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Floristic and Eco-Morphological Study of Antibacterial Plants in Phytotherapeutic Practice of Kasai Oriental in DR Congo

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Authors' contributions

This work was carried out in collaboration among all authors. Author MMM designed the study and wrote the first draft of the manuscript. Authors ONK and PTM performed the statistical analysis and wrote the protocol, Authors LKK and DMYM managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: To make an ethnobotanical survey in the province of Kasai Oriental to identify the plant species used in the treatment of bacterial diseases; carry out a floristic analysis and determine their eco-morphological characteristics.
Study Design: The surveys were conducted in the villages of all the territories of the Kasai Oriental province in RD CONGO for five years and nine months, from March 2013 to December 2018. The confirmation of the identified species was made at the Laboratory of the ISP Mbujimayi and Herbarium of the ecology laboratory of the Department of Biology of the University of Kinshasa.
Place and Duration of Study: The surveys were conducted in the villages of all the territories of the Kasai Oriental province in RD CONGO for five years and nine months, from March 2013 to

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December 2018. The confirmation of the identified species was made at the Laboratory of the ISP Mbujimayi and Herbarium of the ecology laboratory of the Department of Biology of the University of Kinshasa.
Methodology: Pre-established questionnaires were submitted to healers and potential patients living in the region. Data were collected on local phytotherapeutic practices in order to identify indigenous plants used in the treatment of bacterial diseases. The plants listed have been identified and their eco-morphological characteristics were determined.
Results: From examination of the responses of 391 traditional healers and 1,485 residents and potential patients questioned, one hundred and sixteen plant species reputed to be effective against bacteriosis were identified. They belong to 19 orders, 39 families and 87 genera. Among these plants, only 6 families (*Fabaceae, Euphorbiaceae, Rubiaceae, Phyllanthaceae, Lamiaceae* and *Moraceae*) provide 51.57% of the species used against bacterial pathologies i.e more than half. Woody plants (62.94%) predominate among the species used (27.59% of trees, 27.59% of shrubs). Wild savannah species (44.83%) and pantropical ones (32.76%) are the most numerous among the plants of Kasai Oriental which provide drugs against bacteriosis.
Conclusion: The results confirm that several local plant species are commonly used to treat bacterial diseases in Kasai Oriental. Local herbalists use more phanerophyte plants from savannah and especially trees and shrubs.

Keywords: Bacteriosis; Herbal medicine; medicinal plants; traditional healers; kasaï oriental.

1. INTRODUCTION

Laplante (2015) states that a quarter of modern medicines are thought to be derived from natural products, many of which were first used in traditional therapies around the world [1]. Despite advances in modern medicine, traditional medicine is still widely practiced around the world. According to the WHO [2], more than 80% of African populations still use their traditional medicine given their low scientific, technological and economic development. It also states that nearly 40% of African patients perform all of their therapeutic approaches exclusively by traditional medicine [3-4]. Thus, it encourages States to promote the use of "harmless traditional remedies proven to be effective.

The value of traditional medicine of a country is undeniably dependent on the species diversity of the local flora and endogenous knowledge associated with medicinal uses of plants available asserts that the African flora provides valuable, abundant and diverse plant resources used for therapeutic purposes by indigenous populations [5-7]. They are often used without special precautions regarding their safety and effectiveness. Morel and Kabena add that 58% of very useful medicinal plants have not yet been the subject of biological and chemical studies, especially in the tropics and subtropics [8-9].

The Democratic Republic of Congo (DRC) constitutes an important reserve of such plant resources. The socio-economic crises and repetitive wars it have experienced have made the precariousness of the majority of its inhabitants chronic, especially in rural and isolated areas where it borders on poverty [10]. Combined with the exorbitant costs of modern treatment, the quality and distribution of modern health infrastructures as well as the lack of an effective social protection system, traditional medicine is increasingly in demand and is practiced in absence of any official regulations [4,11].

In Kasai Oriental, a province of the DRC, access to modern medicines is sometimes difficult and very limited in rural areas due to the aforementioned factors [12]. So traditional medicine is often the only remedy to relieve the sick [4]. Faced with the various bacterial diseases with high prevalence, the most used treatment is herbal medicine. As plants known to be effective are available in the immediate environment or on the local market, they are therefore accessible to all ages and all budgets. However, despite the very positive results of some traditional phytotherapeutic treatments, despite the heavy use of these resources, African medicinal plants are still scientifically poorly understood.

It is therefore necessary to sound out and explore the traditional knowledge of different environments in order to bring out all the values to be preserved for the future. Therefore the aim of this study is to identify and make an eco-morphological analysis of plant deemed effective

against bacterial diseases in practical traditional phytotherapeutic in Kasai Oriental.

2. MATERIALS AND METHODS

2.1 Study envirOnment

Resulting from the 2015 administrative division, the current Kasai Oriental Province is situated in the center of the DRC and extends over 9545 km^2. As shown on the map in Fig. 1, it is constituted of five Territories and the city of Mbujimayi, its capital.

This province is located in the transition zone between the Guineo-Congolese region and the Zambezian region. It experiences a humid tropical climate of the AAw3 type with a dry season of around three months and average rainfall of around 1500mm per year. Its vegetation cover generally consists of savannah dotted with a few gallery forests in the process of disappearing due to the strong demographic pressure that characterizes this area.

2.2 Ethnobotanical Surveys

The data processed in this work were collected by soubmission on the basis of consent, of pre-established questionnaires to traditional healers and other users of medicinal plants from five Territories of Kasai Oriental and the city of Mbujimayi. These surveys took five years and nine months (from March 2013 to December 2018). The aim was to identify the local plants used in herbal medicine against bacterial pathologies and the related medical practices.

The recorded plants were collected from the herbaria produced for each species. They were identified after comparison with the specimens of the Herbarium of the Laboratory of Systematic Botany and Plant Ecology at the Department of Biology of the University of Kinshasa for the confirmation of the scientific names of the species according APG III and APG IV [13-14].

2.3 Determination of Eco-morphological Parameters

The ethnobotanical and ethnopharmacological data resulting from the examination of the survey sheets were then supplemented for each species by eco-morphological information determined through observations made in the field and those carried out in the laboratory. For confirmation, the eco-morphological data were compared with the information coming from the descriptions of the species found in the reference documents: Flore d'Afrique Centrale and Flore du Congo Belge et du Ruanda Urundi [15-22].

The parameters considered made it possible to determine the following eco-morphological data for each of the species listed:

- **Morphological types:** following types were recorded: trees, shrubs, sarmentose shrubs, bushes, suffrutex, lianas, annual herbs and perennials herbs;

- **Biological types:** phanerophytes (macrophanérophytes, mésophanérophytes, microphanérophytes, nanophanerophytes, phanerophytes climbers, creepers phanerophytes); chaméphytes (erect, prostrate, crawling); therophytes; geophytes (rhizomatous spiny geophyte, rhizomatous macrogeophyte) or hemicryptophytes (Tuberous);

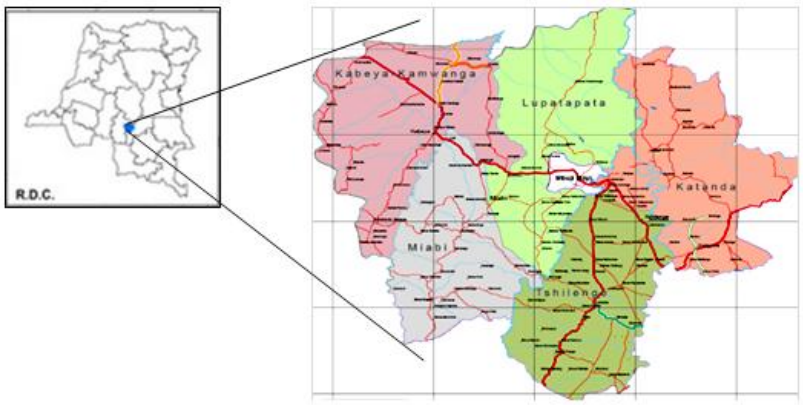

Fig. 1. The current Kasai Oriental and its administrative entities (Omasombo, 2014)

- **Types of root system**, it was either pivoting (simple or tuberous), or fasciculate or adventitious;

- L**eaf surface**, megamacrophylls, macrophylla, mesophylls, microphylls or nanophylls plants were recorded;

- **Phenomenology of leaves:** facing the different seasons, deciduous, semi-deciduous and evergreen species were found in the collection;

- **Types of diaspores**: ballochores, desmochores, pogonochores, pterochores, sarcochores or sclérochores;

- **Phytogeographic distribution**: cosmopolitan, pantropical, Afro-American, paleotropical, Afro-Malagasy, Afro-tropical, Guinean-Congolese or Guinean-Congolese-Zambezian;

- **Biotopes or natural habitats**: gallery forests, savannahs, marshes (low wetlands), fields and fallows, ruderal species, ornamental plants or plot hedges

- **Modes of installation:** spontaneous wild, spontaneous sometimes maintained, spontaneous post-cultivation or by cultivation (cultivated plants).

3. RESULTS AND DISCUSSIONS

3.1 Frequencies of Phytotherapeutic Practices in Kasai Oriental

At the end of all these investigations, the data on the attitudes and behaviors of 1,485 inhabitants of Kasai Oriental on the use of medicinal plants as well as those relating to phytotherapeutic practices collected from 391 phytotherapists or traditional healers led to the results presented by the Figs. 2, 3 and 4.

Fig. 2 shows that 91% or 1707/1876 of the inhabitants of Kasai Oriental interviewed are convinced of the curative power of local plants against various diseases and use them. Fig. 3 reveals that apart from professional healers, 52.1% or 773/1485 of people who use herbal medicine use plants that they already recognize as medicinal against 47.9% (712/1485) who claim to use plants that are recommended or prescribed to them by healers, relatives or friends.

Figure 4 indicates attitudes of the inhabitants towards medicinal plants.

Fig. 4 indicates that 77.85% of the inhabitants of Kasaï Oriental generally and regularly use

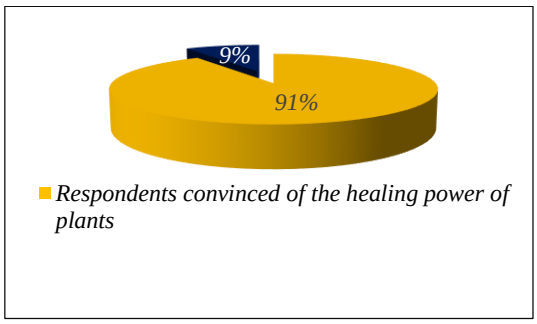

Fig. 2. Frequencies of people convinced of the healing power of plants

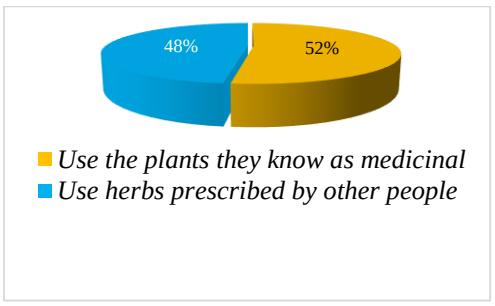

Fig. 3. Knowledge of medicinal plants by users

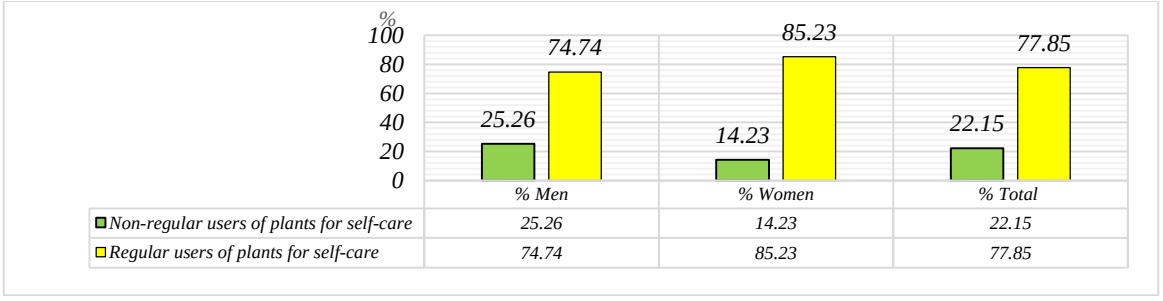

Fig. 4. Attitudes of the inhabitants towards medicinal plants

medicinal plants to treat various diseases. This proportion is 85.23% for women (375/440 interviewed) against 74.74% for men (781/1045 men consulted). The Chi-square test confirmed the frequencies of regular herbal users differ very significantly by sex ($\chi^2c = 19.18 > 6.635 = \chi^2t_{001}$). This leads to the conclusion that women resort more than men to herbal medicine. However, in isolated rural areas and / or far from large centers, 100% of the interviewees of both sexes take care of themselves or seek treatment with plants. These results lead to the following conclusion: 77.85% of the inhabitants of Kasai Oriental use herbal medicine. The latter is sometimes the only health care system in remote and isolated rural areas.

