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Ethnopharmacological Survey of Medicinal Plants Used against Malaria in Bukavu City (D. R. Congo)

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Authors' contributions

All the authors have cordially supported to the work and preparation of manuscript. Authors FMK, AOM and DSN conducted de survey; authors NJK, DSTT and KNN gave the classification of plants; author PTM wrote the first draft and author FMM managed the literature searches. All authors read and approved the final manuscript

Research Article

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ABSTRACT

Aims: An Ethnopharmacological survey was conducted in the city of Bukavu, in order to identify plant species and recipes used in Congolese folk medicine for the treatment of malaria.
Study Design: Survey; plant collection; plant identification and classification: family, used part, treated disease, recipes preparation; floristic characterization.
Place and Duration of Study: "Université Officielle de Bukavu" (DR Congo), from February 2011toDecember 2012.
Methodology: Forty-nine healers belonging to different ethnic groups were interviewed about the plant species used in traditional medicine for the management of malaria in the city of Bukavu. The name of the plants, the plant parts, the modes of preparation and the modes of administration of recipes were recorded. Cited plants were collected and

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identified at herbarium of the Laboratory of Ecology and Plants Resource Management, Faculty of Sciences, “Université Officielle de Bukavu”. The plants ecological status was also determined.
Results: Forty species of plants belonging to twenty seven botanical families were identified. The main habitat preference of species is cultivated (62%), trees constituted 33% of morphological type while 30% of biological type are microphanerophytes. The decoction was the main mode of preparation (47.5%) and almost all recipes (100%of cases) are administrated by oral route. Leaves constituted sixty percent of plant organs used for drug preparation.
Conclusion: Some plant species cited (62.5%) are known in the literature to possess antimalarial activity. Further studies should be undertaken to investigate effectiveness of other plants that have not yet been studied and to determine their chemical composition.

Keywords: Medicinal plants; malaria; Ethnopharmacological survey; Bukavu; D.R. Congo.

1. INTRODUCTION

Malaria is the world's most important parasitic disease caused by five species of parasites of the genus Plasmodium that affect humans (*P. falciparum, P. vivax, P. ovale, P. malariae* and *P. knowlesi*). Malaria due to *P. falciparum* is the most deadly form and it predominates in Africa. It is transmitted to humans by the bites of infected female mosquitoes of more than 30 anopheline species. In the human body, the parasites multiply in the liver, and then infect red blood cells. Symptoms of malaria include fever, headache, nausea, vomiting, muscle aches, splenomegaly, anemia, jaundice etc [1-3].

Nearly half of the world's population is exposed to malaria. According to WHO world malaria report 2012, globally an estimated 3.3 billion people were at risk of malaria in 2011, with populations living in sub-Saharan Africa having the highest risk of acquiring malaria. Children under five years of age and pregnant women were the most severely affected [1]. More than one on five child deaths (20%) occurring in Africa is due to malaria. It’s estimated that each year, an African child has on average 1.6 to 5.4 of malaria fever’s episodes and then each 30 seconds a child dies in this continent. This is also due to the lack of access to health facility centres due to for example distance from the community. According to the latest Doctors without Borders’s campaign, malaria is qualified as "a weapon of mass destruction that nobody cares” [2].

The socioeconomic consequences of this disease are particularly dramatic in rural areas where poverty and malnutrition are more pronounced. In the absence of an effective vaccine, the fight against malaria depends on chemotherapy and the reduction and prevention of human/*Anopheles* mosquito contacts through the use of insecticides treated bed nets, insecticides and environmental care [1].

Malaria is becoming more resistant to a number of current conventional drugs. This has resulted in resurgence in transmission and an increase in adverse outcomes due to therapy failure. Hence, new highly efficacious antimalarial agents are urgently needed. Thus, many communities who live in endemic areas, have experienced for a long time in the use of anti malarial plants in their local environments [4,5].

For thousands of years, plants have constituted the basis of traditional medicine systems and it is believed strongly that if the herbs used to treat malaria by African populations

hundreds of years ago were not effective, malaria would have destroyed Africa [6]. In fact, natural products have been a good source of lead compounds for drug development. For instance, quinine, isolated from *Cinchona* bark, was used as a template for the synthesis of quinoline antimalarial drugs (chloroquine, amodiaquine and mefloquine), and artemisinin isolated from the Chinese plant *Artemisia annua* L. has been used successfully against most chloroquine and other quinolone types – resistant *P. falciparum* strains [7].

