Species known to be medicinal by women in Mahabo-Mananivo** *(Continued)*

| | | | | | |
|---|---|---|---|---|---|
| | | | | | cultivated in Madagascar |
| POLYGONACEAE | *Persicaria senegalensis* (Meisn.) Soják | Fotsimbarinako | Root | Malaria | Naturalized in Madagascar |
| RUBIACEAE | *Canthium sp.* | Fotsikahitry | Leaf | Epilepsy | |
| RUBIACEAE | *Coffea sp.* | Kafe | Leaf | Malaria | |
| RUBIACEAE | *Danais cernua* Baker | Fangalalemy | Leaf Bark | Syphilis - Tooth Decay | Endemic to Madagascar |
| RUBIACEAE | *Paederia foetida* L. | Ahimembo | Leaf | Evacuation of the placenta - Headaches | |
| RUBIACEAE | *Psychotria sp* | Sariloa | Leaf | diarrhea | |
| RUTACEAE | *Cedrelopsis grevei* Baill. | Hafatraina | Leaf Bark | Stomachaches - Acne | Endemic to Madagascar |
| RUTACEAE | *Citrus aurantium* L. | Voasary makirana | Fruit | Cough - Malaria | Naturalized in Madagascar |
| RUTACEAE | *Citrus sinensis* (L.) Osbeck | Voangy gasy | Leaf | Evacuation of placenta-Malaria | |
| SALICACEAE | *Homalium axillare* (Lam.) Benth. | Fotsiakara | Bark | burns | Endemic to Madagascar |
| SALICACEAE | *Scolopia sp* | Hazofotsy | Bark | Rheumatism | |
| SAPINDACEAE | *Litchi chinensis* Sonn. | Letchis | Leaf | diarrhea | cultivated in Madagascar |
| SARCOLAENACEAE | *Leptolaena pauciflora* Baker | Fatra | Bark | Syphilis | Endemic to Madagascar |
| SARCOLAENACEAE | *Sarcolaena multiflora* Thouars | Hela | Leaf | Evacuation of placenta | Endemic to Madagascar |
| SCHIZACACEAE | *Lygodium lanceolatum* Desv. | Sofin'akanga | Leaf | Pancrea pain - Gonorrhea - Tension - Evacuation of placenta | Native to Madagascar |
| SIMARUBACEAE | *Quassia sp.* | Rembiky | Leaf | Aphrodisiac | |
| SMILACEAE | *Smilax anceps* Willd. | Roindambo | Leaf | Convulsion - Pregnancy - Fatigue - Boil | Comoros, Mascarenes, Africa |
| SOLANACEAE | *Capsicum annuum* L. | Sakaipilo | Fruit | Rheumatism - Pain | Naturalized in Madagascar |
| SOLANACEAE | *Datura inoxia* Mill. | Ramiary | Leaf | Asthma - Calming | Naturalized in Madagascar |
| SOLANACEAE | *Nicotiana tabacum* L. | Paraky | Leaf | Nosebleed | Naturalized in Madagascar |
| SOLANACEAE | *Solanum erythracanthum* Bojer ex Dunal | Angivy | Fruit | Cough | Endemic to Madagascar |
| STILBACEAE | *Nuxia capitata* Baker | Valanirana | Leaf | Cough - Tonic - Tapeworm | Endemic to Madagascar |
| STRELITZIACEAE | *Ravenala madagascariensis* Sonn. | Ravinala | Leaf | Tension | Endemic to Madagascar |
| TACCACEAE | *Tacca leontopetaloides* (L.) Kuntze | Tavolo | Tuber | Malnutrition | Naturalized in Madagascar |
| THYMELACEAE | *Gnidia danguyana* Leandri | Avoha | Leaf | Bleeding - Parasites | Endemic to Madagascar |
| ULMACEAE | *Trema orientalis* (L.) Blume | Andrarezina / Vakoky | Leaf | Evacuation of the placenta - Dental Disease | Africa |
| VACCINACEAE | *Vaccinium* sp. | Voakaramy | Leaf | Anemia - Diabetes | |