At the end of the examination of the survey files of 391 traditional healers consulted, a total of 989 drug recipes were recorded, each indicated against one or more specific or possible bacteriosis, or an average of 2.53 recipes deemed to be antibacterial per traditional healer. The elimination of similar recipes resulted in the listing of 343 different drug recipes involving 127 species of plants believed to have antibacterial power. They are used to treat bacteriosis such as: gonorrhea, cholera, conjunctivitis, diarrhea, dysentery, infantile gastroenteritis, urogenital infections, vaginal infections, urinary tract infections, venereal diseases, toothaches (dental caries), meningitis, wounds infected, syphilis, cough, tuberculosis, typhoid, etc.

3.2 Floristic Analysis of the Species Listed

Of the 127 plants listed, only 116 were collected locally and identified. Table 1 presents all the species listed and the eco-morphological data for each specie.

3.2.1 Species distribution according to the orders

Fig. 5 gives distribution of species identified according to orders.

Based on the number of species of each order among the species listed in Fig. 5, only four orders out of 19 include more than half (57.8%) of the species from Kasai Oriental used to treat bacteriosis (i.e. 67 out of 116 plants). It should therefore be concluded that these orders of Malpighiales (20.7%), Fabales (16.38%), Gentianales (12.07%) and Rosales (8.62%) are more represented than the others. The orders Celastrales, Oxalidales, Polypodiales and Vitales are the least represented, each of them has only one species.

3.2.2 Frequencies of represented families among the species listed

Fig. 6 gives percentage represented families among the species listed.

This figure reveals a very different representativeness of families among the listed species. Six families: *Fabaceae* (16.38%), *Euphorbiaceae* (10.35%), *Rubiaceae* (7.76%), *Phyllanthaceae* (6.70%) *Moraceae* (5.17%) and *Lamiaceae* (5.71%) provide more than other families of species with antibacterial principles while 21 other families of 39, however, are single species and therefore the least represented. These first six families only 39 provide more than half (51.72% or 60 of 116) plants from Kasai Oriental used against bacteriosis. By expanding, only thirteen families, or one third of thiry-nine, provide more than two thirds or 73.30% (85 species out of 116) of the plants used against bactériosis.

3.2.3 Frequencies of genera among listed species

Of the 87 genera represented among the species listed in this study, only 9 genera have more than 2 species each. The most represented are the genera Senna with 5 species or 4.31% and Ficus with 4 species or 3.45%. They are followed by the genera *Albizzia*, *Annona*, *Bauhinia*, *Bridelia*, *Jatropha*, *Ocimum* and *Phyllanthus* which each has 3 species or 2.57%. Eight other genera have two species each, ie 1.72%. These are *Combretum*, *Costus*, *Lannea*, *Melia*, *Morinda*, *Piper*, *Solanum* and *Vitex*. All 68 remaining genera are monospecific (*Acacia, Aframomum, Ageratum, Alchornea, Alstonia, Anthocleista, Bidens, Biophytum, Bixa, Boerhavia, Borreria, Brillantaisia, Callichia, Caloncoba, Canarium, Carica, Ceiba, Chenopodium, Clutia, Coleus, Conysa, Craterispermum, Crossopteryx, Croton, Cyphostemma, Daniellia, Desmodium, Emilia, Entada, Eriosema, Erythrina, Euphorbia, Fagara, Gaertnera, Hallea (syn. Mitragyna), Harungana, Heinsia, Hymenocardia, Kalaharia, Lycopersicum, Macaranga, Maesopsis, Mangifera, Maprounea, Maytenus, Milicia, Mimosa, Monanthotaxis, Musanga, Mussaenda, Myrianthus, Parinari, Pentadiplandra, Phymatosorus, Psidium, Psorospermum, Rawvolfia, Ricinodendron, Ricinus, Spathodea, Sterculia, Synadenium, Tabernaemontana, Tephrosia, Terminalap, Terminalema, Vernonia*).

Table 1. Species listed, identified and their characteristics

N°	Local names	Scientific names	Families	TM	TB	SR	SF	PF	Diasp	Hab	MO	DG
1.	KAPALU(Lu) LUFUFU (So)	*Caloncoba welwitschii (Oliv.) Gilg*	*ACHARIACEAE*	Arb	micPh	Piv	Méso	C	Sarco	Fo-g, Sav.	Sp et cult	G-C
2.	DINUNGU DIA MBUJI, MIKONU YA MBUJI	*Brillantaisia patula T. Anders*	*ACANTHACEAE*	Suffr.	Ch-dr	Piv	Macro	S	Ballo	Rud	Sp, Ssp, cult	G-C
3.	KALOMBO	*Lannea antiscorbutica (Hiern) Engl.*	*ANACARDIACEAE*	A	MacPh	Piv	Macro	C	Sarco	Fo-g, R-fo, Rud	Sp	G-C
4.	MUMBU	*Lannea Welwitschii (Hiern) Engl.*	*ANACARDIACEAE*	Arb	MesPh	piv	Meso	C	Sarco	Fo-g, R-fo, Rud	Sp	G-C
5.	DINGEYA, DIANGU,	*Mangifera indica L.*	*ANACARDIACEAE*	A	MesPh	Piv	Meso	S.C	Sarco	Rud	Sp et Cult	Pantr.
6.	MULOLO	*Annona arenaria Thom.*	*ANNONACEAE*	Arb	NanoPh	Piv.	Meso	S.C	Sarco	Sav,	Sp	Pantr.
7.	MULOLO WA PANSHI	*Annona cuneata var. chrsophylla*	*ANNONACEAE*	Suffr	NanoPh	Piv.	Meso	S.C	Sarco	Sav,	Sp	Pantr.
8.	MULOLO	*Annona senegalensis Pers.*	*ANNONACEAE*	Arb	NanoPh	Piv.	Meso	S.C	Sarco	Sav,	Sp	Pantr.
9.	DILATA OU KALATA	*Monanthotaxis poggei Eng et Diels*	*ANNONACEAE*	Arb-sar	NanoPh	Piv	Meso	S.C	Sarco	Fo-g et Li-fo	Sp	G-C
10.	KALUMBU	*Alstonia boonei De Wild*	*APOCYNACEAE*	A	MesPh	Piv	Macro	C	Pogo	Ma	Sp,	G-C
11.	KALUMBU KATOKA (KABALUBALU)	*Callichia magnifica*	*APOCYNACEAE*	Arb	micPh	Piv	Macro	S.C	Sarco	Rud	Sp et Ssp	G-C
12.	KAMPANDAMPANDA	*Rawvolfia vomitoria Afzel.*	*APOCYNACEAE*	Arb	micPh	Piv	Meso	S.C	Sarco	Rud, Sav,	Sp, Ssp	G-C
13.	NDENGA	*Tabernaemontana ventricosa Hochat ex ADC*	*APOCYNACEAE*	Arb	micPh	Piv	Micro	C	Sarco	Fo, Ma	Sp	G-C
14.	KATSHIMUKELA	*Conysa canadensis*	*ASTERACEAE*	Her-an	Thé-dr	Piv	Micro	S	Pogo	Rud et Chp	Sp et S-P-cult	Afro-Am
15.	KALONGO KATOKA	*Ageratum conyzoïdes L.*	*ASTERACEAE*	Her-an	Thé-dr	Piv	Micro	S	Pogo	Rud et Chp	Sp- P-cult	Pantr
16.	MPOTA YA MBUA	*Bidens pilosa L.*	*ASTERACEAE*	Her-an	Thé-dr	Piv	Micro	S	Desm	Chp	Sp- P-cult	Pantr.
17.	KABUIBUABUIBUA	*Emilia abyssinica Sch. Bip. Ex A. Rich.*	*ASTERACEAE*	Her-an	Thé-dr	Piv	Micro	S	Pogo	Chp	Sp- P-cult	Pantr
18.	MUSUMBULULU	*Vernonia amygdalina Del.*	*ASTERACEAE*	Arb	micPh	Piv	Meso	C	Pogo	Rud	Ssp	Afr-trop
19.	MULUBALUBA	*Spathodea campanulata P.Beav.*	*BIGNONIACEAE*	A	MesPh	Piv	Macro	C	Ballo	Fo, Sav et Rud	Sp. P-cult	Afro-trop
20.	NDINGA, KAKULA	*Bixa orellana L.*	*BIXACEAE*	Suffr	NanoPh	Piv	Meso	S	Sarco	Rud	Cult et Ssp.	Pantr
21.	MUPATU, MUPAFU	*Canarium Schweinfurthii ENGL.*	*BURSERACEAE*	A	MacPh	Piv	Meso	C	Sarco	Fo, Fo-g	Sp	G-C.
22.	TSHIPAPAYI, TSHINKUENDA	*Carica papaya L.*	*CARICACEAE*	suffr	micPh	Piv	Macro	S.C	Sarco	Rud	Cult- Ssp	Pantr
23.	TSHILOMBALOMBA	*Musanga cecropioïdes R. Br.*	*CECROPIOIDACEAE*	A	MesPh	Piv	Macro	S	Sarco	Fo-g, R-fo	Sp	G-C
24.	MUKOMUKOMU, MUNKALA, DINKALA	*Myrianthus arboreus P. Beuav.*	*CECROPIOIDACEAE*	A	MesPh	Piv	Macro	S	Sarco	FP et fo-g	Sp,	G-C
25.	TSHIKELA MUTSHI	*Maytenus senegalensis(Lam) Exell*	*CELASTRACEAE*	Arb	NanoPh	Piv	Micro	S	Sarco	sav	Sp	Pantr
26.	DINKANGA BAKISHI	*Chenopodium ombrosioides L.*	*AMARANTHACEAE*	Her-an	Thé-dr	Piv.	Nano	S	Sclero	Rud	Sp et Ssp	Cosm,
27.	DITSHIA, MUPENGA (Tsh)	*Parinari mobola, Oliv*	*CHRYSOBALANACEAE*	A	MesPh	Piv	Micro	S.C	Sarco	Sav	Sp	G-C/Z