The Democratic Republic of Congo (DRC), one of the sub-Saharan countries strongly affected by malaria, contains a large area of Congo basin forest reputed for the extraordinary richness of its flora and boasts a wide variety of medicinal plants species [8]. It is therefore imperative that Congolese biodiversity should be screened in order to find compounds from plants used in traditional medicine that can give new antimalarial drugs. In the present work, we report on the plants, which have been identified as antimalarial plants in Congolese traditional medicine in the Bukavu City, located in the east and mountainous part of the DRC.

2. MATERIALS AND METHODS

2.1. Study Area

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The ethnopharmacological investigations were conducted in Bukavu, the capital of the South Kivu province, located in the eastern part of DRC (Fig. 1).

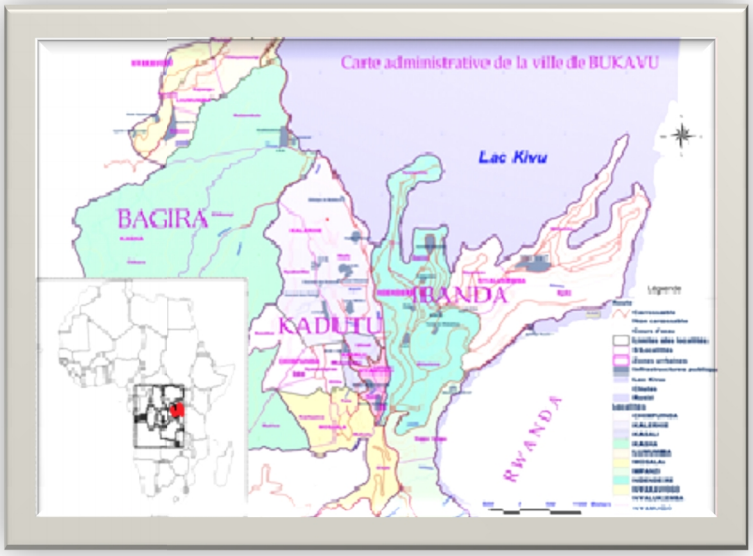

Fig. 1. Location of Bukavu City.

Bukavu is located between 2° 3' S latitude and 28° 50' E longitude. Its average altitude is 1600 m. This city is located in a humid tropical climate with short dry season (3-4 months) and the temperature is wetted by the presence of Kivu Lake [9]. The climate of Bukavu city is regulated geographically by the equator line and altitude. According to its humid climate, the city of Bukavu would have forest vegetation. Nevertheless, the presence of relict species of deciduous seasonal forests in some places is bio-indicators vegetation. Bukavu is

constituted with three “communes”: Ibanda, Bagiraand Kadutu. In 2009, the population of Bukavu was estimated to619,161 inhabitants. The predominant indigenous ethnical groups in this area are: Shi, Lega, Tembo, Bembe, Hutu and Tutsi [10].

2.2 Ethnopharmacological Survey

An ethno pharmacological survey was conducted from February 2011toDecember 2012. Forty-nine traditional healers from above cited ethnic groups were identified and interviewed. The identification of the collected plants was carried out by comparison with different vouchers referenced at the herbarium ofthe Laboratory of Ecology and Resource Management Plants, Faculty of Sciences of the “Université Officielle de Bukavu”, with the help of the botanist team from INERA-Kinshasa (Institut National d’Etudes et de Recherches Agronomiques) including especially Mr Zamena Nsita Jonas, Mr. Nlandu Lukebakio Boniface and Mr Mambwana Mambu Simon. Vouchers specimens are on deposit at the same herbarium.

The data checklist for Ethnobotanical field work focuses on the following elements [11]:

Identification of the traditional healer (name, age, address, quality); plant data (scientific and vernacular names, village survey, parts used, time of harvesting, stage or degree and organ development); plant therapy data : modes of preparation and administration (transaction and pharmaceutical form, concentration of the organ, dose, frequency of taking, instructions and any other associated plants); other indications (diseases and symptoms, physiological effects, against indications and side effects).

2.3 Floristic Characterizations of Plants Collected

Medicinal plants used in traditional medicine against malaria in Bukavu are characterized in this work by their morphological types, biological types, habitat types and phytogeographical distribution.

2.3.1Morphological types

The morphological types are defined according to Letouzey [12] and the "PHARMEL" Database [13].They include: lianas (L), trees (T), shrubs (Sh), sub-shrubs (Ssh), annual herb (Ah), vicace herb (Vh), climbing shrubs (Sh cl).and perennial herb (Ph).

