Ethnopharmacological survey of plants used against malaria in Lubumbashi city (D.R. Congo)

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ABSTRACT
Ethnopharmacological survey was conducted in Lubumbashi city located in south eastern part of The Democratic Republic of the Congo in order to identify the plant species used in traditional medicine for the treatment of malaria. Thirty one healers belonging to five “communes” of Lubumbashi city namely: Kamalondo, Katuba, Kampemba, Kenya and Rwashi were interviewed about the plant species used in traditional medicine for the management of malaria in this city. 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 identified at herbarium of the Laboratory of Ecology and Plants Resource Management, Faculty of Sciences University of Lubumbashi. The plants ecological status was also determined. Nineteen species of plants belonging to sixteen botanical families were identified. The main habitat preference of species is cultivated (21%), trees constituted 42% of morphological type while 58% of biological type are Microphanerophytes. The decoction was the main mode of preparation (74%). Leaves constituted 57 % of plant organs used for drug preparation. Some plant species cited 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, Lubumbashi, D.R.Congo.

INTRODUCTION
Malaria is one of the major tropical parasitic diseases responsible for significant morbidity and mortality especially among children and pregnant women. According to the World Health Organization, half the world’s population is at risk of malaria and one to two million annual deaths can be attributed to this disease [1- 3].

A variety of anti-malaria medications are available. Some antimalarial drugs such as chloroquine, amodiaquine, mefloquine had been used to treat malaria. But most of the drugs used today are becoming less effective because of the problem of drug resistance[1,4]. Plasmodium falciparum, the most severe form of malaria parasite species, is responsible for the vast majority of deaths associated with the disease. Key interventions to control malaria include: prompt and effective treatment with artemisinin-based combination therapies; use of insecticidal nets by people at risk; and indoor residual spraying with insecticide to control the vector mosquitoes [1,5].

There is now broad consensus on the urgent need for new, affordable and efficient compounds that could serve as primary molecules for antimalarial treatment. New high-ly-effective antimalarial drug candidates, based on new mechanisms of action or with new structures, are urgent-ly needed to overcome the problem of rapid emergence of drug resistance and achieve long-term clinical efficacy [1,3,5].

Due to the crucial role that plant-derived compounds have played in drug discovery and development for the treatment of several diseases, the isolation of new bioactive compounds from medicinal plants based on traditional use or ethnomedical data appears to be a very promising approach [6]. Ethnobotanical survey is an important step in the identification, selection and development of the therapeutic agents from medicinal plants[6,7].

The Democratic Republic of the Congo (DRC), one of the endemic areas 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. This is the reason why some ethnopharmacological surveys are undertaken in some parts of the DRC in order to collect data on plants used in traditional medicine to treat some diseases [9-15]. The present work, aims to analyze the traditional use of medicinal plants in the treatment of malaria in Lubumbashi, a city located in the south eastern of the DRC.

EXPERIMENTALS

Study area

The ethnopharmacological investigations were conducted in Lubumbashi, the capital of the Katanga province, located in the south eastern part of DRC (Fig. 1).

Figure 1: Lubumbashi in the Democratic Republic of the Congo, the area of study.

Lubumbashi is the second largest city of DRC, second only to the nation's capital Kinshasa. Lubumbashi lies at around 1,208 meters above sea level. The high altitude serves to cool somewhat the Climate year round which would be very hot otherwise. This city is located in a humid subtropical climate (Cwa, according to the Köppen climate classification). Annual average rainfall is 1,238 mm. Lubumbashi is the mining capital of the Democratic Republic of the Congo, acting as a hub for many of the country's biggest mining companies. Population estimates vary widely but average around 1.5 million and Swahili is the spoken language [16].

Ethnopharmacological survey

This survey was conducted for 10 months, from March 2011 to December 2012. Thirty one healers belonging to four “communes” of Lubumbashi city namely: Kamalondo, Katuba, Kenya, Kampemba and Rwashi were interviewed about the plant species used in traditional medicine for the management of malaria in the city of Lubumbashi. The name of the plants, the plant parts, the modes of preparation and the modes of administration of recipes were recorded. Nineteen plants were collected and identified at herbarium of the Laboratory of Ecology and Plants Resource Management, Faculty of Sciences, University of Lubumbashi in D.R Congo. The plants ecological status was also determined. Vouchers specimens are on deposit at the same laboratory.