N°	Local names	Scientific names	Families	TM	TB	SR	SF	PF	Diasp	Hab	MO	DG
28.	MPANDANGANGA	*Psorospermum febrifugum Spach.*	*HYPERICACEAE*	Arb	NanoPh	Piv	Micro	S	Sarco	Sav	Sp	Afro-Malg
29.	TSHIBANGA	*Combretum molle, R. Br. ex G. Don*	*COMBRETACEAE*	A	MesPh	Piv	Micro	C	Ptéro	Sav	Sp	G-C
30.	MUNGONGA, NSUMBI	*Combretum racemosum P. Beauv.*	*COMBRETACEAE*	Arb	micPh	Piv	Micro	C	Ptéro	Sav	Sp	G-C
31.	TSHIBANGU MUTSHI, MUBANGA	*Terminilia mollis, Laws.[1] in Oliv*	*COMBRETACEAE*	A	MesPh	Piv	Meso	C	Sarco	Sav, Fo-g	Sp	Afro-trop
32.	TSHITETATETA	*Costus afer Ker-Gawl*	*COSTACEAE*	Her-vi	MGéo-rh	Adv	Macro	S	Sarco	Fo et Ma	Sp	Afro-trop
33.	TSHITETATETA	*Costus lucanusianus J. Braun&K Schum*	*COSTACEAE*	Her-vi	MGéo-rh	Adv	Macro	S	Sarco	Fo et Ma	Sp	G-C
34.	DITOLU	*Alchornea cordifolia, Müll. Arg.*	*EUPHORBIACEAE*	Arb-sar	micPh	Fasc	Méso	S.C	Sarco	Li-Fo, R-fo	Sp	Afro-trop
35.	MPUMBU MUCI CIOMBA	*Clutia Timpermaniana J. Léonard*	*EUPHORBIACEAE*	Suffr	Ch-tub	Piv-tub	Micro	C	Sarco	Sav	Sp	Pantr
36.	KABUJI MUTSHI, KANYAMPEMBA	*Croton mubango Müll. Arg.*	*EUPHORBIACEAE*	Arb	micPh	Piv	Micro	S.C	Sarco	Rud et Sav	Ssp	G-C
37.	NKAMBUA, KAPULUAYI, MVIDIE, TSHIMPOTONJI, CIMBOTONJI	*Jatropha curcas L.*	*EUPHORBIACEAE*	Arb	NanoPh	Piv	Méso	C	Sarco	Sav, Rud, Jard et P-H	Cult, Sp, Ssp	Pantr
38.	NKAMBUA MUKUNZA, TSHIMPOTONJI, KAPULUAYI, CIMBOTONJI, MVIDIE,	*Jatropha gossypifolia L.*	*EUPHORBIACEAE*	Suff	NanoPh	Piv	Meso	C	Sarco	Sav, Rud, Jard et P-H ou P-Or	Cult, Ssp, Sp	Pantr
39.	NKAMBUA MULANGI, MVIDIE, TSHIMPOTONJI, CIMBOTONJI	*Jatropha podagrica*	*EUPHORBIACEAE*	Suff	NanoPh	Piv	Meso	C	Sarco	P-H ou P-Or	Cult et Ssp	Pantr
40.	LUEBEBA, LUIBIBA	*Macaranga saccifera*	*EUPHORBIACEAE*	A	MesPh	Fasc	Mega	S.C	Sarco	Fo-g, Ma et	Sp	G-C
41.	KAVULA MOMA, KAFULADIMA, KASANGA MOMA, KANYANGALA	*Maprounea africana Müll. Arg.*	*EUPHORBIACEAE*	Arb	micPh	Piv	Micro	C	Ballo	Sav	Sp	Afro-trop
42.	TSHILELA	*Ricinondendron heudelotii (Baill) Piere ex Heckel*	*EUPHORBIACEAE*	A.	MesPh	Piv	Méso	C	Sarco	Rud, Fo-g, Sav	Ssp et Cult	G-C
43.	MUDIANTONDO	*Ricinus cummunis L.*	*EUPHORBIACEAE*	Suffr	NanoPh	Piv	Macro	S.C	Ballo	Rud	Sp et Cult	Pantr
44.	NTULU WA MABEJI	*Synadenium grantii*	*EUPHORBIACEAE*	Arb	MesPh	Piv	Meso	S.C	Sarco	Rud, P-H, Sav	Cult	Pantr
45.	KABUDIMBU, KAKASA KA TSHIULA (Lu)	*Euphorbia hirta L.*	*EUPHORBIACEAE*	Her-an	Thé-dr	Piv	Nano	S	Ballo	Rud et Chp	Sp- P-cult	Pantr
46.	TSHITSHIMBU	*Daniellia asbteenia*	*FABACEAE*	A	MesPh	Piv	Macro	C	Ballo	Sav.	Sp	G-C
47.	KAFUMBA	*Bauhinia purpurea L.*	*FABACEAE*	Arb	micPh	Piv	Méso	S.C	Ballo	P-H	cult	Paléotr
48.	TSHIFUMBA	*Bauhinia thonninghii Schumach.*	*FABACEAE*	Arb	micPh	Piv	Méso	S.C	Sclero	Sav et Fo-g	Sp	Paléotr
49.	KAFUMBAFUMBA	*Bauhinia tomentosa L.*	*FABACEAE*	Arb	micPh	Piv	Méso	S.C	Ballo	P-H et P-Or	Sp et cult	Paléotr

N°	Local names	Scientific names	Families	TM	TB	SR	SF	PF	Diasp	Hab	MO	DG
50.	KALONGO KA LUBIKA	*Senna (Cassia) alata L.*	*FABACEAE*	Suff	NanoPh	Piv	Méso	S.C	Ballo	Rud et chp	Ssp	Pantr
51.	LUKUNDABAJANYI LUTOKA	*Senna hirsuta L.*	*FABACEAE*	Suff	NanoPh	Piv	Meso	S.C	Ballo	Rud et chp	Sp- P-cult	Pantr
52.	LUKUNDABAJANYI	*Senna occidentalis (L) Link.*	*FABACEAE*	Suff	NanoPh	Piv	Meso	S.C	Ballo	Rud et chp	Sp- P-cult	Pantr
53.	NDUNDA MUKUNZA	*Senna (Cassia) siamea Lam.*	*FABACEAE*	A	MesPh	Piv	Meso	S.C	Ballo	Rud et P-Or	Sp, Ssp, cult	Pantr
54.	TSHIMBELAMBELA.	*Senna tora*	*FABACEAE*	Suff	NanoPh	Piv	Micro	S.C	Ballo	Rud et chp	Sp- P-cult	Pantr
55.	NDAMATA (Lu) KALAMA (So)	*Desmodium velutinum (Willd.) D.C.*	*FABACEAE*	Suffr.	NanoPh	Piv	Meso	S	Desm	Sav	Sp,	Pantr
56.	KAMBAYAMBAYA(Tsh.), KABABA(Songie)	*Eriosema glomeratum (Guill et (Perr.) Hook f.*	*FABACEAE*	Suffr	NanoPh	Piv	Micro	S.C	Ballo	Sav	Sp	Afro-trop.
57.	TSHITSHIPITSHIPI	*Erythrina tomentosa R. Br. (D.C.)*	*FABACEAE*	Arb	NanoPh	Piv	Meso	C	Ballo	Sav.	Sp	G-C
58.	BUBAWU	*Tephrosia voghelii Hook. f.*	*FABACEAE*	Suffr.	NanoPh	Piv	Micro	S	Ballo	Rud	Sp et cult-	Afro-trop
59.	DISANA	*Acacia seyal*	*FABACEAE*	Arb	NanoPh	Piv	Micro	S	Ballo	Rud	Cult	Pantr.
60.	MUSASA MUKUNZA, Damba (Otetela)	*Albizzia adianthifolia (Schum) W F Wight*	*FABACEAE*	Arb	micPh	Piv	Micro	C	Ballo	Sav	Sp	Afro trop
61.	MUSASA WA DITU (Tshiluba)	*Albizzia coriaria Welw. ex Oliv*	*FABACEAE*	A	MesPh	Piv	Micro	C	Ballo	Fo-g,	Sp	G-C
62.	MUSASANGA ou MUSASA MUTOKA, MUSASASASA, TSHISASASASA	*Albizzia lebbeck (L.) Benth*	*FABACEAE*	A	MesPh	Piv	Micro	C	Ballo	Fo-g,Sav, Rud,	Sp, Ssp, cult	Afro-trop
63.	TSHINGEJA, TSHITEFU	*Entadopsis abyssinica (Stend.Ex A. Rich) Gilbert et Bout.. Syn.: Entada abyssinica Steud. ex A Rich.*	*FABACEAE*	Arb	NanoPh	Piv	Meso	C	Ptero	Sav	Sp et Ssp	Afro-trop
64.	MADAME LALA	*Mimosa sensitiva*	*FABACEAE*	Li	Ch-rp	Piv	Micro	S	Desm	Rud	Sp-P-cult	Pantr
65.	MUTONDO MASHI, MUVULA MPUTA	*Harungana madagascariensis Lam. Ex Poir.*	*HYPERICACEAE*	Arb	MesPh	Piv	Méso	S	Sarco	Sav, Fo-g	Sp.	Afro-trop
66.	NYINYI A NZOLO	*Coleus hybridus Hort.*	*LAMIACEAE*	Suffr	NanoPh	Piv	Micro	S	Sclero	Rud	Cult	Cosm
67.	LUENYI	*Ocimum basilicum L.*	*LAMIACEAE*	Her-an	Thé-dr	Piv	Micro	S	Sclero	Sav	Sp et Cult	Pantr
68.	DISULU	*Ocimum canum Sims*	*LAMIACEAE*	suffr	NanoPh	Piv	Micro	S	sclero	Rud	Ssp et Cult	Pantr
69.	TSHIDI BU LUENYI, TSHILUABENYI	*Ocimum gratissimum L*	*LAMIACEAE*	Suffr	NanoPh,	Piv	Micro	S	Sclero	Chp, Rud	Cult, et Ssp	G-C,
70.	TSHIKUDIMATA	*Vitex madiensis Oliv.*	*LAMIACEAE*	Arb	NanoPh	Piv	Méso	C	Sarco	Sav et Fo-g	Sp	G-C
71.	DIPODI	*Vitex welwitschii De Wild.*	*LAMIACEAE*	A	MesPh	Piv	Méso	S.C	Sarco	Fo-g et Sav	Sp	G-C/Z
72.	DINGILA MPATA, MULUALUA, NDONDA MAYI, TSHILOLELOLE	*Anthocleista vogelii Planch.*	*LOGANIACEAE*	A	MesPh	Piv	Mega	S	Sarco	Fo-g	Sp	G-C
73.	KONYI MUTENGELA	*Ceiba pentandra (L.) Gaertn.*	*MALVACEAE*	A	MesPh	Piv	Meso	C	Pogo	Rud, Fo-g	Sp, Ssp	Pantr
74.	MUABI, MULENDA	*Sterculia quinqueloba (Garcke) K. Schum*	*MALVACEAE*	A	MesPh	Piv	Meso	C	Ballo	Sav, Rud, Chp	SP et Ssp	Afro-trop
75.	NDUNGA WA TUMUMA	*Melia azedirach L.*	*MELIACEAE*	A	micPh	Piv	Meso	C	Sarco	Rud	Ssp	Pantr.

N°	Local names	Scientific names	Families	TM	TB	SR	SF	PF	Diasp	Hab	MO	DG
	(NEEM)											
76.	NDUNGA WA TUMUMA (cidi bu)	*Melia sp*	*MELIACEAE*	A	micPh	Piv	Meso	C	Sarco	Rud	Ssp	G-C/Z
77.	MUKOBAKOBA	*Trichilia prieureana A. Juss.*	*MELIACEAE*	Arb	micPh	Piv	Macro	C	Sarco	sav	Sp	G-C
78.	KASAMBA NKUSU, KASAMBA	*Ficus persicifolia Welw. ex warb*	*MORACEAE*	Arb-sar	micPh	Piv	Meso	S	Sarco	Fo-g, Sav	Sp	Afro-trop
79.	TSHIKUYI TSHIKUNZA	*Ficus polita (Miq.) Vahl*	*MORACEAE*	A	micPh	Piv	Meso	C	Sarco	Sav	Sp	Afro-trop
80.	TSHIKUYI TSHITOKA	*Ficus seretii Lebrun et Boutique*	*MORACEAE*	A	micPh	Piv	Meso	C	Sarco	Sav	Sp	Afro-trop
81.	TSHIKUYI TSHIFIKA	*Ficus sycomorus L.*	*MORACEAE*	A	micPh	Piv	Meso	C	Sarco	Fo-g	Sp	G-C
82.	LUSANGA	*Milicia excelsa (Welw.) C.C. Berg. Syn.: Chlorophora excelsa (Welw.) Benth.*	*MORACEAE*	A	MacPh	Piv	Méso	C	Sarco	Fo-g et Sav	Sp.et Ssp	G-C
83.	MAZAYI, MAZAYA, DIZAYA	*Treculia africana Decne*	*MORACEAE*	Arb	MesPh	Piv	Meso	S	Sarco	Fo-g	Sp	G-C
84.	TSHINKALAFU, NKALAFU	*Psidium guayava L.*	*MYRTACEAE*	Arb	micPh	Piv	Meso	S	Sarco	Rud	Cult et Ssp	Pantr
85.	TSHIDIATAMBEMBA	*Boerhavia diffusa L.*	*NYCTAGINACEAE*	Her-an	Thé-pr	Piv-tub	Micro	S	Desm	Ch, rud,	Sp- P-cult	Pantr
86.	KALUMA DIBOMBA, KALUMA DIBONDA	*Biophytum sensitivum (L.) DC Syn.: B. Helenae Busch, et Muschler, Engl*	*OXALIDACEAE*	Her-an	Thé-dr,	Piv.	Nano,	S	Sarco	Sav.	Sp, Sp- P-cult	G-C
87.	MUKUALUKOYA	*Pentadiplandra brazzeiana Baill.*	*PENTADIPLANDRACEAE*	Li	Ph-gr	Piv-tub	Meso	S	Sarco	Fo-g	Sp,	G-C
88.	TSHIFUBA	*Bridelia atroviridis Müll Arg*	*PHYLLANTHACEAE*	arbs	NanoPh	Piv	Micro	S	Sarco	Sav	Sp	Afro-trop
89.	TSHINKUNKU, MUJIMUINA (Tshiluba)	*Bridelia ferruginea Benth.*	*PHYLLANTHACEAE*	arbs	NanoPh	Piv.	Méso,	S.C	Sarco	Sav.	Sp.	G-C/Z
90.	TSHINKUNKU TSHIA DITU	*Bridelia micranta (Hochet)*	*PHYLLANTHACEAE*	A	micPh	Piv	Méso	S.C	Sarco	Fo-g	Sp.	G-C.
91.	TSHILENGU	*Uapaca guinensis (Uapaca heudelotii*	*PHYLLANTHACEAE*	A	MesPh	Piv	Meso	C	Sarco	Fo-g, Sav, Ma	Sp et Ssp	G-C
92.	LUKUANGA, MUPETA	*Hymenocardia acida Tul.*	*PHYLLANTHACEAE*	A	micPh	Piv	Micro	S.C	Sarco	Sav	Sp	Afro-trop
93.	LUANGANDINDI, MUNSANGALA	*Phyllanthus muellerianus (O Ktze) Exell*	*PHYLLANTHACEAE*	Arb-sar	micPh	Fasc	Micro	S.C	Ballo	Rud, Sav, Fo-g	Sp et Ssp	Pantr
94.	KAPUNGAPUNGA (tshil.) KAPONDO (So)	*Phyllanthus niruri L.*	*PHYLLANTHACEAE*	Her-an	Thé-dr	Piv	Micro	S	Ballo	Rud, et chp	Sp- P-cult	Paléotr
95.	KAPUNGAPUNGA (tshil.) KAPONDO (So)	*Phyllanthus urinaria L.*	*PHYLLANTHACEAE*	Her-an	Thé-dr	Piv	Micro	S	Ballo	Rud, et chp	Sp- P-cult	Paléotr
96.	NKETU	*Piper guineense Schumach. et Thonn*	*PIPERACEAE*	Li	Ph-gr	Piv	Méso	S	Sarco	Fo-g	Sp.	Pantr
97.	DILOMBOLOMBO	*Piper ombellatum L.*	*PIPERACEAE*	Suffr.	NanoPh	Piv	Macro	S	Sarco	Fo-g	Sp	Pantr.
98.	TSHIANZA TSHIA DIBUA	*Phymatosorus scolopendria*	*POLYPODIACEAE*	Her-vi	Géo-rh	Adv	Meso	S	Pogo	Rud, Sav, Fo-g	Sp	Afro-Malg.
99.	NDUNGA WA BIPATU	*Maesopsis eminii Engl.*	*RHAMNACEAE*	A	MesPh	Piv	Micro	C	Sarco	Rud, Fo-g, Sav	Sp et cult	G-C