2.3.2 Phytogeographical distribution

The phytogeographical types of distribution presented in this work are defined in accordance with the chorological subdivisions agreed for the Central African region [12-16]. These are: Cosmopolitan (Cosm.), Pantropical (Pan), Paleotropical (Pal), Afro-tropical (Af tr), Guinean (Guin), Centroguinean (C-Guin), Afro-american (Af am), American tropical (Am tr), tropical Asia (Asia tr) and Afro-madagascar (Af ma) [17,18].

2.3.3 Biological types

Biological types below have been selected: Mesophanerophytes (MsPh), Microphanerophytes (McPh), Nanophanerophytes (NPh), Chamaephytes (Ch), Therophytes

(Th) and Geophytes (G), Therophytes scapeux (Th sc), climbing Therophytes (T cl), erected Chamephytes (Ch er) and climbing Chamaephytes (Ch cl).

2.3.4 Habitat preferences

Only the most characteristic habitat of each plant species is indicated. The types of habitats retained in this document are therefore: farms or crops which are cultivated species (cult), Forests (For), Fallow (Fal), Ruderal or plants found in the village (Rud) and Sub-spontaneous Cultured (Cult ssp), and secondary Forest (FoS).

3. RESULTS AND DISCUSSION

Forty species of plants used in Bukavu city (DRC) for the management of malaria were identified. These plants are arranged in alphabetical order of family's and species and listed in Tables 1 and 2.

Table 1. Ecological characteristics of plants used against malaria in Bukavu city (DRC)

Families	Plants species	Morphogical type	Biological type	Habitat type	Phytogeogr Distribution
Alliaceae	*Allium sativum* L.	Vh	G	Cult	Cosm.
Apocyanaceae	*Catharanthus roseus* (L.) G. Don.	Ssh	NPh	Cult	Pan (Am tr)
Asteraceae	*Ageratum conyzoides* L.	Ah	Tsc	Rud	Pan
	Artemisia annua L.	Ah	NPh	Cult	Pal
	Athemis nobilis L.	Vh	NPh	Cult	Pan
	Bidens pilosa L.	Ah	Th	Rud	Pan
	Matricaria camomilla L.	Ah	NPh	Fal	Cosm
	Tithonia diversifolia (Hem)A.Cray.	Ssh	NPh	Rud	Pan (Am tr)
	Vernonia amygdalina Del	Sh	McPh	Fal	Af tr
Bromeliaceae	*Anana cosmesus* Merr.	Vh	Ch er.	Cult ssp	Pan (Am tr)
Caricaceae	*Carica papaya* L.	T	McPh	Cult	Pan (Am tr)
Chenopodiaceae	*Chenopodium ambrosioides* L.	Ah	Tsc	Cult ssp	Cosm (Am tr)
Cucurbitaceae	*Momordica foetida* Schumach.	Ah	Tgr	FoS	Af tr
Cupressaceae	*Cuprecuss lusitanica* Mill.	T	MsPh	Cult	Pan (Am tr)
Euphorbiaceae	*Euphorbia pilulifera* L.	Ah	Th	Fal	Pan
Fabaceae	*Arachis hypogaea* L.	Ah	Tsc	Cult	Pan (AM tr)
	Cassia occidentalis L.	Ssh	NPh	Cult	Pan
	Erythrina abyssinica Lam. ex DC	T	McPh	Cult	C-Guin
	Indigofera arrecta Hochst. ex A. Rich	Ah	McPh	Fal	Pan
	Senna spectabulus L.	Vh	McPh	Cult	Pan

Hypericaceae	*Harungana madagascariensis* Lama. ex Poir.	T	McPh	For	Af ma
Lamiaceae	*Mentha piperita L.*	Ah	Th	Cult	Cosm
	Tetradernia ruparia (Hochst). Codd.	A	NPh	Cult ssp	Af tr
Lauraceae	*Persea americana* Mill.	T	MsPh	Cult	Pan (Am tr)
Meliaceae	*Melia azedarach* L.	T	MsPH	Cult	Pan (Asia tr)
Myrtaceae	*Eucalyptus globulus* L.	T	McPh	Cult	Pan
	Psidium guayava L.	T	McPh	Cult ssp	Pan (Am tr)
Nyctaginaceae	*Mirabilis jalapa* L.	Sh	Ch er	Cult	Pan (Am tr)
Passifloraceae	*Passiflora foetida* L.	Vh	Ch cl	Ja	Af tr
Phytolaccaceae	*Phytolacca dodecandra* L'Hérit	Sh gr	Ch gr,	Fal	Af tr
Piperaceae	*Piper guineense* Schum and Thonn.	L	McPh	For	Guin
Plantaginaceae	*Plantago palmata* Hook.f.	Vh	NPh	Rud	Cosm
Poaceae	*Cymbopognon citratus* (DC) Stapf.	Vh	Tsc	Cult	Pan (Asia tr)
Rubiaceae	*Cinchona ledgeriana* Moes.	T	McPh	Cult	Af tr
Rutaceae	*Citrus limon* (L.) Burn.f,	T	McPh	Cult	Pan
	Citrus aurantium L.	T	McPh	Cult	Pan (Asia tr)
Solanaceae	*Physalis peruvianna* L..	Ah	Th	Rud	Pan
Trepeolacaea	*Tropaeolum majus* L.	Vh	Ch er	Cult	Cosm (Am tr)
Verbenaceae	*Lantana camara* L.	T	NPh	Cult ssp	Pan (Am tr)
Xanthrorrhoeaceae	*Aloe sp.*	Ah	G	Cult	Pan

