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Ethnopharmacological study of medicinal plants used in Douala City (Littoral region), Cameroon

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Abstract

From ancient times, the applied use of herbs has been common among indigenous people throughout the world. This study consists of valuing the traditional natural heritage of the Douala region, through an ethnobotany's study that has been conducted to collect as much information as possible about therapeutic uses of plants. This survey was done through semi-structured interviews of traditional healers and other resource persons and led to the census of 192 medicinal plant species belonging to 139 genera and 55 families. The *Asteraceae*, *Fabaceae-Papilionoideae* and *Poaceae* families are the most represented. These plants are used in the preparation of 403 treatment recipes to treat 175 human illnesses. Among the listed medicinal plants, the greatest number (81 species) are prescribed in the treatment of diabetes, 80 species in the treatment of malaria, 56 species in the treatment of diarrhea. The *Eremomastax speciosa*, *Justicia secunda*, *Annona muricata*, *Zingiber officinale*, *Kalanchoe coccinea*, *Vernonia amygdalina* and *Ageratum conyzoides* species had 100% fidelity indices in the treatment of nappy rash, anemia, nerve problems, cough, otitis, malaria and intestinal worms, headache, respectively. Leaves are the most used plant parts (86.98%), decoction is the principal method of preparation (82.81%) while oral route (97.40%) is the main mode of administration of the treatments. The main collection sites for medicinal plants are the surroundings of houses, roadsides and refuse dumps. Herbaceous have the largest proportion of medicinal plant species (72.92%). This documentation of medicinal plants can serve as a basis for future studies on new medicinal resources.

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Introduction

According to reports from the World Health Organization (WHO), more than 80% of the population in developing countries rely almost exclusively on traditional medicine which in most cases is based on herbs rather than conventional medicine (WHO, 2010). In Cameroon nearly 820 species of plants are exploited for medicinal purposes and come mostly from several regions (Nkongmeneck, 2007). This is explained not only by the lack of financial means to buy non-traditional medicines, but also by the non-existence of health infrastructure (dispensaries or pharmacies) at reasonable distances (WHO, 2010). Another factor is that of tradition, some of whose treatments are surrounded by a "magic" aspect of considerable importance (WHO, 2002). Medicinal plants are valuable resources in African where the demand for traditional medicines and other herbal health products is increasing, particularly in rapidly growing urban societies. These plants are also invaluable resources for the pharmaceutical industry (WHO, 2010). Despite these enormous potentialities and prospects, the supply of medicinal plants is in serious decline due to the breakdown of knowledge transmission within families, deforestation, the degradation of ecosystems, pollution caused by many human activities, etc. It has been noted that there is a clear regression in the transmission of knowledge and know-how associated with medicinal plants within families due to the rural exodus, the rapid loss of natural habitats, etc. In fact, the sector has for several years been confronted with an erosion of this ancestral knowledge while there is a strong social demand for increased use of plants for health care (Wyk *et al.*, 2002).

Many traditional medicine practitioners are older men and, as in many cases the information has not been recorded or transmitted. We risk losing forever this cultural heritage and this basis for future research. However, there is a tendency of return toward nature even though this may present certain

dangers given the lack of dissemination of knowledge. In Cameroon, the Littoral region and more specifically the city of Douala (a cosmopolitan city and economic capital) is experiencing heavy pollution and urbanization, a high and ever increasing demographic pressure (INS, 2015). To these problems is added the low purchasing power of populations plagued by poverty and precariousness, thus limiting their access to adequate health care (BUCREP, 2017). As a result, traditional healers and people in the city resort more often to traditional medicine and harvest plants anarchically in the wild to heal themselves. This is often done without worrying about the sustainable management of these resources. In addition, for decades, the vegetation of the city of Douala has been subjected to severe deforestation, increased urbanization, expansion of agriculture, creation of roads, etc. (Letouzey, 1985). One of the main consequences is the disruption of ecosystems including the destruction of plant diversity in the city and the degradation of the surrounding forests (Anonymous 5, 2008). This may result in a scarcity or disappearance of useful species as well as the proliferation of plants species derived from human action (ruderal plants) and invasive species (Priso, 2016). Indeed the scarcity or disappearance of certain species compels the users of medicinal plants to travel outside the city to harvest the plants they need, or to look for substitute plants in town. This also raises fears about the future of the majority of these plants that are under pressure from these phenomena in their natural environments.