**Table 2 Species known to be medicinal by women in Mahabo-Mananivo** *(Continued)*

| | | | | | |
|---|---|---|---|---|---|
| ZINGIBERACEAE | *Aframomum angustifolium* (Sonn.) K. Schum. | Longoza | Leaf | Splinter | Africa |
| ZINGIBERACEAE | *Curcuma longa* L. | Tamotamo | Leaf | Albumin - Pregnancy - Malaria - Jaundice Viral | |
| ZINGIBERACEAE | *Hedychium coronarium* J. Koenig | Longoza | Leaf | Evacuation of the placenta - Scabies | |
| ZINGIBERACEAE | *Zingiber officinale* Roscoe | Sakaintany | Tuber - Leaf | Pregnancy: Nausea - Evacuation of placenta-cough-diarrhea | |

Complete list of the vernacular names, scientific identification, use and distribution of all the species mentioned during ethnobotanical interviews.

respondents are single mothers who prefer to practice traditional care during childbirth and/or childhood diseases.

### Diversity of medicinal plants and their application

152 medicinal plants were recorded during our ethnobotanical interviews as part of the collective women's pharmacopeia. The diversity of medicinal plants in the botanical groups shows that dicotyledons have a very high percentage of use (87%), followed by 8% of monocotyledons and finally 5% of pteridophytes. The most important medicinal families are: Asteraceae (11 species), Poaceae and (9 species), Myrtaceae, Euphorbiaceae and Fabaceae (6 species each), Rubiaceae (5 species), Apocynaceae and Zingiberaceae (4 species each), Anacardiaceae, Moraceae, Melastomataceae and Solanaceae (3 species each). Our findings illustrate the most well known and cited species by women have a high rate of endemism or regional nativity. (Table 2).

Medicinal plants are mainly used in the care of the digestive system (53.95%), followed by reproductive system (49.34%), then the circulatory system with 42.76%. Then, the plants used against skin diseases have a frequency of use of 28.29%, those used against diseases of the respiratory system with 20.39%. Eighteen percent (18%) of plants are taken for the care of diseases related to nervous systems, those used against diseases associated with hearing and visual are a minority (0.66% only) (Figure 2).

In the rural commune of Mahabo-Mananivo, leaves are most often cited as the part used for medicinal treatment, followed by bark and entire plant. Decoction is the most used method of preparation with a percentage of 51.60%. It is followed by infusions (13.07%), fumigation (12.40%), poultice (10.45%), maceration (4.58%), inhalation (3.90%), dusting (2.60%) and drops (1.40%) (Figure 3).

Among the medicinal plants collected, a majority are sourced from the littoral forest of Agnalazaha while the cultivated fields, weedy disturbed areas, marshes, savannah, savoka (fallow fields), and river follow up (Table 3).

## Discussion

Our focus on the use of medicinal plants by women of Mahabo-Mananivo reinforced the notion that female