N°	Local names	Scientific names	Families	TM	TB	SR	SF	PF	Diasp	Hab	MO	DG
100.	MUTOTSHI	*Crossopteryx febrifuga (Afzel) Benth.*	*RUBIACEAE*	Arb	micPh	Piv	Micro	S.C	Sarco	Sav	Sp	Afro-trop
101.	KAFUANKUSU, KAKOYI MPAMBULA	*Borreria ocymoïdes (Burm.) DC*	*RUBIACEAE*	Her-an	Thé-dr	Piv	Nano	S	Scléro	Rud, et Chp	Sp- P-cult	Pantr
102.	TSHINSANSA	*Craterispermum cerinanthum Hiern*	*RUBIACEAE*	Arb	micPh	Piv	Micro	S	Sarco	Fo-g	Sp.	G-C
103.	KAMPANGA NZEVU	*Gaertnera parvipaniculata Petit*	*RUBIACEAE*	Arb	micPh	Piv	Micro	C	Sarco	Sav	Sp	G-C
104.	MPUMBU MUTSHI	*Heinsia crinita (Afzel.) G. Taylor*	*RUBIACEAE*	arbs	micPh,	Piv	Méso,	S	Sarco	Fo-g	Sp	Afro-trop
105.	MUJIWU, MUJILANGA	*Hallea (Mitragyna) stipulosa (DC) O. Kuntze*	*RUBIACEAE*	A	MacPh	Piv	Mega	C	Sarco	Fo-g et Ma	Sp	Afro-trop
106.	MULALAMBUA, NKUSU MUTSHI	*Morinda lucida Benth.*	*RUBIACEAE*	Arb	micPh	Piv	Méso	S	Sarco	Sav et Rud.	Sp et Ssp	G-C
107.	NKONGA BULULU	*Morinda morindoides (Bak) Milne-redhead*	*RUBIACEAE*	Li	Ph-gr	Fasc	Méso	S	Sarco	Fo-g	Sp	G-C
108.	NTEMBUATEMBUA	*Mussaenda arcuata Lam. ex Poir.*	*RUBIACEAE*	arb-sar	NanoPh	Fasc	Micro	S	Sarco	Sav.	Sp.	Afro-Malg
109.	NKOLA MASUNGU, KOLAMASUMU	*Fagara macrophylla (Oliv.) Engl.*	*RUTACEAE*	A	MesPh	Piv	Mega	S.C	Sarco	Fo-g	Sp	G-C
110.	KAMATA (Lu et So) TUMATA (Lu)	*Lycopersicum cerasiforme Dun*	*SOLANACEAE*	Her-an.	Ch-pr	Piv	Micro	S	Sarco	Chp	cult.	Pantr.
111.	NKULANYI (DIKULAKULA)	*Solanum acculeastrum Dunal*	*SOLANACEAE*	arbs	NanoPh	Piv	Méso	S	Sarco	Rud	Sp, Ssp, cult	Pantr.
112.	NKULANYI	*Solanum torvum Sw.*	*SOLANACEAE*	Suffr	NanoPh	Piv	Méso	S	Sarco	Rud	Sp,et Ssp	Pantr.
113.	MUKESU	*Trema guineensis (Schum et Thonn) Ficalho*	*ULMACEAE*	Arb	micPh	Piv	Meso	S.C	Sarco	Rud et Fo-g	Sp- P-cult	G-C
114.	KEBA KA NYOKA, MENU A NYOKA	*Kalaharia spinescens*	*VERBENACEAE*	Her-vi	hemicr-tu	Piv-tub	Micro	S	Sarco	Sav et Chp	Sp, Sp- P-cult	Cosm
115.	KABONZO	*Cyphostemma vanmeelii*	*VITACEAE*	Li	Ph-gr	Piv	Micro	S	Ballo	Sav	Sp	G-C/Z
116.	MUTUTUNGULU	*Aframomum sanguineum, K. Schum.*	*ZINGIBERACEAE*	Her-vi	MGéo-rh	Adv	Micro	S	Sarco	Sav	Sp	Afro-trop

Legend: 1. TM = Morphological type (A = Tree, Arb = shrub, arb-sar = sarmented shrub, arbs = shrubs, Her - an = annual herb, Her-vi = Perennial herb, Li = liana, Suff = suffrutex); 2. TB = Biological type (Ch = Chaemephyte: [dr = erect, pr = prostrate, tub = tuberous, rp = crawling], Géo-rh = rhizomatous geophytes, MGéo-rh = Rhizomatous macrogeophyte, hemicr-tu = tuberous hemicriptophyte, Ph-gr = Climbing phanerophytes, MacPh = Macrophanerophyte, MesPh = Mesophanerophyte, micPh = microphanerophyte, NanoPh = nanophanerophyte, Thé-dr = upright therophyte; 3. SR = Root system (Adv = adventitious, Fasc = fasciculate, Piv = simple swivel, Piv-tu = tuberous pivot); 4. SF = Leaf area (Macro = macrophyll, Mega = megaphyl, Meso = mesophyll, Micro = microphyll, Nano = nanophyll); 5. PF = Seasonal leaf phenomenon (C = deciduous, SC = semi-deciduous, P = persistent); 6. Diasp = diaspore (Ballo = ballochore, Desm = desmochore, Pogo = pogonochore, Ptero = pterochore, Sarco = sarcochore, Sclero = sclerochore); 7. Hab = habitat (Chp = field and fallow, Fo-g = gallery forest, Jard = parcel garden, Ma = marsh, PH = parcel hedge plant, P-Or = ornamental plant, Rud = ruderal, Sav = savannah); 8. MO = Mode of occupation (Cult = cultivated, Sp = spontaneous wild, Ssp = spontaneous sometimes maintained, Sp- P-cult = spontaneous post-cultivation); 9. DG = biogeographic distribution (Afro-Am = African-American, Afro-Malg = Afro-Malagasy, Afro-trop = afro-tropical, Cosm = cosmopolitan, GC = Guinean-Congolese, GC / Z = Guinean-Congolese and Zambezian, Paleotr = paleotropical, Pantr = Pantropical).

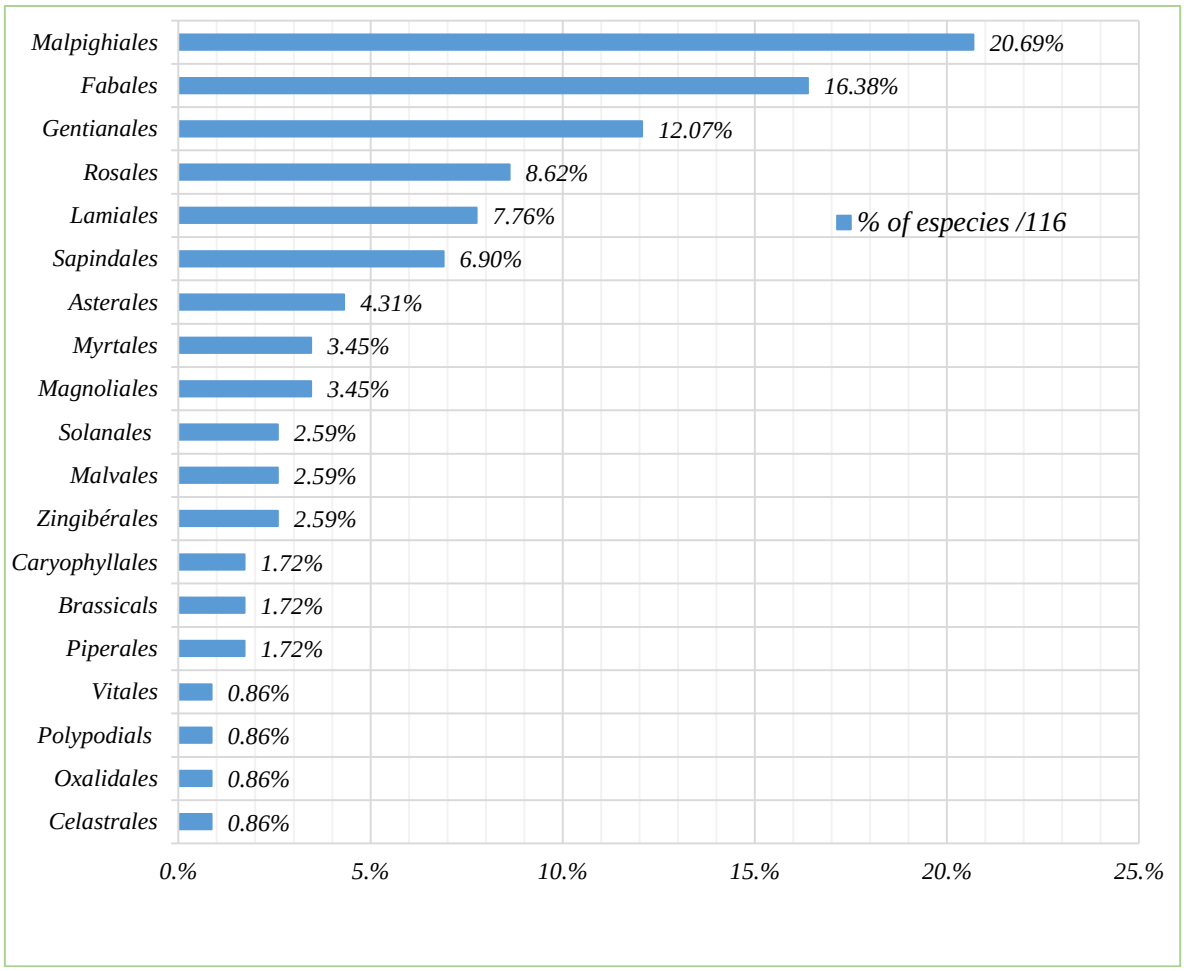

Fig. 5. Distribution of species identified according to orders

3.2.4 Frequencies of medicinal use of the species used

Of the 116 plant species known to be antibacterial in Eastern Kasai, only 15 plants are cited by more than 50% of traditional practitioners interviewed. These are *Morinda morindoides* (87%), *Phyllanthus niruri* and *urinaria* (83%), *Morinda lucida* (82%), *Phyllanthus muellerianus* (80%), *Crossopteryx febrifuga* (72%), *Gaertnera parvipaniculata* (72%), *Piper umbellatum* (71%), *Piper guineense* (64%), *Ocimum gratissimum* (63%), *Chenopodium ambrosioides* (63%), *Carica papaya* (62%), *Lycopersicum cerasiforme* (59%), *Euphorbia hirta* (57%), *Ocimum basilicum* (57%) and *Ceiba pentandra* (53%). Only eight of these species are most popularly used in several different drug prescriptions. These are in descending order *Phyllanthus muellerianus, Crossopteryx febrifuga, Morinda lucida, Piper guineense, Maesopsis eminii, Phyllanthus (niruri, urinaria), Morinda morindoides and Piper umbellatum.*

3.3 Eco-morphological Analysis of the Identified Species

3.3.1 Distribution of species according to their morphological types

Fig. 7 indicates the distribution of inventoried species according to their morphological types.