While much work has already been done on the use of medicinal plants in the Littoral region and surrounding areas (De Rosny *et al.*, 1987, 1994; Dibong *et al.*, 2011; Mpondo *et al.*, 2012; Dibong, 2015; Ladoh *et al.*, 2016; Priso, 2016.), it is still necessary to pursue research on this subject given the importance of the ancient tradition of using plants for medicinal purposes, the growing number of local healers, population growth, anarchic urbanization associated with impoverishment accentuated by the economic crisis. Nowadays, there is a worldwide renewed interest in traditional medicine among

populations, decision-makers and international organizations. Based on the fact that the potential of plant diversity in the Douala region is under the constant threat of increasing population growth, uncontrolled urbanization, pollution, economic crisis, and anthropogenic activities resulting in the scarcity and disappearance of several medicinal plant species, the present study was aimed at updating the database of medicinal plants in the city of Douala.

Materials and methods

Study area

The Littoral region has four Departments (Moungo, Nkam, Sanaga-Maritime, Wouri). The ethno-

pharmacological surveys were carried out in five districts (Douala I, Douala II, Douala III, Douala IV, Douala V) of the Wouri Division in Douala city which is the headquarter of the Littoral region of Cameroon (Fig. 1). This city is located about thirty kilometers from the Atlantic Ocean between latitude 04°01'-04°57'North and 09°42'-09°47' East longitude and 13 m average altitude (Fig. 1) (BUCREP, 2010). Douala and its surroundings are part of the humid dense rainforest with mono-modal rainfall. This area is one of the most urbanized in Cameroon.