L: Lianas, T: trees, Sh: shrubs, Ssh: sub-shrubs, Ah: annual herb, Vh: vicace, Sh, cl: climbing shrubs, and Ph: perennial herb.

Cosm: *Cosmopolitan, Pan: Pantropical, Pal: Paleotropical, Af tr: Afro-tropical, Guin: Guinean, C-Guin: Centroguinean, Af am: Afro-american, Am tr: American tropical, Asia tr: tropical Asiaand Aft r: Afro-madagascar.*

MsPh: *Mesophanerophytes, McPh: Microphanerophytes, NPh: Nanophanerophytes, Ch: Chamaephytes, Th: Therophytes and G: Geophytes,Th sc: Therophytes scapeux, T cl: climbing Therophytes, Ch er: erected Chamephytes and Ch cl: climbing Chamaephytes,*

Cult: *farms or crops which are cultivated species, For: Forests, Fal: Fallow, Rud: Ruderal or plants found in the village and Cult ssp: Sub-spontaneous Cultured, and Fos: secondary Forest.*

Table 2. Ethnobotanical data on plants used against malaria in Bukavu city (DRC)

Families	Plants species	Used parts	Treated diseases	Vernacular name (language)	Preparation mode(solvent)	Frequency (%)
Alliaceae	*Allium sativum* L.	Bulbs	Hypertension	Itunguru sumu (Mashi) Litunguru Sumo (Swahili)	Tincture (Alcohol)	10^a 0^b
Apocyanaceae	*Catharanthus roseus* (L.) G. Don.	Leaves	Diabetes	Vinka (Swahili)	Decoction (water)	12^a 4^b
Asteraceae	*Ageratum conyzoides* L.	Leaves	Dermatosis.	Kahyorhe (Mashi)	extortion	8^a 4^b
	Artemisia annua L.	Leaves	Flu, vermifuge	-	Infusion (water)	18^a 46^b
	Athemis nobilis L.	Flowers	Fever, flu	-	Infusion (water)	8^a 4^b
	Bidens pilosa L.	Leaves	Cough Vermifuge	Kashisha (Swahili) Nyassa (Kilega) Igishokoro (Kinyarwanda)	Decoction (water)	8^a 15^b
	Matricaria camomilla L.	Fruits	-	-	Infusion (water)	10^a 4^b
	Tithonia diversifolia (Hem)A.Cray.	Leaves	Amibiasis, Diabetes	Cilula (Mashi)	Decoction (water)	12^a 0^b
	Vernonia amygdalina Del	Fruits	Diabetes	Mubirizi (Mashi)	Maceration (bananas' juice)	4^a 15^b
Bromeliaceae	*Ananacosmesus* Merr.	Leaves	Constipation, typhoid fever	Nanasi (Swahili), inanasi (Mashi)	extorsion	4^a 0^b
Caricaceae	*Carica papaya* L.	Roots	Constipation, hemorrhoids, hypertension	Papayi (Swahili), ipapayi (Mashi)	Decoction (water)	18^a 8^b
Chenopodiaceae	*Chenopodium ambrosioides* L.	Leaves	-	Kivunjahoma (Swahili), mugembye (Mashi)	Infusion (water)	8^a 38^b
Cucurbitaceae	*Momordica foetida* Schumach.	Leaves	Vermifuge	Lulali, muhu (Mashi)	extorsion	4^a 0^b
Cupressaceae	*Cuprecuss lusitanica* Mill.	Leaves	Hemorrhoids	Mashindano (Swahili), nsindani (Mashi)	Infusion (Water)	4^a 0^b
Euphorbiaceae	*Euphorbia pilulifera* L.	Aerial part	Dermatosis	-	Maceration (Oil)	4^a 23^b
Fabaceae	*Arachis hypogaea* L.	Seed	Constipation, typhoid	Kalanga (Swahili), Kabemba (Mashi)	Maceration (water)	4^a 0^b