Taking into account the morphological types of plants from Kasai Oriental used against bacterial pathologies, Fig. 7 reveals that the most exploited species are woody plants (62.94%) among which 27.59% of trees, 27.59% of shrubs, 4.31% of sarmentous shrubs and 3.45% of shrubs. Herbaceous species (15%) were the least common among plants used for the same purpose (11.20% annual herbs 4.31% against perennial herbs).

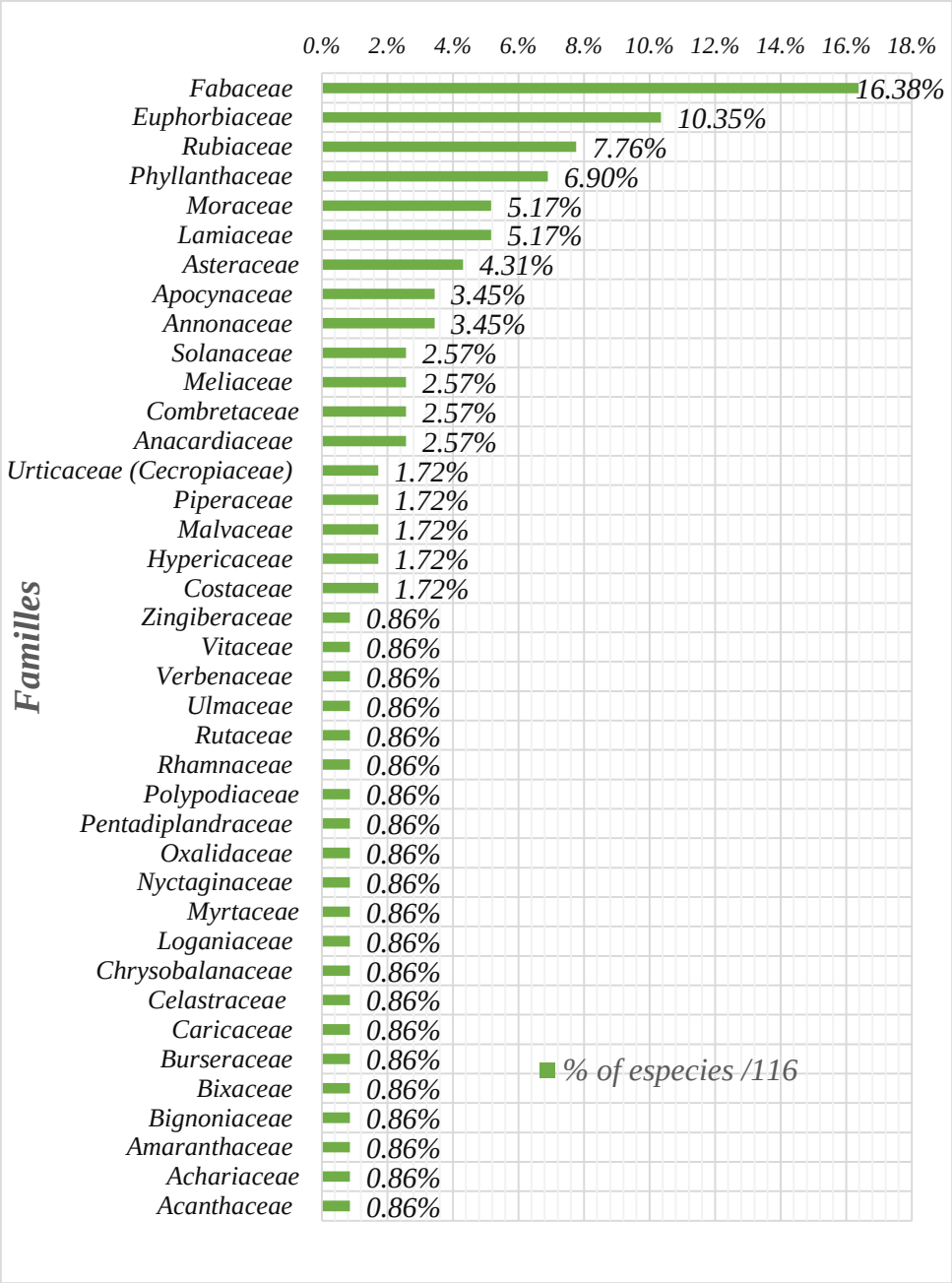

Fig. 6. Representativeness of families among the species listed

3.3.2 Distribution of species identified according to biological type

Fig. 8 gives the distribution of inventoried species according to biological type. This figure shows that herbal medicine against bacterial pathologies in Kasai Oriental uses more phanerophyte species. In fact, 81.90% of the species recorded are phanerophytes against only 0.86% of hemicryptophytes. Among the phanerophytes, the groups of microphanerophytes and nanophanerophytes predominate with 27% each followed by mesophanerophytes which account for 22% of the species.

3.3.3 Distribution of species according to their root systems

The Distribution of plant species according to their root systems is given in Fig. 9.

This figure indicates that the majority of species from Kasai Oriental used by traditional healers to treat bacteriosis have a pivoting root system. Indeed, 92.45% of the species listed have taproots. In 89% of these species, the root system is simple taproot while 3.45% have taproots, the main one being tuberous. The root system of the rest of the species is either fasciculate (4.31%) or adventitious (3.45%). Considering that the roots are more used by phytotherapists of Kasai Oriental for the preparation of medicines, their harvest without necessary precautions on perennial individuals with pivoting root system would increase the risk of perishing of exploited individuals and would constitute a threat for these important resources and utilities. Such medicinal exploitation would constitute one of the factors at the base of the scarcity of certain species which already pose enough problems to harvest them.

3.3.4 Distribution of species according to leaves surface dimensions

The distribution of plant species according to leaves surface dimension is given in Fig. 10. Considering the size of the leaves of plants used, the data in Fig. 10 indicate that among the plants in Kasai Oriental considered as effective against bacterial diseases, mesophyll species are the most used while aphyles species are totally absent from the list. These results show that 46.55% of species are mesophylls, 34.48% are microphylls while macrophylls plants represent 12.07% against the group of megamacrophylls as well as that of nanophylls represent only 3.45% each.

3.3.5 Distribution of species according to the seasonal phenomenology of their leaves

Fig. 11 shows the distribution of species according to the seasonal phenomenology of their leaves.

According to Fig. 11; 32% of Kasai Oriental plant species used against bacteriosis are deciduous during the bad season while 41% have leaves that persist throughout the year. About 27% of species remain green all year round but lose a significant amount of leaves daily throughout the seasons, they are said to be semi-deciduous. This intermediate position would have allowed a mixture of the original tropical flora with a contribution of species from the Zambezian flora. This explains the high proportion of deciduous plants among the species recorded in this area.

3.3.6 Distribution of species according to the types of diaspores produced

The distribution of species according to the produced diaspores types is summarized in Fig. 12. According to Fig. 12, it can be concluded that among the plants of Kasai Oriental used against bacteriosis, sarcochore plants are the most numerous. Species with sarcochora diaspora represent 59.48% against 21.55% of ballochore diaspores. Species producing other types of diaspores separately exhibit frequencies below 10%: sclochora (9.90%), pogonochora (6.03%), desmochora (3.45%) and pterochora (2.59%).

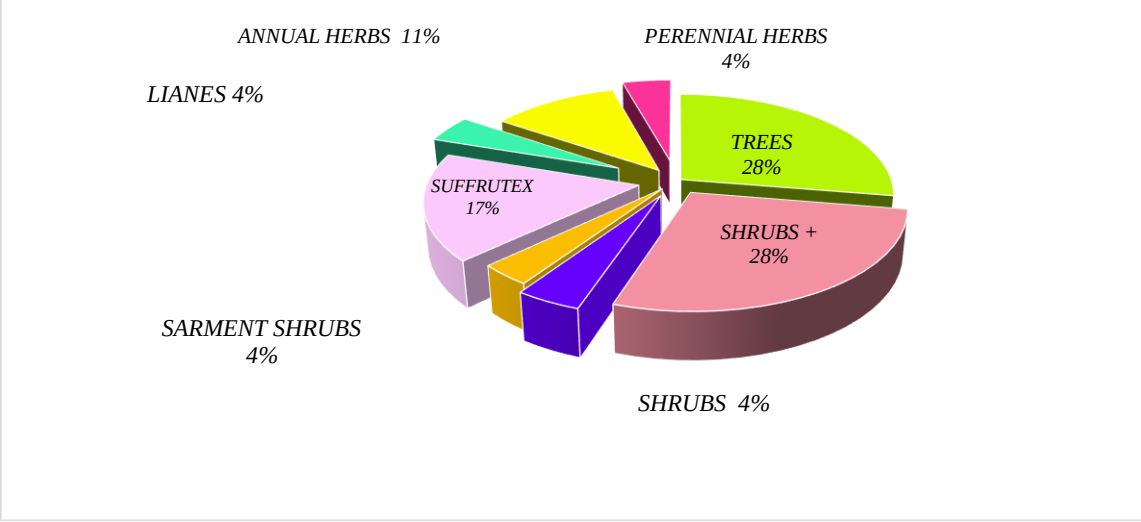

Fig. 7. Distribution of inventoried species according to their morphological type

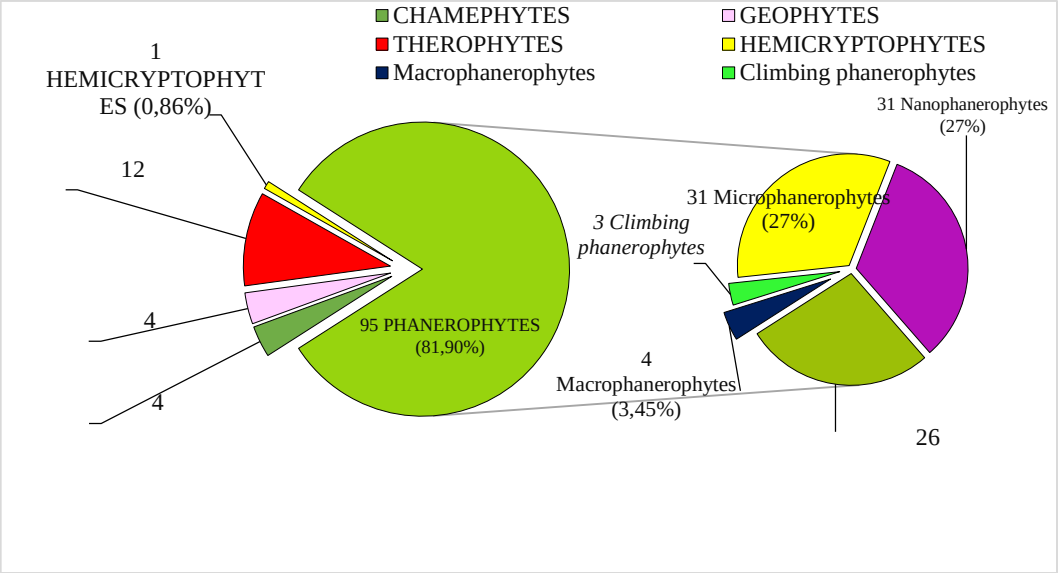

Fig. 8. Distribution of species according to biological types

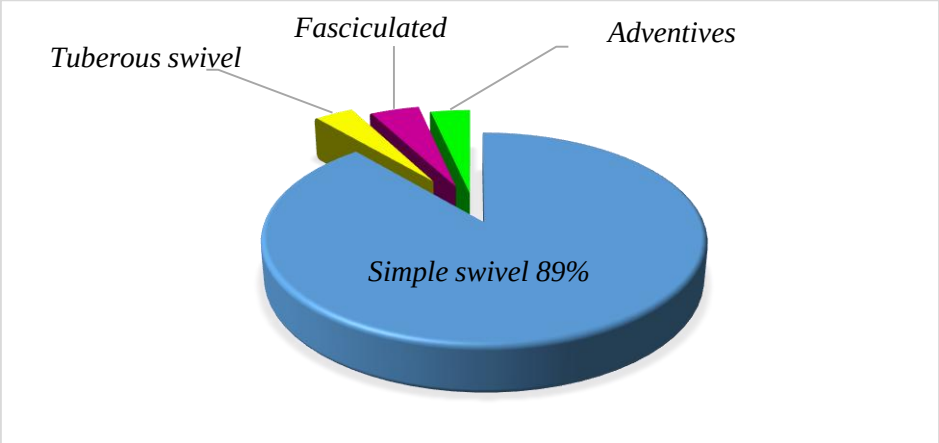

Fig. 9. Distribution of species according to the root systems of the species listed