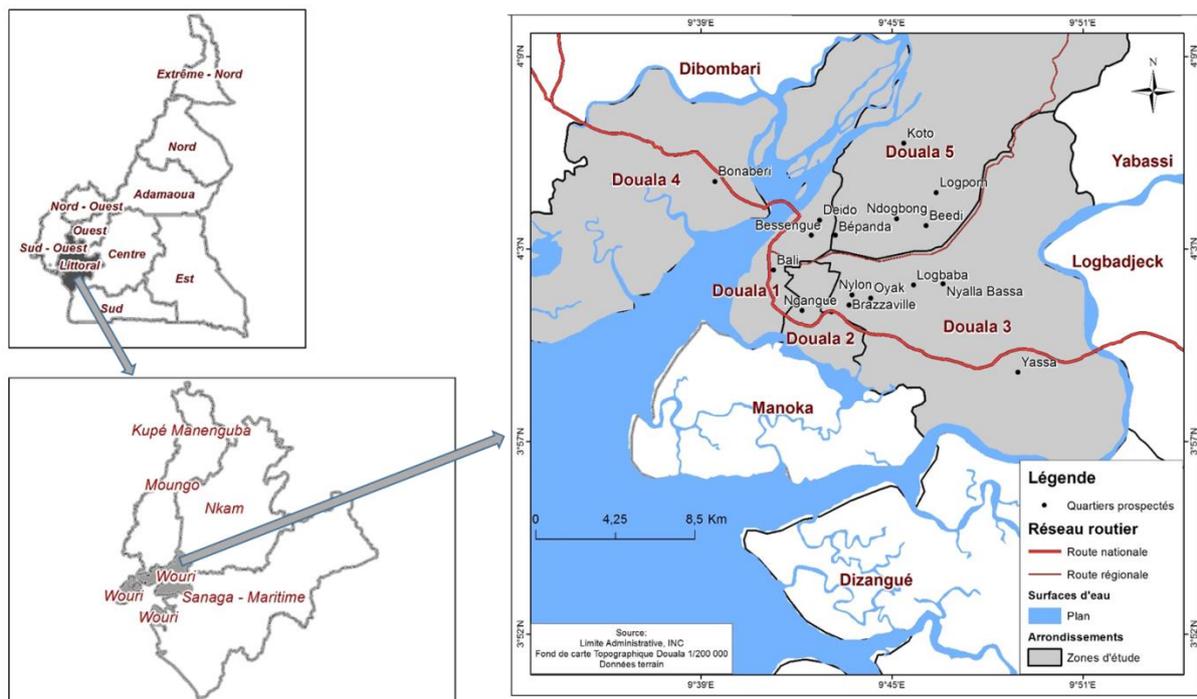


Fig. 1. Localization of the study sites.

The climate of the Douala region is equatorial of Cameroonian domain. It is a Cameroonian maritime type characterized by a high annual relative humidity exceeding 80%. According to Din *et al.* (2008) it is close to the saturation rate throughout the year, with an average value equal to 84.42%. Records of the temperature and rainfall from 1973 to 2002 show that rainfall reaches 3500mm and the temperature is almost constant throughout the year, with an annual average of 27.5°C with an annual thermal amplitude of the order of 3.2°C. The dry season runs from December to February and is interrupted by rain. The

rainy season lasts nine months and runs from March to November with maxima in August (680mm of rainfall) (Priso, 2016).

Ethno-pharmacological investigations

Ethno-pharmacological surveys were conducted in 16 districts in the Wouri Division between 2018 and 2019. The informants were selected on the basis of random sampling. Indeed in each district, 08 to 13 volunteers were chosen at random. The surveys were developed with semi-structured interviews in local and French languages, using the standard survey form used by the Scientific and

Technical Research Commission of the Organization of African Unity (STRC/OAU) (OAU, 1985).

Thus, information on plants was obtained through an oral conversation in which open questions were favored in order to avoid compromising the spontaneity of responses (Bruni *et al.*, 1997). This method has been used by several researchers interested in medicinal plants, notably Bouquet (1964), Adjanohoun *et al.* (1988, 1996). (Farmers, Civil servant);

They were oriented towards people who could be involved in the use of plants for therapy (herbalists, traditional healers practitioners, herb sellers, midwives, indigenous people, old men and others) and focused on socio-demographic surveys, namely: civil status, different diseases treated, common and local names of plants, plant organs used, recipes, modes of preparation, mode of administration, nature of the plant, collection sites, use alone or in combination, state in which the organs of the plant are used (fresh or dry), quantities of plant material used, solvents us.

The surveys were conducted after obtaining the consent of local authorities, traditional rulers and informants in the 16 neighborhoods. The approach used consisted of inquiring about the existence of one or several traditional healer and sellers of medicinal plant parts in the different markets of the city of Douala (Dakar market, double-balle market in Bépanda, goat market and Nkoulouloun market in New-Bell). The choice of this approach was motivated on the one hand by the fact that the traditional chieftaincy is considered as the seat of the tradition and consequently the seat par excellence of the cultural heritage of a community on which rests knowledge on ethnobotany (Konan, 2012), on the other hand that markets are reputed to provide the city with medicinal plants (Tongo *et al.*, 2003, Dibong *et al.*, 2011).

The team was accompanied by native people who knew the duala language and had a good knowledge of the local flora. Data on the frequency of collection of medicinal plants were collected. Identified and unidentified medicinal plant species in the field were

harvested according to botanical techniques, pressed, dried, for identification and/or confirmation by comparison with specimens deposited at the National Herbarium of Cameroon.

Statistical analysis of the data

The information obtained was codified in a database and processed. The descriptive statistics were used to summarize the data with Microsoft Excel 2013 and XLStat 2013 software. The following parameters were estimated: Citation Frequency (FC), preference ranking of medicinal plants, diseases treated in the study area and Fidelity Index of favorite medicinal plants.