Floristic Characterizations of Plants Collected

In this work, medicinal plants used in traditional medicine against malaria in Lubumbashi city are characterized by their morphological types, biological types, habitat types and phytogeographical distribution.

1°. Morphological types

The morphological types were inventoried as following: lianas (L), trees (T), shrubs (Sh), sub-shrubs (Ssh), annual herb(Ah), vicace herb (Vh), climbing shrubs (Sh cl) and perennial herb (Ph).

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. These are: Cosmopolitan (Cosm.), Pantropical (Pan), Paleotropical (Pal), Afro-tropical (Af tr), Guinean (Guin), Centroguinean (C-Guin), African (Af am), American tropical (Am tr), tropical Asia (Asia tr) and Afro-madagascar (Af ma) [8,11-16].

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).

4° Habitat preferences

Only the most characteristic habitat of each plant species is indicated. The types of habitats retained in this work are therefore: farms or crops which are cultivated species (cult), Forests (For), Fallow (Fal), Ruderal or plants found in the village (Rud) and Subspontaneous Cultured (Cult Ssp) and Secondary Forest (Fos).

RESULTS AND DISCUSSION

Nineteen species of plants used in Lubumbashi 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.

**Morphological types**

This survey was conducted for 10 months, from March 2011 to December 2012. Thirty one healers belonging to four “communes” of Lubumbashi city namely: Kamalondo, Katuba, Kenya, Kampemba and Rwashi were interviewed about the plant species used in traditional medicine for the management of malaria in the city of Lubumbashi. The name of the plants, the plant parts, the modes of preparation and the modes of administration of recipes were recorded. Nineteen plants were collected and identified at herbarium of the Laboratory of Ecology and Plants Resource Management, Faculty of Sciences, University of Lubumbashi in D.R Congo. The plants ecological status was also determined. Vouchers specimens are on deposit at the same laboratory.

It can be noted from this figure that ligneous plants represent about 79% of species (Trees=42% and Shrub=37%) while liana and annual herb represent 21%.
Table 1. Ecological characteristics of plants used against malaria in Lubumbashi city (DRC)

<table>
<thead>
<tr>
<th>Families</th>
<th>Plants and species</th>
<th>Morphological types</th>
<th>Biological types</th>
<th>Habitat type</th>
<th>Phytogeographical distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anisophyllaceae</td>
<td>Anisophylla pomifera Engl. &amp; Brehmer</td>
<td>T</td>
<td>McPh</td>
<td>Fal</td>
<td>Af tr</td>
</tr>
<tr>
<td>Annonaceae</td>
<td>Hexalobus monopetalatus (A. Rich) Engl. &amp; Diels</td>
<td>Sh</td>
<td>MsPh</td>
<td>Rud.</td>
<td>Af ma</td>
</tr>
<tr>
<td>Apiaceae</td>
<td>Centella asiatica (L.) Urb.</td>
<td>Ah</td>
<td>Ch cl</td>
<td>Rud.</td>
<td>Pan</td>
</tr>
<tr>
<td>Apocynaceae</td>
<td>Landolphia congolensis (Stapf) Pichon</td>
<td>L</td>
<td>Ph cl</td>
<td>For</td>
<td>C-Guin</td>
</tr>
<tr>
<td>Asteraceae</td>
<td>Bidens pilosa L.</td>
<td>Ah</td>
<td>Th</td>
<td>Rud.</td>
<td>Pan</td>
</tr>
<tr>
<td>Caricaceae</td>
<td>Carica papaya L.</td>
<td>T</td>
<td>McPh</td>
<td>For</td>
<td>C-Guin</td>
</tr>
<tr>
<td>Fabaceae</td>
<td>Dalbergia boehmii Taub.</td>
<td>T</td>
<td>McPh</td>
<td>For</td>
<td>C-Guin</td>
</tr>
<tr>
<td>Verbenaceae</td>
<td>Vitex madiensis Oliv.</td>
<td>Sh</td>
<td>McPh</td>
<td>For</td>
<td>C-Guin</td>
</tr>
</tbody>
</table>

Legend:
- Trees (T), Shrubs (Sh), Liana (L) and annual herb (Ah).
- Macrophanerophytes (MaPh), Mesophanerophytes (MsPh), Microphanerophytes (McPh), Therophytes (Th), climbing Chamephytes (Ch cl), erected Chamephytes (Ch er) and climbing Phanerophytes (Ph cl).
- Cultured (Cult), subs spontaneous Cultured (Cult ssp), Ruderals (Rud), Fallow (Fal), and Forest (For).
- Pantropical (Pan), Afro-tropical (Af tr), Guinean (Guin), Centro-guinean (C-Guin), tropical America (Am tr) and Afro-madagascar (Af ma).