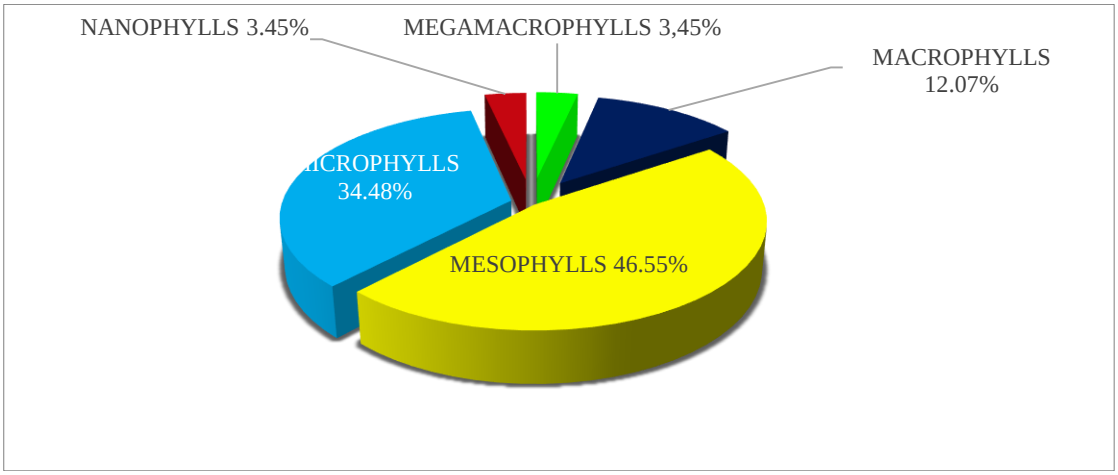

Fig. 10. Distribution of plants according to leaf area

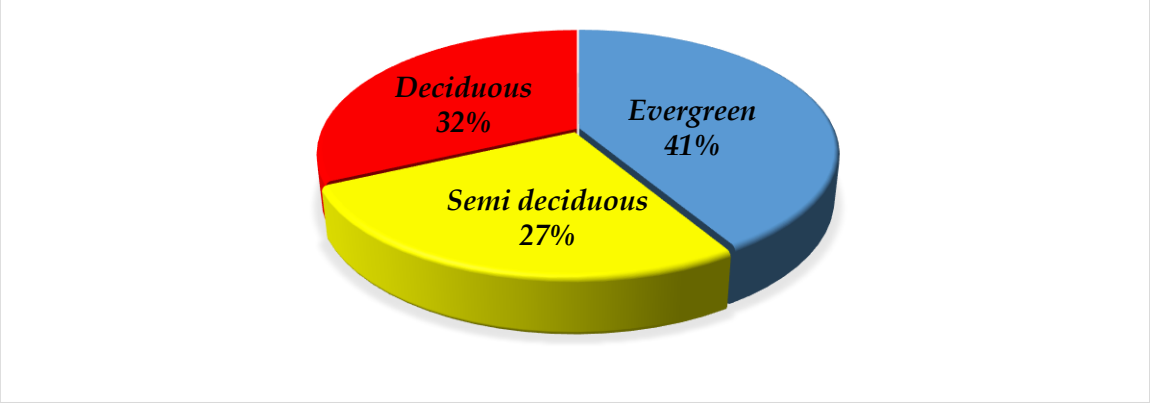

Fig. 11. Distribution of species according to the seasonal leafs phenomenon

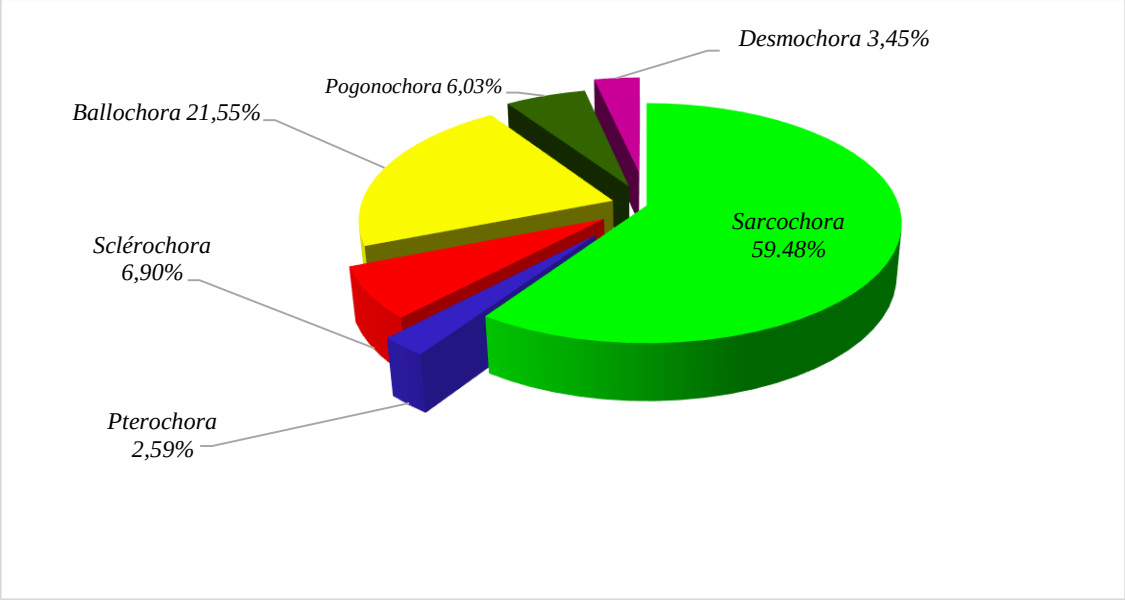

Fig. 12. Distribution of species identified by type of diaspora

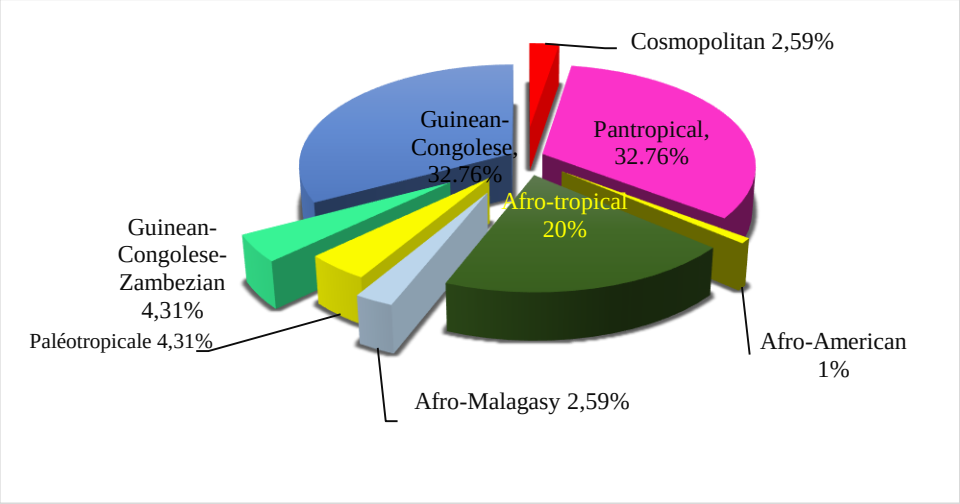

Fig. 13. Distribution of plants according to their biogeographic areas

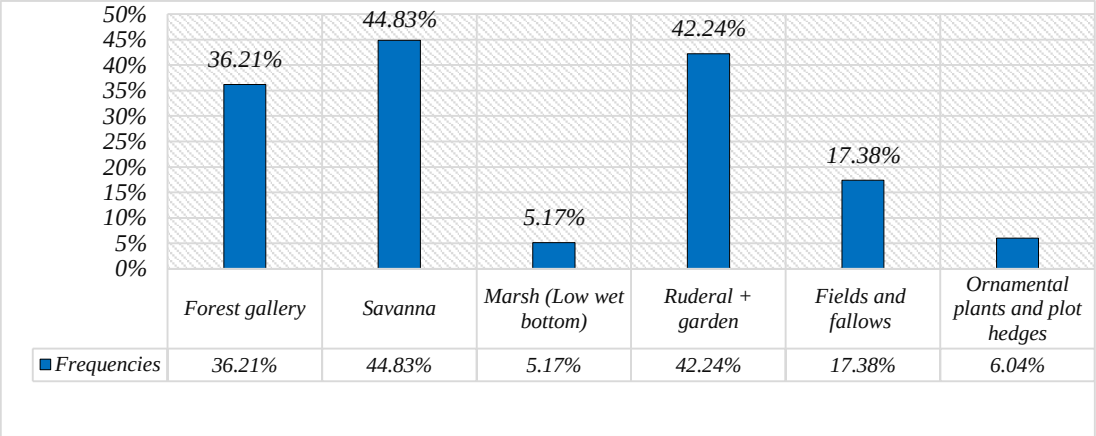

Fig. 14. Distribution of species according to their natural habitats

3.3.7 Phytogeographic distribution of recorded species

Fig. 13 presents the phytogeographic distribution of recorded plant species.

Fig. 13 shows that among the 116 species used by traditional healers of Kasai Oriental against bacteriosis are generally intertropical. The most frequently used species are the Guinean-Congolese and pantropical ones, while the cosmopolitan, Afro-Malagasy and Afro-American species were, on the other hand, the most rarely exploited. In fact, pantropical species and those in Guineo-Congolese appear with the same frequency of 32.76% against 19.82% for afro-tropical species, 4.31% of paleo-tropical species, 4.31% of species Guinean-Congolo-Zambezian and 2.59% for cosmopolitan species as well as for Afro-Malagasy (2.59%) and finally 0.86% for African-American.

3.3.8 Distribution of species according to their natural biotopes

The distribution of plant species according to their naturel biotopes is represented by histograms given in Fig.14.

According to the frequency of their habitats, Fig. 14 indicates that among the species recorded, 44.83% are savannah, 36.21% gallery forest while the lowland wetland or marsh species represent only 5.17%. In addition to these natural biotopes characteristic of the environment of our study area, it should be noted that 42.24% of the species listed are ruderal plants, frequent in places marked by human activities. The invasive species of fields and fallows represent 17.38% while ornamental plants and / or those of plot hedges constitute 6.04% of the species used. The Chi-square frequency test ($\chi 2c = 14.271 > 11.070 = \chi 2t005$) confirms a significant difference for the species of the recorded biotopes. This leads to the conclusion that savannah species predominate among plants from Kasai Oriental used against bacterial pathologies. The presence of ubiquitous species or those adapted to several biotopes is manifested in the percentage calculation.

3.3.9 Distribution of species according to the modes of colonization of biotopes

Fig. 15 gives the distribution of plant species according to the modes of biotopes colonization.

This figure shows that 72.41% of the species recorded are those which settle in a wild and spontaneous way, while cultivated plants represent only 13.91%. The spontaneous species sometimes maintained by humans constitute 26.72% and in turn dominate the invasive species which are often spontaneous post-cultivation, which represent 17.24%. The statistical Chi-square test ($\chi 2c = 99.05 > 11.345 = \chi 2t001$) shows that the difference is very significant between these frequencies. It should therefore be concluded that the traditional healers of Kasai Oriental mainly use wild and spontaneous plants to treat bacterial diseases. Spontaneous wild species, spontaneous sometimes maintained and spontaneous and invasive post-cultivation species are more frequently used compared to cultivated plants.

These results converge with the confirmation by Laghmouch that human activities play an important role in the establishment of different

plant species in this area. In fact, apart from spontaneous wild species, all the other categories are subject to various human influences or during their establishment in their biotopes [23]. Whether cultivated, spontaneous post-cultivation or spontaneous sometimes maintained, humans interfere positively or negatively in their process of settling and colonizing environments as well as in their evolution and that of their biotopes.

3.4. Discussion

The obtained results demonstrates that the therapeutic use of local plants against bacterial diseases is a widely used tradition in Kasai Oriental. This confirms the popular character of certain phytotherapeutic practices in this area where traditional medicine is more utilitarian and even a source of income. In addition, the diversity of plant resources exploited testifies the value of these practices.