Frequency of quote

The frequency of citation (FC) of the species was calculated to evaluate the most used species. It represents the percentage of informants citing the species (S), based on the total number of informants surveyed (N) (Singh *et al.*, 2011) as presented in the formula: $FC = \frac{S}{N} \times 100$

A high frequency of citations indicates the potential importance of the plant species reported in the study area. Knowledge of the quotient frequency of a particular plant may be useful in determining its reliability and effectiveness for the treatment of one or more diseases (Cakilcioglu *et al.*, 2011).

Preference ranking of medicinal plants

The preference ranking was done for the most requested medicinal plants in a given region. Such ranking is done with selected key informants during an investigation (Martin, 1995, Tugume *et al.*, 2016). Thus, the ranking of the most used and available medicinal plant species was based on the information provided by the 15 selected key informants. These plants were chosen according to the importance that these informants attach to the species: (frequency of use and effectiveness of each of them, number of healing days for the successful treatment of particular diseases).

Then the scores are given according to their efficiency and availability. Thus the highest score (10) is given for medicinal plants which informants believe to be

easily accessible and most effective in the treatment of diseases.

The lowest score (1) is given to the least effective and rare plants. The values assigned to each species by all informants were summed to obtain a global ranking value (Hoffman & Gallaher, 2007).

Fidelity index or Fidelity level

The Fidelity Level (FL) is the percentage of a species' citation to the treatment of a particular disease. It makes it possible to quantify the importance of a plant species to treat a particular condition or to appreciate the popularity of certain species used in a locality (Friedman *et al.*, 1986, Hoffman & Gallaher, 2007). It was calculated for the species most used by the target public with a quoting frequency greater than 80% by the following expression: $FL = N_p / (N) \times 100$, with FL corresponding to the fidelity index; Where N_p is the number of informants who suggest the use of the plant for the treatment of a particular disease and N is the total number of informants who mentioned this plant species for any other use (Friedman *et al.*, 1986; Trotter & Logan, 1986).

Results and discussion

Socio-demographic characteristics of the respondents

During the semi-structured interviews, 182 people were interviewed in the city of Douala. A breakdown of these resource persons by sex, age, educational status, occupation, source of traditional knowledge and number of plants reported has been established (Table 5).

It shows that 100 men were questioned against 82 women. The age of these people is between 22 and 70 years old. Nineteen people under the age of 25 were classified as youth; 106 people between the ages of 25-50 were considered adults; 57 people over the age of 50 were considered elderly. On the other hand most of the respondents are men with an average age of 52 because young people are not very interested in herbal medicine. Regarding the level of schooling, the illiterates were the most numerous with a proportion of 42.31%, followed by those having the level of primary education (26.37%) and those of the level of secondary study (23.08%). The level of university education is lowest (8.24%) (Table 5). In terms of the

distribution of resource persons, five groups of people were interviewed.

Among them, 32% represent the indigenous population, 20% are herbalists, 18% are traditional healers, 16% are plant traders and 14% are midwives (Table 1).

Table 1. Socio-demographic characteristics of interviewees.

Socio-demographic characteristics		Number	Percentage (%)
Genre	Male	100	54.95
	Female	82	45.05
Ages	Youths (< 25 ans)	19	10.44
	Adults (25 -50 ans)	106	58.24
	Aged (> 50 ans)	57	31.32
	Illiterate (no formal education)	77	42.31
Educational status	Primary	48	26.37
	Secondary	42	23.08
	University	15	8.24
	Herbalist	37	20.33
Occupation of the respondent	Indigenous population	59	32.42
	Midwives	25	13.74
	Traditherapists	32	17.58
	Plant traders	29	15.93

In general, the transmission of ancestral knowledge and experiences on medicinal plant treatment recipes is done orally in indigenous communities. There is no data record. Most of the respondents were men with an average age of 52 years. The African belief is that traditional healers should be male (Cheikhyoussef *et al.*, 2011). This average age has been reported in other ethnobotanical survey studies conducted in Ethiopia (Chekole *et al.*, 2015), Uganda (Tugume *et al.*, 2016), Turkey (Cakilcioglu *et al.*, 2011) and in India (Hong *et al.*, 2015). Elderly people (aged 51 to 80) in society have more knowledge about medicinal plants because of direct and prolonged contact with these plant resources. On the other hand, younger people have little interest in traditional medicine in general and there is a risk of loss of knowledge if nothing is done to motivate them.