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

<table>
<thead>
<tr>
<th>Families</th>
<th>Plants Species</th>
<th>Used Parts</th>
<th>Treated Diseases</th>
<th>Preparation Mode (Solvent)</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anisophyllaceae</td>
<td>Anisophylla pomifera Engl. &amp; Brehmer</td>
<td>Leaves</td>
<td>Hypertension, cough, Malaria, Cough, malaria</td>
<td>Decoction (Water)</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>Hexalobus monopetalatus</td>
<td>Leaves</td>
<td>Malaria , fever, cough, Malaria, cough</td>
<td>Decoction (Water)</td>
<td>57</td>
</tr>
<tr>
<td>Family</td>
<td>Species</td>
<td>Parts</td>
<td>Uses</td>
<td>Preparation</td>
<td>Dosage</td>
</tr>
<tr>
<td>-----------------</td>
<td>--------------------------------------</td>
<td>-------------</td>
<td>------------------------------------------------</td>
<td>------------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>Apiaceae</td>
<td>Centella asiatica (L.) Urb.</td>
<td>Leaves</td>
<td>Malaria, skin ulcers, dysentery</td>
<td>Maceration Powder to apply</td>
<td>65</td>
</tr>
<tr>
<td>Apocynaceae</td>
<td>Landolphia congolensis (Stapf) Pichon</td>
<td>Leaves, Stem</td>
<td>Malaria, Against eczema, skin ulcers, malaria, dysentery</td>
<td>Decoction (Water)</td>
<td>45</td>
</tr>
<tr>
<td>Asteraceae</td>
<td>Bidens pilosa L.</td>
<td>Leaves</td>
<td>Malaria, pneumonia, urinary infection, Malaria</td>
<td>Decoction (Water)</td>
<td>76</td>
</tr>
<tr>
<td>Caricaceae</td>
<td>Vernonia amygdalina Del</td>
<td>Leaves</td>
<td>Malaria, Against amoebae and jaundice</td>
<td>Decoction (Water)</td>
<td>32</td>
</tr>
<tr>
<td>Caricaceae</td>
<td>Carica papaya.L</td>
<td>Leaves</td>
<td>Malaria, pneumonia, urinary infection, Malaria</td>
<td>Decoction (Water)</td>
<td>17</td>
</tr>
<tr>
<td>Phyllanthaceae</td>
<td>Antidesma venosum</td>
<td>Leaves</td>
<td>Snake bite, Diarrhea, malaria</td>
<td>Suppository powder Decoction (Water)</td>
<td>49</td>
</tr>
<tr>
<td>Euphorbiaceae</td>
<td>Jatropha curcas. L.</td>
<td>Leaves</td>
<td>Malaria, jaundice, vomiting, rheumatism</td>
<td>Decoction (Water)</td>
<td>55</td>
</tr>
<tr>
<td>Fabaceae</td>
<td>Dalbergia boehmii</td>
<td>Leaves</td>
<td>Cancer, malaria, Stomach aches, cancer</td>
<td>Decoction (Water)</td>
<td>25</td>
</tr>
<tr>
<td>Fabaceae</td>
<td>Dalbergia Nitidula</td>
<td>Leaves</td>
<td>Sore teeth, malaria, gonorrhea</td>
<td>Decoction (Water)</td>
<td>38</td>
</tr>
<tr>
<td>Fabaceae</td>
<td>Dalbergia Nitidula</td>
<td>Roots</td>
<td>Toothache, malaria, Stomach aches</td>
<td>Decoction (Water)</td>
<td>67</td>
</tr>
<tr>
<td>Loganiaceae</td>
<td>Strychnos cocculoides</td>
<td>Leaves</td>
<td>Swelling of the testicles, malaria, menstrual pain umbilical hernia</td>
<td>Decoction (Water)</td>
<td>62</td>
</tr>
<tr>
<td>Loganiaceae</td>
<td>Cissampelos owariensis P. Beauv ex DC</td>
<td>External Parts</td>
<td>Malaria, diuresis, stomach aches</td>
<td>Decoction (Water)</td>
<td>27</td>
</tr>
<tr>
<td>Méliaceae</td>
<td>Ekebergia bangwelensis Welw.</td>
<td>Leaves</td>
<td>Malaria, Female Infertility</td>
<td>Decoction (Water)</td>
<td>59</td>
</tr>
<tr>
<td>Family</td>
<td>Genus, Species</td>
<td>Part Used</td>
<td>Medicinal Use</td>
<td>Preparation</td>
<td>Reference</td>
</tr>
<tr>
<td>------------</td>
<td>----------------------------------------------------</td>
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<td>---------------------------------------------------</td>
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<td>-----------</td>
</tr>
<tr>
<td>Oleaceae</td>
<td>Schrebera trichoclada Welw.</td>
<td>Leaves, Stem</td>
<td>Stomach Pain, Malaria, Gonorrhea, Female Infertility</td>
<td>Decoction (Water)</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rubiaceae</td>
<td>Crossopterix febrifuga</td>
<td>Leaves, Roots</td>
<td>Hernia, gonorrhea, rheumatism, Constipation, fever, poisoning, malaria</td>
<td>Decoction (Water)</td>
<td>74</td>
</tr>
<tr>
<td></td>
<td>Hymenodictyon floribundum (Hoscht &amp; Steud) BL Rob</td>
<td></td>
<td></td>
<td>Decoction (Water)</td>
<td>43</td>
</tr>
<tr>
<td>Solanaceae</td>
<td>Capsicum frutescens. L</td>
<td>Roots, leaves</td>
<td>Hemorrhoid, tooth decay, bile disorders, Malaria abscess</td>
<td>Decoction (Water)</td>
<td>65</td>
</tr>
<tr>
<td>Verbenaceae</td>
<td>Vitex madiensis Oliv.</td>
<td>Leaves</td>
<td>Lung disease, malaria</td>
<td>Decoction (Water)</td>
<td>48</td>
</tr>
</tbody>
</table>