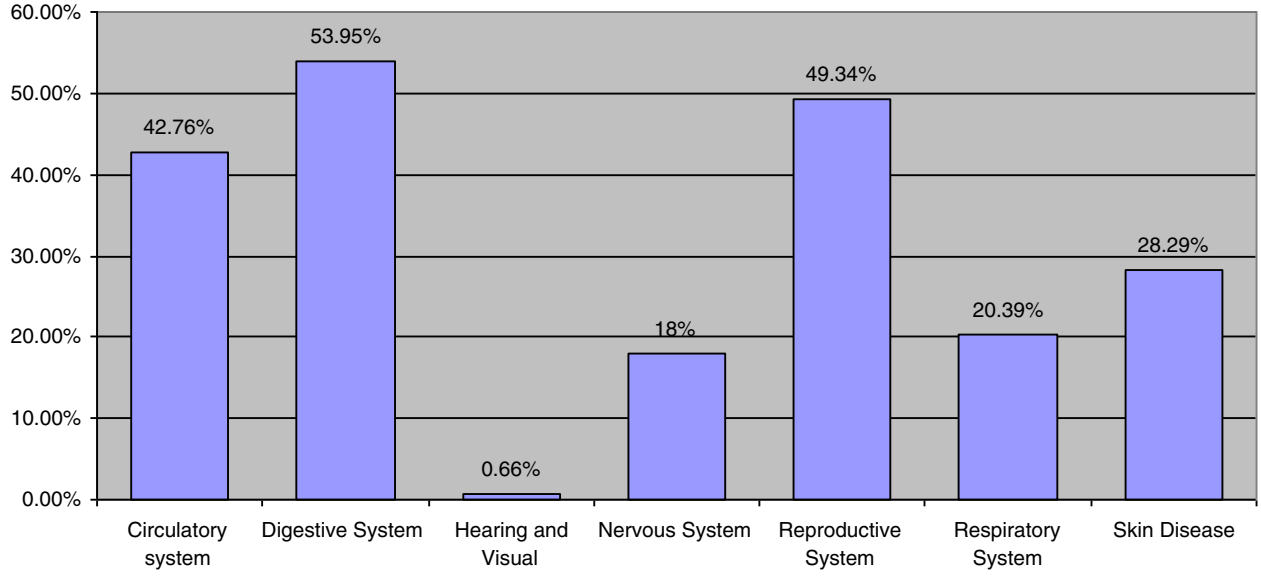


**Figure 2 Frequency of diseases mentioned as treated by a medicinal species.**

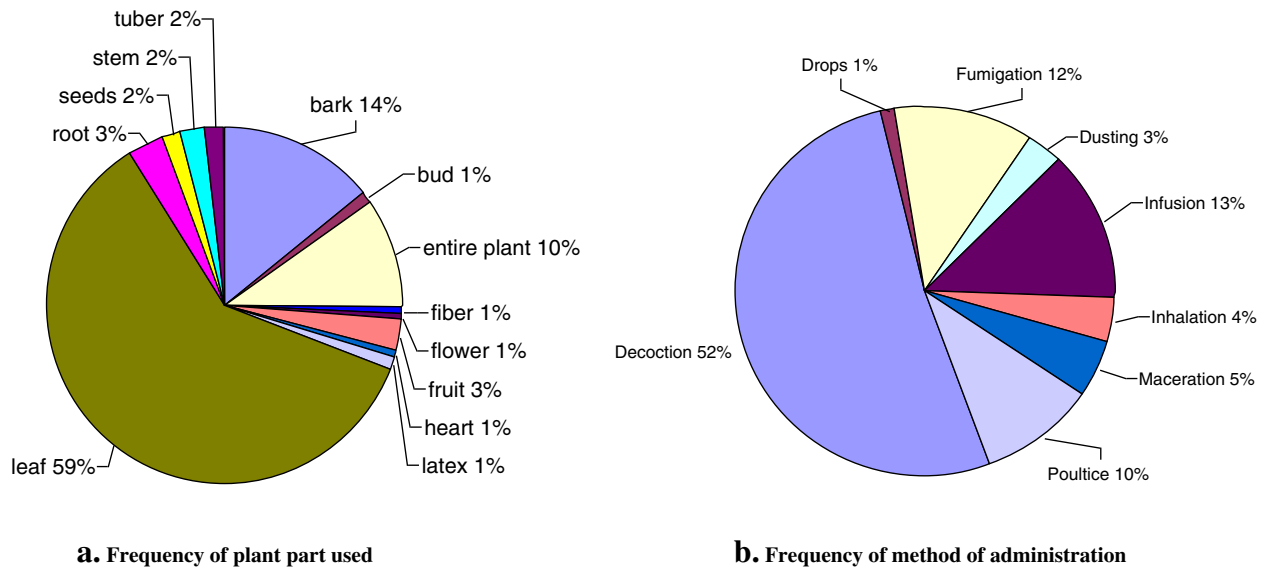


**Figure 3 Distribution of type of plant part used (a.) and method of medicinal administration. (b.)** Percentage of citations for plant parts used and method of administration for medicinal plant treatment as reported during the interviews. Some plants are noted as having multiple medicinal uses with multiple parts of plants utilized.