Distribution of resource persons according to plant collection sites

At the end of the surveys, it emerged that populations harvest medicinal plants in various environments. Twenty-nine individuals (15.93%) reported harvesting roadside plants, 33 individuals (45%) around rubbish, 39 people (21.43%) around houses, and 81 people

reported harvesting crop plants wherever they are. They were the most numerous with 44.51% (Table 2).

Table 2. Distribution of resource persons according to the collection sites of the declared medicinal plants.

Medicinal plants collection sites	Number	Percentage (%)
House surroundings	39	21,43
Road borders	29	15,93
Refuse heaps	33	18,13
Every where	81	44,51
Total	182	100

Distribution of plants according to the categories of people interviewed

A total of 192 plants were identified during this study. These plants are used in the preparation of 403 treatment recipes for 175 diseases. They were divided according to the groups of people who gave the information (Table 3). The distribution of resource persons according to the number of medicinal plants reported shows that the indigenous population is the most knowledgeable about medicinal plants. Indeed these gave the medicinal properties of 104 plants and 108 recipes. Plant traders followed with 97 plants and 98 recipes, herbalists with 64 plants and 74 recipes, midwives with 57 plants and 77 recipes. Traditional healers provided the lowest numbers of plants and recipes, 32 plants for 46 recipes.

Table 3. Distribution of resource persons according to the number of medicinal plants declared.

Group of persons	Number of plants declared	Percentage (%)	Number of treatment recipes	Percentage (%)
Indigenous populations	104	54,17	108	26,80
Plant traders	97	50,52	98	24,32
Herbalist or healers	64	33,33	74	18,36
Midwives	57	29,69	77	19,11
Traditherapists	32	16,67	46	11,41
Total	192	100	403	100

Modes of acquiring ethnobotanical knowledge

Methods of acquiring knowledge in herbal medicine are diverse and are based on three main types: family transmission (51.04%), training in traditional medicine (30.73%) and initiation (16.67%) (Table 4).

Table 4. Modes of acquisition of ethnobotanical knowledge.

Mode of knowledge acquisition	Number	Percentage (%)
Family transmission	98	51.04

Training on traditional medicine	59	30.73
Initiation	32	16.67
Total	192	100

Diversity and uses of medicinal plants

The populations of the city of Douala possess rich traditional knowledge in medicinal plants and use a varied flora in the treatment of various affections. The surveys of the target population made it possible to inventory 192 species of plants used for medicinal purposes and distributed among 139 genera and 55 families.

The families with the largest numbers of species used for medical purposes are in descending order: *Asteraceae* (20 species divided into 18 genera), *Poaceae* (11 species divided into 10 genera), *Fabaceae-Papilionoideae* (11 species divided into 08 genera), *Acanthaceae* (09 species divided into 07 genera), *Euphorbiaceae* and *Malvaceae* (09 species divided into 06 genera each), *Amaranthaceae*, *Lamiaceae*, *Solanaceae* (09 species divided into 05 genera each), *Cucurbitaceae* and *Rubiaceae* (06 species divided into 04 genera each) (Table 5). However, 10 families are represented by 02 species and 31 families by 01 species.

Table 5. Most represented medicinal plant families in terms of species and genera (n ≥ 3 species).