**Biological types**

It can be deduced from the analysis of the biological types of the inventoried flora used in folk medicine against malaria in Lubumbashi city that the Microphanerophytes constituted itself more than half (58%) of plants species used for malaria management in this city, followed by climbing Phanerophytes and Mesophanerophytes (11%) each, followed respectively by Macrophanerophytes, erected Chemophytes, climbing Chamephytes and Theophytes that are the less represented biological type (5%) (Fig. 3).

**Habitat preferences**

As it can be seen in figure 4, the analysis of habitat preference of plant species from the survey indicates that about one plant on five (21%) are cultivated species, Fallow represent 15%; Ruderal represent 16% and Forest, 37%.

**Phytogeographic Distribution**

The Phytogeographic distribution of the inventoried flora against malaria in Lubumbashi city (Fig. 5) can be resumed as follow: Afro-tropical represent 37% of all species, followed respectively by C-Guin (21%), Pan (Am tr) (16%), Pan (Af tr), Af ma and Guin represent only 5% each.
Botanical Families Involved in the Study

Nineteen species of plants belonging to 16 different families were collected. Asteraceae and Fabaceae families are the most represented with two plants species each (11%) followed by Melliaceae, Loganiaceae, Caricaceae, Apocynaceae, Apiaceae, with one specie each (5%) and the others families are represented as shown in Figure 6.

Characteristic of Recipes of Medicinal Plants

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

1. Plant parts used

The leaves are the most used parts in the treatment of malaria with medicinal plants in Lubumbashi city (Fig. 7). It represents 57% 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 [9-15, 17].

2. Mode of preparation of recipes

Water is the most used solvent for the preparation of the recipes (92%) and decoction is the main mode of preparation of remedies, it represents 74% of preparation modes (Fig.8). This confirms the results already reported by several other authors [9-15,17-19]. 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.

CONCLUSION

This study, done in Lumbashi city (DRC), lists some plants used in malaria management in Congolese traditional medicine. Several of these plants are also used against this parasitic disease in other Congolese and African parts. Thus, some plant species used as antimalarial by the traditional medicine practitioners in the study area need to be screened in order to identify the species having antiplasmodial activity, isolate bioactive compound(s) and determine their structure(s) and their toxicity. Such results could help in the development of new drugs for the management of malaria.

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