	Cassia occidentalis L.	Leaves	Dermatosis, hypertension Vermifuge	Mushegamanjokakashegema (Mashi)	Decoction (Water)	4^a 19^b
	Erythrina abyssinica Lam. ex DC	Fruits	-	Cigohwa (Mashi)	Infusion (water)	4^a 12^b
	Indigofera arrecta Hochst. ex A. Rich	Leaves	Diabetes	Kasholoza, Kavunanfuka (Mashi)abwebwe (B), musholotsi (H) umwikokori (N), umusoro (Rw.)	Infusion (water)	8^a 4^b
	Senna spectabulus L.	Leaves	Vermifuge	-	Decoction (Water)	4^a 0^b
Hypericaceae	*Harungana madagascariensis* Lama. ex Poir.	Roots	Antidote	Kadwamuko (M), ndura (S)	Decoction (water)	4^a 15^b
Lamiaceae	*Mentha piperita L.*	Leaves	Constipation	-	Decoction (water)	10^a 0^b
	Tetradernia ruparia (Hochst). Codd.	Leaves	Angina, cough.	Mutizo gw'ebushi (Mashi).	Decoction (water)	10^a 0^b
Lauraceae	*Persea americana* Mill.	Leaves	Diarrhea, hypertension, cough	Ivoka (M), avokado (S)	Decoction (water)	10^a 0^b
Meliaceae	*Melia azedarach* L.	Leaves	Rheumatism.	Mwarubaini (S), marumaru (M)	Decoction (water)	14^a 4^b
Myrtaceae	*Eucalyptus globulus* L.	Leaves	Asthma, cough, fever.	-	Infusion (water)	12^a 4^b
	Psidium guayava L.	Bark	Dermatoses, diarrhea.	Mapera (S), ipera (M)	Decoction (water)	4^a 8^b
Nyctaginaceae	*Mirabilis jalapa* L.	Leaves	Antihemorragic	Kalifumo (M).	Decoction (water)	4^a 0^b
Passifloraceae	*Passiflora foetida* L.	Leaves	Hypertension	-	Infusion (water)	4^a 4^b
Phytolaccaceae	*Phytolacca dodecandra*L'Hérit.	Roots	Abortifacient, dermatoses.	Cimpokolo, muhokolo (M)	Decoction (water)	4^a 12^b
Piperaceae	*Piper guineense* Schum and Thonn. L	Seed	Antidote.	Muborobondo (M).	Decoction (water)	4^a 0^b
Plantaginaceae	*Plantago palmata* Hook.f.	Leaves	Diarrhea, flu, antidote	Cibarhama (M).	Decoction (water)	4^a 0^b
Poaceae	*Cymbopognon citratus*	Leaves	Angina, fever, flu	Cahi (M).	Infusion (water)	18^a 35^b

	(DC) Stapf.					
Rubiaceae	*Cinchona ledgeriana* Moes.	Bark	Flu	Kankina (M)	Decoction (water)	18[a] 35[b]
Rutaceae	*Citrus limon* (L.) Burn.f,	Fruits	Fever, flu, cough	Ndimu (M), chunghwa kali (S)	Maceration (banana juice)	4[a] 4[b]
	Citrus aurantium L.	Fruits	Constipation, flu, cough	Cungwa (S), icungwa (M)	Maceration (banana juice)	4[a] 16[b]
Solanaceae	*Physalis peruvianna* L.	Leaves	-	Mbuma (M), mbupuru (N) umuhire (Rw.)	Infusion (water)	8[a] 0[b]
Trepeolacaea	*Tropaeolum majus* L.	Fruits	Antidote	-	Tincture (alcohol)	10[a] 0[b]
Verbenaceae	*Lantana camara* L.	Leaves	Cough	Kashubanshuha (M).	Decoction (water)	8[a] 27[b]
Xanthrorrhoeaceae	*Aloe sp.*	Aerial part	Vermifuge	Kizimia muliro (M)	Decoction (water)	4[a] 12[b]

[a.] *Frequency of citation by traditional healers (number of times out of 49 interviewees)*

[b.] *Frequency of citation in the literature (number of articles retrieved during the search period mentioning the plant as antimalarial)*

3.1 Morphological Types

Fig. 2 illustrates the relative importance of morphological types of plant species cited by traditional healers in Bukavu.