Familles	Number of species	Frequency (%)	Number of genera	Frequency (%)
Asteraceae	20	10.42	18	12.95
Poaceae	11	5.73	10	7.19
Fabaceae-Papilionoideae	11	5.73	8	5.76
Acanthaceae	9	4.69	7	5.04
Euphorbiaceae, Malvaceae	9	4.69	6	4.32
Amaranthaceae, Lamiaceae, Solanaceae	9	4.69	5	3.60
Cucurbitaceae, Rubiaceae	6	3.13	4	2.88
Araceae	5	2.60	4	2.88
Combretaceae	4	2.08	3	2.16
Convolvulaceae, Rutaceae	4	2.08	1	0.72
Apocynaceae	3	1.56	3	2.16
Cyperaceae, Melastomataceae	3	1.56	2	1.44
Moraceae	3	1.56	1	0.72

The high number of inventoried species indicates that this study area has a varied flora that is used in the treatment of various diseases. This makes the Douala region an important source of medicinal plant supply

for urban communities. In addition, a majority of listed plant species is reported to be involved in more than one disease category. This is the case of *Peperomia pellucida* and *Phyllanthus amarus*, which are involved in the treatment of 16 categories of diseases, *Moringa oleifera* (15 categories of diseases), *Ageratum conyzoides*, *Costus afer* and *Solanum incanum* (14 categories of diseases), *Capsicum frutescens* (11 categories). The use of a plant to treat several conditions is probably due to the presence of many metabolites in this plant and also the fact that the same molecule can be active against different pathogens (Leonti *et al.*, 2003). Most of the medicinal plant species collected and identified in the study area have also been used medically to treat the same or different diseases in other parts of Cameroon as elsewhere. Among others, we can mention studies conducted :

- in other regions of Cameroon, particularly in the West (Tchuenguem *et al.*, 2017), in the North-West (Focho *et al.*, 2009), in the South (Betti & Lejoly, 2009), in the South-West (Fongod *et al.*, 2014) in the east (Etame-Loe *et al.*, 2018) etc.;
- in Africa, particularly in Côte d'Ivoire (N'Guessan *et al.*, 2011), Ethiopia (Mengesha, 2016), Uganda (Onwa *et al.*, 2016), DRC (Fundiko *et al.*, 2017) in South Africa (Bath, 2013); in Nigeria (Aliyu *et al.*, 2017), Benin (Kpètèhoto *et al.*, 2017), etc.;
- in Asia, in countries such as India (Bharali *et al.*, 2017), Bangladesh (Sohel *et al.*, 2016), Thailand (Neamsuvan *et al.*, 2012), Nepal (Bhattarai *et al.*, 2006), Malaysia (Chan *et al.*, 2016), Pakistan (Mustafa *et al.*, 2016), Iran (Haddad *et al.*, 2017), etc.;
- in America in countries like Brazil (Palheta *et al.*, 2017), Mexico (Alonso-Castro *et al.*, 2011), Paraguay Argentina (Trillo *et al.*, 2010), etc.;
- in Europe countries such as Switzerland (Ankli *et al.*, 2002), Italy (Passulacqua *et al.*, 2007), etc.

The biological activities of these plants involved in the treatment of several diseases confirm their ethnobotanical uses. For example, *Capsicum frutescens* is used in the management of various cancers and an activity attributed to the presence of capsaicin which has anti-mutagenic and anti-carcinogenic activities (Surh, 2002). Also,

pharmacological studies of extracts, fractions or compounds isolated from *Peperomia pellucida* showed analgesic, anti-inflammatory, antipyretic, antioxidant, anti-hyperglycemic, anti-hyperuricemic, antidiarrheal, anti-osteoporotic activities, depressant effects, gastro -protective, hypotensive, cytotoxic, antimicrobial, thrombolytic, and fibrinolytic (Kartika *et al.*, 2016). In conclusion, these plants have broad traditional and pharmacological uses in various pathological and physiological conditions. Therefore, these are attractive topics for other experimental and clinical research. The similarity of the same plant species for identical or divergent ethno-medical uses, in different regions of the world and different cultural groups, is a reliable indication of the bio-activity potential of these plant species (Maroyi, 2013).

Morphological distribution of listed medicinal plants

At the end of this survey, three morphological types were counted. These are the herbaceous plants that make up the largest proportion of registered medicinal plant species (72.92%), followed by shrubs (20.31%) and trees (6.77%) (Fig. 2).