caregivers are the first line of health care in many Malagasy homes. We found that traditionally, men collect the medicinal plants while women were mostly responsible for the drying, storage and preparation of the plant to take care of the family members. Reproductive, prenatal and postpartum health were the most frequently cited use for medicinal plants in women's health, a trend seen worldwide [26], however, the women's pharmacopeia was not limited to reproductive and childbirth care and many medicinal species from Agnalazaha Forest are used to treat multiple diseases. We found eight native species that were very well known, and were used to treat multiple diseases. *Voacanga thouarsii* is used during childbirth and for the treatment of gonorrhea, syphilis, mycosis, wounds, hypertension and is also used for the care of the digestive tract and stomach ulcers. *Cinnamosma madagascariensis* treats dental decay and general oral care, malaria, and for care of complications after childbirth. *Olax emirnensis* is used during childbirth, and to treat malaria, hepatitis, epilepsy, dysentery, fatigue, and thought to have magical properties and to provide protection against witchcraft. *Syzygium emirnense* is used in childbirth, diarrhea, dental disease, and scabies. *Nepenthes madagascariensis* is used during childbirth, and for treatment of malaria, filariasis, ear infections, syphilis, and gonorrhea. *Phyllarthron madagascariense* is taken to support breastfeeding, to treat malaria and combat fatigue. *Suregada boiviniana* helps to evacuate the placenta and treat epilepsy, dysentery, and malaria. *Asteropeia micraster* also helps to evacuate the placenta and treat diarrhea, fatigue and mumps. Our study found that many of the medicinal species sourced from Agnalazaha Forest were also utilized for other daily living needs. Native medicinal species may also be used as timber, construction materials, and firewood. Conservation concerns mostly lie in the overuse of these valuable daily living species. Conversations with community members highlighted the concern and interest they had for protecting the natural resource of Agnalazaha Forest while ensuring the forest could still be used. It is our goal that through careful ethnobotanical studies of the modern use of Agnalazaha Forest, we can help the community of Mahabo-Mananivo understand their forest use and establish community driven sustainable conservation plans.

## Conclusions

This study highlighted the diversity of medicinal plants used by women and female healers in the Commune of Mahabo-Mananivo. From the perspective of plant diversity,

**Table 3 Frequency of localities where medicinal plants are sourced near and around Agnalazaha Forest**

| Sampled locations | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Forest | Marsh | Savanna | Savoka | River | Cultivated | Disturbed areas |
| Frequency (%) | 40 | 11 | 7 | 4 | 4 | 20 | 14 |

152 species of medicinal plants in 134 genera and 79 families were identified during the ethnobotanical surveys. First, there is widespread use of medicinal plants that affect the digestive, reproductive and circulatory system. The eight native species widely used are *Cinnamosma madagascariensis*, *Voacanga thouarsii*, *Nepenthes madagascariensis*, *Syzigium emirnense, Olax emirnensis, Phyllarthron madagarascariensis, Suregada boiviana*, and *Asteropeia micraster*. This work is only the beginning of a comprehensive study on the ethnobotany of medicinal plants utilized by the community Mahabo-Mananivo from the Agnalazaha Forest. Further studies encompassing ecophysiological, pharmacological and ecological studies are necessary to build a more complete picture on how these rare and compelling littoral forests are used. By documenting the use littoral forest species, we hope to add to the value of these rare forests but also highlight the importance of biodiversity on the health and wellbeing of a community.

## Additional file

**Additional file 1: Ethnobotanical questionnaire.** PDF of the questionnaire used during ethnobotanical interviews.

### Competing interests
The authors report no competing interests.

### Authors' contributions
All authors participated in the design of the study and conducted fieldwork. MR analyzed the data. MR and ARK wrote the manuscript. All authors read and approved the final manuscript.

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