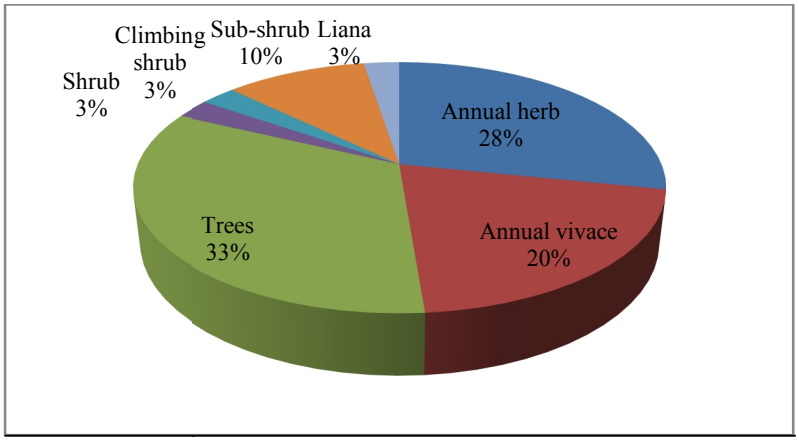

Fig. 2. Weighted morphological types

The analysis of plant species recorded during the ethnopharmacological survey of plants used in the treatment of malaria in Bukavu (Fig. 2) shows the predominance of woody species (53%) among which trees represent 33 %. In fact, the use of leaves than other parts of the plants could prevent the destruction of overused plants for medicinal recipes.

3.2 Biological Types

The relative importance of biological type is illustrated in the Fig. 3.

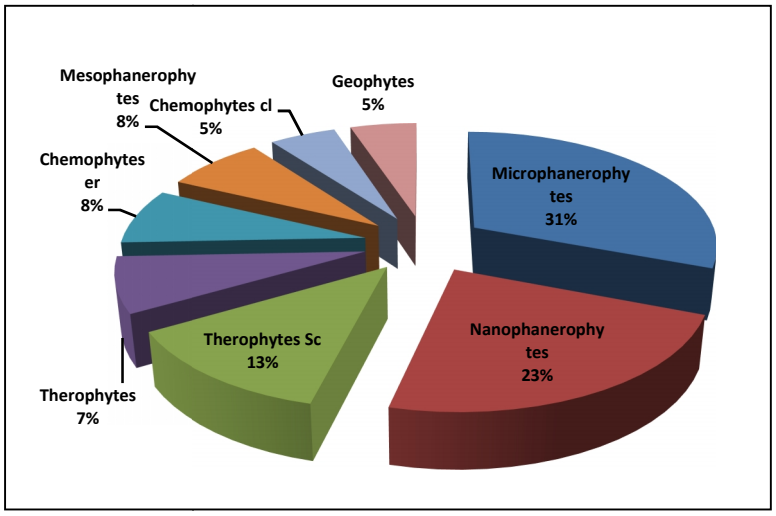

Fig. 3. Weighted biological types

Microphanerophytes and Nanophanerophytes constituted more than half (52%) of plants species used for malaria management in Bukavu (Fig. 3). Therophytes climbing are the less represented biological type (2.5%).

3.3 Biotopes Types

The analysis of habitat preference of plant species from the survey (Fig. 4) indicates that about two plants on three (65%) are cultivated species. This indicates that these species can be domesticated in order to preserve the biodiversity.

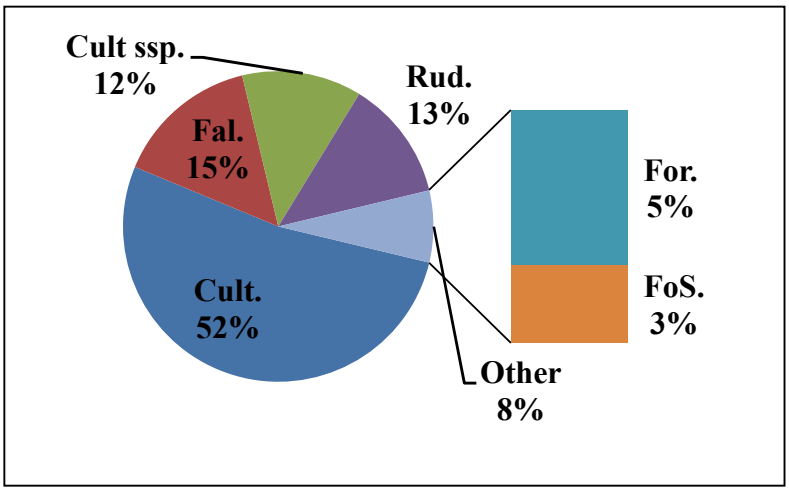

Fig. 4. Weighted biotope types

3.4 Phytogeographic Distribution

Fig. 5 shows relative phytogeographical distribution of antimalarial plant species used in traditional medicine in Bukavu.