It has been observed that the majority of the species used are concentrated in a few families only. This marks the predominance of neighboring species among the plants used and suggests that phytotherapeutics of Kasai Oriental would select plants that are similar for their needs. However, it is difficult to identify in detail from our data the reasons behind these choices. However, a few traditional healers (45 out of 391) stated that they took odors into account when selecting new plants. Some have claimed that certain plants with odors similar to those of other already recognized medicinal species can be tried against the same diseases. They are sometimes retained if the results are positive. This is the case, for example, with *Heinsia crinita* and *Clutia timpermaniana* which emit the same characteristic odor. Such practices would constitute a risk factor for poisoning or complications during trials with new species not yet evaluated to rule out any danger. Thus, the evaluation of the efficacy and safety of medicinal plants in this medium is therefore necessary.

Several species of the most represented families across our data were already mentioned by several authors as having medicinal properties against various diseases. These are: *Annona senegalensis, Piper guineense, Piper umbellatum, Senna occidentalis, Acacia seyal, Albizzia adianthifolia, Entada abyssinica, Milicia excelsa, Maesopsis eminii, Caloncoba welwitschii, Croton mubango, Euphorbia hirta, Jatropha curcas, Synadenium grantii, Ricinus cummunis, Psorospermum febrifugum, Bridelia ferruginea, Phyllanthus muellerianus, Phyllanthus niruri, Uapaca guinensis, Carica papaya, Psidium guayava, Chenopodium ambrosioides, Boerhavia diffusa, Rawvolfia vomitoria, Crossopteryx febrifuga, Borreria ocymoïdes, Gaertnera parvipaniculata, Heinsia crinita, Morinda lucida, Morinda morindoides, Brillantaisia patula, Coleus hybridus, Ocimum basilicum, Ocimum gratissimum, Lycopersicum cerasiforme, Solanum acculeastrum, Ageratum conyzoïdes et Vernonia amygdalina* [4,9,24-29].

The *Fabaceae*, *Euphorbiaceae*, *Rubiaceae*, *Phyllanthaceae*, *Lamiaceae* and *Moraceae* are families which provide more species used; they alone bring together 60 species in total, or 51.72% of all listed species. These results are consistent with those of many authors [4,26,29-34].

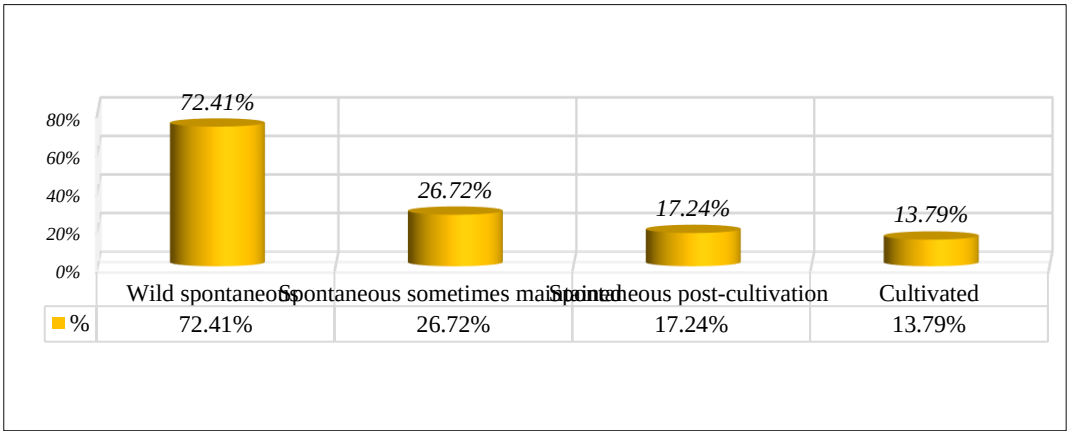

Fig. 15. Distribution of species according to the modes of colonization of biotopes

The strong representativeness of *Fabaceae* (19 species) among the plants listed in this work could be justified by the regrouping of three old families (*Fabaceae*, *Caesalpiniaceae* and *Mimosacea*) which all became subfamilies of the great *Fabaceae* family in the new APG classification (2009). On the other hand, the *Euphorbiaceae*, often more represented by certain authors occupy the second place in our study [27]. This position would in turn be the consequence of the break-up of the old *Euphorbiaceae* family by the separation of the *Phyllanthaceae*. If they could be combined as in the past, the number of species of *Euphorbiaceae* and *Phyllanthaceae* exceeds that of *Fabaceae*.

In addition, several authors have already reported and sometimes demonstrated interesting therapeutic properties for several species of the families most represented in this study. These include the analgesic, healing, antipyretic, antimalarial, antimicrobial, antihypertensive, antidiabetic, antioxidant and anti-inflammatory activities of several plants [4,9, 25,29-36].

Of the 33 *Euphorbiaceae* species identified by Kahumba and which were traditionally used against sexually transmitted infections (possibly bacterial) in the city of Lubumbashi, only 10 are common compared to the 20 species of *Euphorbiaceae* and *Phyllanthaceae* inventoried in this present document study [27].

In studies identifying medicinal plants used against other diseases elsewhere, it was also find some common species with those listed in this work: 45 species on the list of Kibungu [30] who inventoried more than 168 medicinal plants from the Bas-Congo province and their uses. Sixteen species out of the thirty-seven plants used in personal hygiene by women in Kinshasa [9] and nine species among the 46 cited as treating malaria in Butembo [37] are also on the list. Nine common species were also recorded on the list of 31 antidiabetic plants used in the City of Kisangani [38], 8 species on the list drawn up by Kalonda [39] concerning the plants used against malaria in Lubumbashi and only 3 common species with the list of aromatic plants of the ecosystems of the islands of Lwiro and Idwi [40]. In their ethnobotanical, ethnopharmacological and ecological studies, Ngbolua identified several plants used in traditional medicine, among which 11 species are also on the list resulting from this study [36,41-42].

The various differences between the lists would come from the difference of the diseases considered and also from the floristic difference and from that of the phytotherapeutic habits of the various environments concerned as recommended by Gilson & Liben [43]. The fact that several plants known to be effective against bacteriosis in Kasai Oriental are also used elsewhere as medicinal species strengthens confidence in their healing powers. Depending on the environment, these plants are given curative powers on the same diseases or on different diseases in several regions of the DRC and even elsewhere.

However, it should be noted that a few species included in the list resulting from this study do not appear frequently in the literature. There are 20 following species among which 10 belong to families already mentioned elsewhere such as: *Albizzia coriaria, A. lebbeck, Bauhinia purpurea, B. tomentosa, Combretum racemosum, Ficus persicifolia, Jatropha podagrica, J. gossypifolia, Phyllanthus urinaria* and *Craterispermum cerinanthum*. The other 10 species belong to genera that are not frequently encountered in the literature on medicinal plants and seem to constitute a peculiarity of herbal medicine in Kasai Oriental. These are the following species: *Callichia magnifica, Clutia timpermaniana, Daniellia alsteeniana, Eriosema glomeratum, Fagara macrophylla, Macaranga saccifera, Phymatosorus scolopendria, Sterculia quinqueloba, Tabernaemontana ventricosa* and *Treculia africana*. Some species known to be antibacterial infections are reported to be also effective against other non-bacterial diseases. Depending on the habits of the environment, some of these species also give food, condiment and / or aromatic products. This is particularly the case for species with edible fruits such as: *Annona senegalensis, A. cuneata, A. arenaria, Aframomum sanguineum, Canarium shweinfurthii, Carica papaya, Costus afer, C. lucanusianus, Lycopersicon cerasiforme, Mangifera indica, Piper guineense and Psydium guajava.* This is also the case for species whose edible parts are the leaves (*Mussaenda arcuata, Ocimum basilicum, O. canum, O. gratissimum, Piper ombelatum, Brillantaisia patula*) or flower corollas (*Ceiba pentandra*). Thus, meals comprising the edible parts of these plants, which are also used in the preparation of medicaments, can be qualified as medicaments.

Indeed, each time they are served at the table, consumers consciously or unconsciously and sometimes preventively benefit from the therapeutic effects of these plants as stated by Cabalion and Fleurentin [44-45].

Regarding the biological types of the listed species, this work revealed the predominance of woody species among the plants of Kasai Oriental used against bacteriosis. These results converge with those of Ngbolua in the District of Lukunga in Kinshasa where the plants used in herbal medicine are distributed in 38% trees, 26% shrubs, 15% lianas, 15% herbs perennials and 3% annual herbs [42]. They also agree with the conclusions of Kabena who confirms that shrubs were the most used and constituted 35% of the intimate hygiene species of women in Kinshasa [9]. This high frequency of woody plants can be attributed to the characteristics of the predominantly savannah vegetation in our study area. Indeed, the local flora includes many woody species scattered over a grassy carpet dominated mainly by a few species of grasses. If the latter dominate in density and in terms of area occupied, woody species are distinguished by their diversity which is one of the factors of their choice.

According to the biological types of these same species, this study revealed a high frequency of phanerophyte species especially nanophanerophytes and microphanerophytes while the use of hemicryptophytes was found rare among the species used against bacteriosis in herbal medicine in Kasai Oriental. These results are similar with those of Kabena who also found that microphanerophytes (32%) occupied the first position among the intimate hygiene plants of women in the city of Kinshasa [9]. Ngbolua on the medicinal flora of the Lukunga District in Kinshasa had also found similar results with 28% of mesophanerophytes, 20% of microphanerophytes, 18% of lianous phanerophytes, 13% of rhizomatous geophytes, 8% of nanophanerophytes, 5 % of bulbous geophytes and megaphanerophytes against 3% of therophytes [42]. It should be considered that the similarities between the vegetation of these zones would be at the base of this convergence of the results.

In conclusion, the results of this study confirm that perennial species (phanerophytes and woody) are more used in herbal medicine in Kasai Oriental. This would be due to the fact that the latter offer a guarantee of permanent availability all year round. This allows them to be harvested for various uses when needed. This consideration is just as plausible because the surveys of this study revealed that most herbalists in Kasai Oriental most often harvest their drugs when they need them. For De Weerdt, the high use of phanerophytes is also due to their place in all tropical flora. In Kasai Oriental, this biological type is diverse and scattered over a carpet of hemicryptophytes throughout the vegetation of the area [46].

With regard to leaf dimensions, the present work confirmed the predominant use of mesophyll species to treat bacteriosis in Kasai Oriental. This conclusion corroborates that of Kabena according to which mesophylls plants were the most represented with around 43% among intimate hygiene plants in Kinshasa [9]. These results would once again be linked to the type of vegetation depending on the climatic conditions of the area. Indeed, the scarcity of forests in Kasai Oriental would explain the low representativeness of species with very large leaves, while the hot and humid tropical climate which characterizes this space would in turn explain the total absence of aphylic plants in this collection.

As for the distribution of the species identified according to the diaspores, the phytotherapists of Kasai Oriental use more species with sarcochore diaspores. This conclusion corroborates that of Kabena who also confirmed the predominance of species with sarcochore diaspores and the rarity of species with desmochore and pogonochore diaspores among the plants for intimate hygiene of women in Kinshasa [9]. The similarity between the conclusions of these two studies would be due to the similarity between the vegetation of these two areas. Indeed, despite the situation of Kinshasa in the middle of the central basin, the grassy savannah dominates its vegetation as in Kasai Oriental.

With regard to the chorological distribution of the plants identified in this study, pantropical species and those from Guinea-Congolese are the most used in Kasai Oriental. Kabena's study, on the other hand, declared the predominance of Afro-tropical plants (35%) while there was only one African-American species and one cosmopolitan (i.e. 3%) among the plants intimate hygiene of women in Kinshasa [9]. This difference would be the consequence of the geographical location of Kasai Oriental in the transition zone between the

Guinean-Congolese region and the Zambezian region, whereas the Kinshasa site explored by the Kabena study is located entirely in the central basin from the Guinea-Congolese region [9].

Considering the habitats of Kasai Oriental species used in herbal medicine against bacterial pathologies, the conclusion of the present study confirmed a more frequent use of savannah species (44.83%). Among the plants for intimate hygiene of women in Kinshasa, savannah species (51%) were also confirmed to be predominant, followed by species from secondary forest (19%) before those from primary forest with 14% Kabena (2014). If the predominance of savannah species in Kasai Oriental is attributable to the fact that the savannah is the natural plant formation that covers the large part of this province, the large number of ruderal species is obviously due to the fact that more than 70.59% of this province is already occupied by heavily anthropized areas [23].

The divergences that appear compared to the conclusions of Kabena were linked to the fact that Kasai Oriental is currently 65.65% occupied by the agricultural complex and the permanent agriculture zone covers 4.96% of the land space [9]. In addition, it should always be taken into account that most of the medicinal plants consumed in large cities such as Kinshasa are often harvested outside these.