It can be deduced from Fig. 5 that the great part of antimalarial plant species used in Bukavu are plants that are commonly largely distributed. This include pan-tropical species or species found in tropical Africa, America and Asia; paleo-tropical or species found in tropical Africa and Asia and in Madagascar and Australia; Afro-Malagasy species or species which are common to the islands of Madagascar and continental Africa [19].

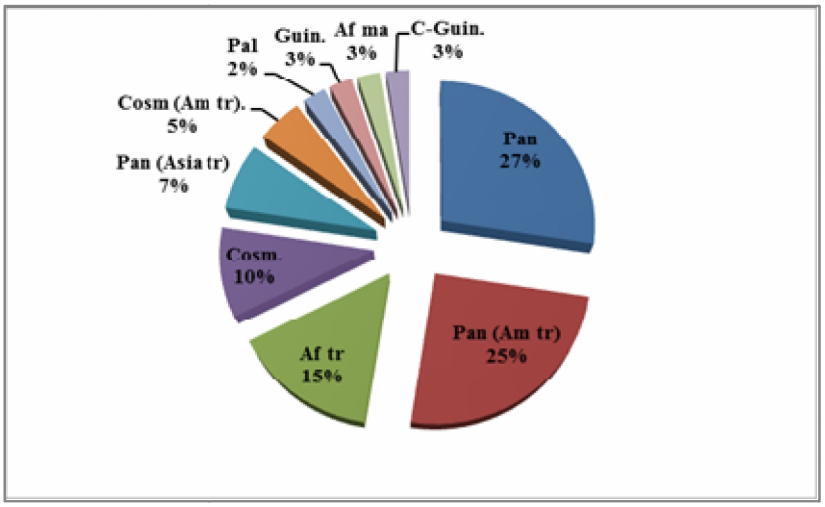

Fig. 5. Phytogeographic distribution

3.5 Botanical Families Involved in the Study

Forty species of plants belonging to 27 different families were collected. Asteraceae family is the most represented with seven plant species (17.5%) followed by Fabaceae with fiveon 40species. Lamiaceae, Myrtaceae and Rutaceae possess two plant species each and the others families are represented by one plant species each (Fig. 6).

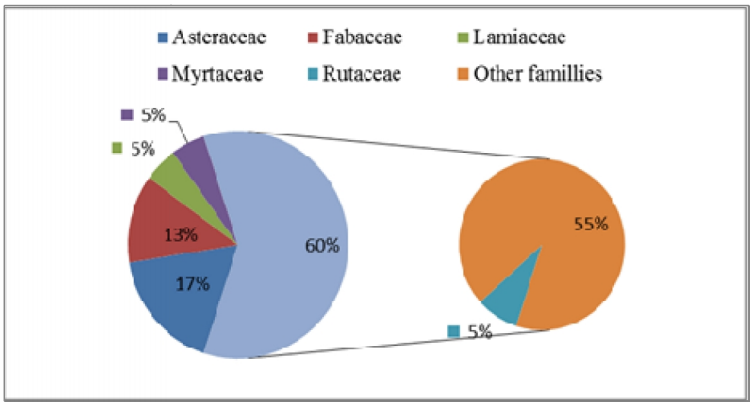

Fig. 6. Relative importance of botanical families of plant species used against malaria in Bukavu city

3.6 Characteristic of Recipes of Medicinal Plants

Recipes used are characterized by the relative importance of plant parts, mode of preparation and administration used.

3.6.1 Plant parts used

The leaves are the most used parts in the treatment of malaria with medicinal plants in Bukavu (Fig. 7). It represents almost 60% of used plant parts cited by traditional healers in this survey. The use of leaves could be justified by the abundance of chemical groups they contain. In fact, leaves are known as main synthesis site of secondary metabolites in plants and are the most commonly used plant parts by traditional medicine practitioners [18,20-23].

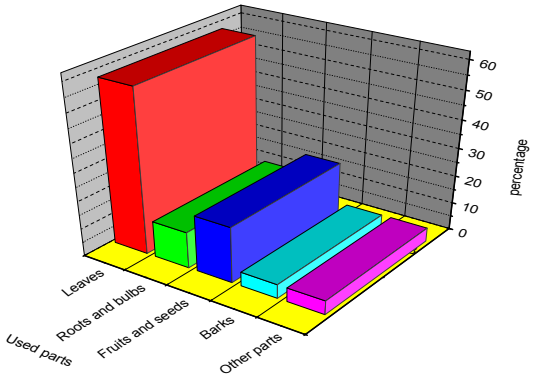

Fig. 7. Weighted used parts

3.6.2 Mode of preparation of recipes

Water is the most used solvent for the preparation of the recipes (77.5%) and decoction is the main mode of preparation of remedies, it represents 47.5% of preparation modes (Fig. 8).This confirms the results already reported by several other authors [8,18,23-27]. In fact, water is the cheapest and the most available solvent that can dissolve a high number of metabolites and high temperature permits a rapid extraction of active ingredients. However, some of these metabolites can be degraded by heat.

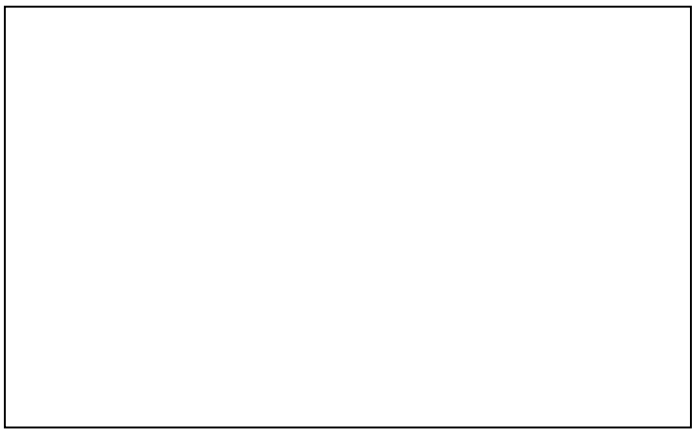

Fig. 8. Mode of preparation of recipes

3.6.3 Administration route and dose

Careful observation and discussions with traditional healers during surveys revealed that traditional healers had knowledge of dosage and frequency of phytomedicines to be administered. Frequency is often determined after observing physical condition of the patient (i.e. patient height, weight or age and history of ailments). So according to Adjanohoun [11] imperfections observed in traditional medicine seem to be no more injurious to health than those likely to occur in other forms of medicine. The simple fact of not finding the same frequency in regimens of traditional medicine is not sufficient to conclude in correctly to the non-existence of African medicine dosages.

In general, the concentration or the amount of the organ, the dose, the frequency or the period of taking the product depends to the prescriber. In most cases, the drug is prescribed in two or three doses. Usually a beer glass is taken as the first step of the assay and all preparations were administeredorally (100%of cases).

3.7 Similarities of Use

Some species found in Tables 1 and 2, used in Bukavu and its surroundings against malaria are commonly used as raw materials for some synthetic molecules and phytomedicines against this disease. This is the case of quinine from *Chinchonaledgerianna* Moes bark, artemisinin from *Artemisia annuan* L. At the other hand, vincamine® extracted from *Catharantus roseus* is indicated against headache and dizziness [28], and the steam *of Eucalyptus globules* Labill (Called fever tree) is used in case of fever induced by *Plasmodium*. In fact, it's known that feverremains the main sign of malaria diagnosis [3,7]. Kilma®, a Congolese phytomedicine, is a combination of *Lantana camara* L. with *Gardenia ternifolia* and *Crossopterix febrifuga* [29].

Vernoniaamygdalin, Chenopodiumugandae (*Chenopodiumambrosoioides*related species), *Erythrina abyssinica, Ingodiferaarrecta, Tetraderniaruparia, Lantana trifolia, Euphorbia candelabrum*Tremex. Hotschyand*E.tirucalli*L.(near*E.pilulifera*L.)but also as*Aloesp.,* are also indicated as antimalarial plants in Rwandan traditional medicine [30].

Bidens pilosa, Harunganama dagascariensis, Aloe sp., Vernonia sp., Cassia didymobotrya (species related to *C. occidentalis*), *Momordica sp*. and *Euphorbiacrotonoides* (close to *E. pilulifera* L.) are used inthe treatment of malariain the eastern part of Africa [31].

Some of these plant species are also reported by some authors as antimalarial recipes in African traditional medicine [11,17,30-32].

4. CONCLUSION

The study lists some plant species usedinthe treatment of malariain Bukavu, a city located in the east part ofthe Democratic Republic of theCongo. Literature confirms some plants' activities in other African parts. The herbal remedies used against malaria and pharmacological studies of these preparations are necessary and might lead to interesting antimalarial remedies. Apart from well established plants like *cinchona* and *artemisia*, studies need to be done on some promising plants like *Lantana camara* and *Bidens pilosa* to determine antimalarial/antiplasmodial activity, isolate bioactive compound(s) and determine their structure(s) and their cytotoxicity.

CONSENT

Not applicable.

ETHICAL APPROVAL

Not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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