4. CONCLUSION

Traditional therapeutic recipes are mainly based on the use of active ingredients contained in plants or their extracts. It is traditional societies that hold most of the knowledge and associated practices using phytotherapeutic resources. The sustainability of these practices now seems threatened. Indeed, very little of this knowledge has been systematically recorded; the consequence being a progressive loss of this treasure on the occasion of the death of certain personalities inclined to the practice of absolute secrecy. Has it not been rightly said that an old man who dies in Africa is a whole library that disappears? Phytotherapeutic knowledge is certainly affected by such losses. The recording of these practices and knowledge ensures their sustainability for possible future regulation.

The aim of this work was to carry out an ethnobotanical study aiming to inventory the plants of Kasai Oriental deemed effective by herbalists in the treatment of bacterial diseases.

After analyzing the data from surveys of traditional healers and users of herbal medicine, the following conclusions emerged:

- The use of herbal medicine against bacteriosis is common in Kasai Oriental. It is a medicine that is both utilitarian and a source of income. The diversity of the plant resources exploited testifies to the value of these practices;
- 116 species of plants used against bacteriosis were inventoried. They belong to 19 orders, 39 families and 87 genera;
- The *Fabaceae*, *Euphorbiaceae*, *Rubiaceae*, *Phyllanthaceae*, *Lamiaceae* and *Moraceae* families are the most represented in terms of the species mentioned. The genera *Senna* and *Ficus* are the most endowed with species;
- The plants exploited are most often woody phanerophytes. Among these species, shrubs predominate as well as mesophylls;
- Species with sarcochore diaspores are the most frequently used as well as plants whose leaves persist throughout the year;
- Savannah species, wild and pantropical plants are the most frequent among those which provide drugs used against bacteriosis by traditional healers of Kasai Oriental;

Given the importance of these species, their protection is necessary and deserves concerted efforts both collectively and individually at the local, provincial, national level, to enhance further their value. Relevant pharmacological and phytochemical studies are also needed to assess their therapeutic efficacy and safety for the production of new and improved herbal drugs.

CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Julie Laplante. Médicaments et médecines traditionnelles. Le cas d'interventions en santé internationale auprès des autochtones de l'Amazonie brésilienne. Éthique publique [Online]. 2006;8(2). Online since 12 September 2015, connection on 20 May 2021. DOI: https://doi.org/10.4000/ethiquepublique.1856
2. WHO. Global report on traditional and complementary medicine; 2019. Accessed 18/05/ 2021. Available:https://www.who.int/health-topics/traditional-complementary-and-integrative-medicine#tab=tab_1
3. WHO. Traditional medicine strategy; 2014-2023. Accessed 07/02/2021. Available:https://www.who.int/medicines/publications/traditional/trm_strategy14_23/en/
4. Kalanda K, Musuasua M and Ndala K. Detection of the antibacterial properties of aqueous extracts of some medicinal plants used in Mbujimayi. Annals of ISP / MBUJIMAYI. French. 2005;13:5-22.
5. Berche P, Simonet M, Gaillard JL. Bacteriology: Bacteria of human infections. Collection De la biologie à la Clinique; Lavoisier; 1994.
6. Combe C, Passas E, Letranchant L, Champagne H. Phytotherapy and antiretrovirals: Actions carried out in a therapeutic education program in Medicine and Infectious Diseases. French. 2019;49(4):158-169.
7. Sofowora A. Medicinal plants and traditional medicine from Africa. Paris: Karthala; 2010.
8. Morel JM. Practical treatise on phytotherapy: Yesterday's remedies for tomorrow's medicine Paris: Grancher; 2008.
9. Kabena NO, Ngombe KN, Ngbolua KN, Kikufi BA, Lassa L, Mboloko E et al. Ethnobotanical and ecological studies of feminine intimate hygiene plants used in Kinshasa (Democratic Republic of Congo). Int. J. Biol. Chem. Sci. French. 2014;8(6):2626-2642.
10. Barbara F (translation Altide P, Weniger B.). The convention on biological diversity in the DRC: Implementation of the project "La Cuvette Centrale as a reservoir of medicinal plants". Ethnopharmacologia, French. 2012;48.
11. Ilumbe BG, Joiris V, Lohandjola NG, Habari JP. Contribution à l'étude des plantes médicinales utilisées dans le traitement des abcès dans le territoire de Bikoro, province de l'Equateur en RDC. Int. J. Biol. Chem. Sci. 2019;13(1):353-368.
12. Tilburt JC, Kaptchuk TJ. Herbal medicine research and global health: an ethical analysis Bulletin of the World Health Organization. 2008;86:577–656.
13. APG III. An update of the angiosperm phylogeny group classification for the orders and families of flowering plants: APG III. Botanical Journal of the Linnean Society. 2009;161:121-129.
14. APG IV. An update of the Angiosperm phylogeny group classification for the orders and families of flowering plants: APG IV. Botanical Journal of the Linnean Society. 2016;181:1-20.
15. Anonymous. Flora of Central Africa (Zaire-Rwanda-Burundi): Spermatophytes, 1972-1992. National Botanical Garden of Belgium; 1994.
16. Anonymous. Flora of Congo, Rwanda and Burundi. Spermatophytes, 1967-1971. National Botanical Garden of Belgium; 1972.
17. Hauman L, Gilbert G, Boutique R, Wilczek R, Léonard J, Hoyle AC et al. Angiospermae-dicotyledoneae: Rosaceae, connaraceae, and mimosaceae. In Flora of Belgian Congo and Ruanda-Urundi. INEAC. Vol II. Brussels; 1952.
18. Léonard J. Spermatophyte: Euphorbiaceae. In Flora of Belgian Congo and Ruanda-Urundi. INEAC. Vol. I-VII and IX. Brussels; 1960.
19. Balle S, Hauman L, Lebrun J, Robyns W, Boutique R. Angiospermae - dicotyledoneae: Piperaceae, ulmaceae moraceae, loranthaceae, polygonaceae (1952-1963). In Flora of Congo and Rwanda - Burundi: Spermatophytes. INEAC. vol. VIII and X. Brussels; 1967.
20. Tailfer Y. The dense forest of Central Africa: Practical identification of main trees, Volume I; CTA; Wageningen (Netherlands); 1989.
21. Tailfer Y. The dense forest of Central Africa: Practical identification of main trees, Volume II; CTA; Wageningen (Netherlands); 1989.

22. Lubini A. The vegetation of the LUKI biosphere reserve in Mayombe (Zaire). In Opera Botanica Belgica, Belgium. 1997;100.
23. Laghmouch M. Map of the land use of the Democratic Republic of the Congo at 1: 500,000. Tervuren: Department of Earth Sciences. MRAC, Tervuren. Belgium; 2008.
24. Moretti C, Debitus C, Fournet A, Sauvain M, Bourdy G and Laurent D. Tropical biological diversity and therapeutic innovation by ORSTOM. In Annals of the Belgian Society of Tropical Medicine, French. 1993;73(3).
25. Nzuki BF, Termote C, Kibungu K, et Van Damme P. Identification et importance locale des plantes médicinales utilisées dans la région de Mbanza-Ngungu, République démocratique du Congo. In Bois et Forêts des Tropiques. 2013;316(2):63-77.
26. Ekoumou C. Phytochemical and pharmacological study of 5 traditional recipes used in the treatment of urinary tract infections and cystitis. Doctoral thesis, Faculty of Medicine, Pharmacy and Odonto-Stomatology (F.M.P.O.S), University of Bamako; 2003.
27. Kahumba B. Chemical and biological study of Euphorbiaceae used in traditional medicine against sexually transmitted infections: Case of Uapaca kirkiana Mull. Arg. Doctoral thesis in Pharmaceutical Sciences; University of Lubumbashi; 2005.
28. Patwardhan B. Drug discovery and development: Traditional medicine and ethnopharmacology perspectives Sci. Topics Bulletin of the World Health Organization. 2009;86:577–656.
29. Kabongo MF. Ethnobotanical and chemical study of plants known to be antidiarrhoeal used in the District of Tshilenge, DEA thesis; Pharmacological faculty, UNILU; 2014.
30. Kibungu K. Some medicinal plants from Bas Congo and their uses; A.O. LIC. SC. BOT; 2003.
31. Mangambu M, Mushagalusa JD, Kasali F. et Kadima NJ. Contribution to the phytochemical study of some anti-diabetic medicinal plants in the city of Bukavu and its surroundings (Sud-Kivu, DRCongo). J. Appl. Biosci. French. 2014;75: 6211-6220.
32. Ngoy K. Studies of some plants known to be anti-diarrheal used in Lubumbashi and its surroundings; DEA thesis; Faculty of Sciences, UNILU; 2009.
33. Mulamba MKJ. Chemical and ethnobotany study of some plants known to be antimalarial used in Mbujimayi and its surroundings. DEA thesis; Faculty of Sciences, UNILU; 2012.
34. Bokaketi EG, Moundaga RA, Tondo BN. Identification of some plants with medicinal properties found in certain markets, among certain traditional healers in Brazzaville and in Nganga-Lingolo. E.N.S. Department of Natural Sciences, Marien Ngouabi University (Brazzaville); 2016.
35. Lutwig T, Lumbu S, Kahumba B, Kahambwe T, Mbayo K, Kalonda M, et al. Contribution to the study of some anti-diarrheal medicinal plants in use in the city of Lubumbashi and its surroundings. Annals of Pharmacy, UNIKIN, French. 2005;13(1):75-86.
36. Ngbolua KN, Mpiana PT, Mudogo V, Ngombe NK, Tshibangu DST, Ekutsu E, et al. Ethno-pharmacological survey and floristical study of some medicinal plants traditionally used to treat infectious and parasitic pathologies in the Democratic Republic of Congo. International Journal of Medicinal Plants. Photon. 2014;106:454-467.
37. Kasali FM, Mahano AO, Kadima NJ, Mpiana PT, Ngbolua KN, Tshibangu TSD. Ethnopharmacological survey of medicinal plants used against malaria in Butembo City (D. R. Congo). Journal of Advanced Botany and Zoology. 2014; 1(1).
38. Katemo M, Mpiana PT, Mbala BM, Mihigo SO, Ngbolua KN, Tshibangu DST, et al. Ethnopharmacological survey of plants used against diabetes in Kisangani city (DR Congo). Journal of Ethnopharmacology. 2012;144:39–43.
39. Kalonda EM, Mbayo MK, Mulamba JM, Lumbu JBS, Misakabu FM, Mpiana PT, et al. Ethnopharmacological survey of plants used against malaria in Lubumbashi city (D.R. Congo). Journal of Advanced Botany and Zoology. 2014;1(2).
DOI: 1015297.
40. Mpiana PT, Kazadi M, Kusamba C, Mwanga IM, Matabaro A, Ngbolua KN. Floristic survey and wild oilseed plants frequency in Lwiro and Idjwi island ecosystems in albertine rift. Journal of Advanced Botany and Zoology. 2015;2:14-30.
DOI: 10.15297.

41. Ngbolua KN, Benamambote BM, Mpiana PT, Muanda DD, Ekutsu EG, Tshibangu DST, et al. Ethno-botanical survey and ecological study of some medicinal plants species traditionally used in the district of Bas-Fleuve (Bas-Congo Province, Democratic Republic of Congo). Research Journal of Chemistry. 2013;01(02):01-10.
42. Ngbolua KN, Mandjo BL, Munsebi JM, Masengo CA, Lengbiye EM, Asamboa LS, et al. Ethnobotanical and ecological studies of plants used in traditional medicine in the Lukunga District in Kinshasa (DR Congo). International Journal of Innovation and Scientific Research, French. 2016;26(2):612-633.
43. Gilson P, Liben L. Map of the soils and vegetation of the Belgian Congo and Ruanda-Urundi. Kasai explanatory leaflet; 1960.
44. Cabalion P. Tradition and innovation: “A honeycomb world”. Drugs and food: the ethnopharmacological approach. In European Colloquium of Ethnopharmacology and XXF International Conference of Ethnopharmacology, Heidelberg. ORSTOM editions, Paris; 1993.
45. Fleurentin J. Ethnopharmacology and foods: Introduction to the subject and reflections on biological efficacy. Drugs and food: the ethnopharmacological approach. In European Colloquium of Ethnopharmacology and XXF International Conference of Ethnopharmacology, Heidelberg. ORSTOM editions, Paris; 1993.
46. De Weerdt J, Toirambe B, Delvaux CL, Verhegghen A, Defourny P, Beeckman H. The flora of Kasai-Oriental; In Omasombo TJ et al. Kasai Oriental: a Gordian knot in the Congolese space. MRAC, Tervuren, Belgium; 2014.

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