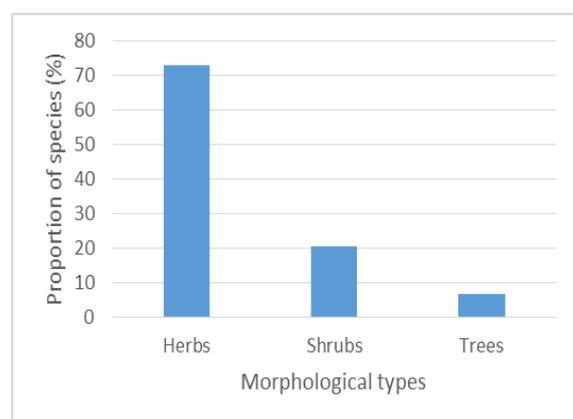


Fig. 2. Distribution of morphological types identified.

The popularity of herbaceous herbs as a source of herbal therapies is often attributed to their high pharmacologically active constituents in relation to woody plants, their abundance throughout the year, their accessibilities and their ease of use for local populations (Stepp, 2001; Namukobe *et al.*, 2011), and because forests are degraded at a breakneck pace over time (Stepp, 2004). Shrubs are also preferred because of their year-round availability, and also

because they are not affected by seasonal variations like herbaceous plants (Tolossa *et al.*, 2013). However, harvesting herbs that are in most cases annuals is an indicator that the collection of medicinal plants is not a great threat to conservation.

Distribution of respondents according to the organs of the declared plants

The results of organ surveys revealed that a large number of herbal recipes are made from leaves (86.98%), followed by stems, roots, whole plant, fruits, bark, seeds and aerial parts representing respectively 33.85%, 30.73%, 28.13%, 18.75%, 14.06%, 13.54% and 10.94%. Plant parts such as flowers (7.81%), tubers (5.73%), rhizomes (1.04%) and buds (0.52%) are not commonly used (Fig. 3).

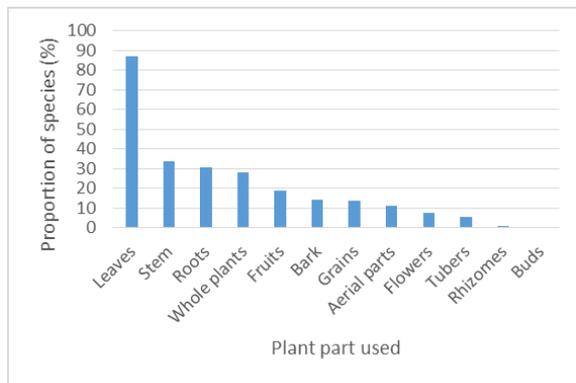


Fig. 3. Different types of organs of medicinal plants used.

The use of leaves to prepare herbal remedies is a common practice in many communities. These high rates of leaf utilization compared with other parts of the plant can be attributed to the ease with which they can be obtained in large quantities. The leaves are the main photosynthetic organ in plants and are considered a key component of the natural pharmacy for the synthesis of constituents, especially those that are more pharmacologically active against diseases. The preference of leaves over other parts of the plant is therefore due to the accumulation of active ingredients such as tannins and other alkaloids (Passulacqua *et al.*, 2007). As noted by Cunningham (2001), overexploitation of the leaves can lead to deterioration of medicinal plants, as leaf removal limits the transformation of vegetative development into reproductive development, such as flower production and seed / fruit development. This limits

the natural regeneration of plants. Root harvesting, on the other hand, is more destructive because it often involves the uprooting of whole plants which, therefore, affects regeneration for sustainable use. Herbal preparations made from more than two plant organs may endanger the species unless sustainable use mechanisms are put in place. Many studies have shown that leaves of different plants possess bio-active substances against different diseases and pathogens (Searels *et al.*, 2013). Since leaf harvesting is less destructive than that of roots or barks, it is necessary to test the effectiveness of the leaves for different conditions treated. In the case where the roots and the barks are involved in the treatment of these affections. This minimizes the risk of over-exploitation. For example, the leaves of *Vernonia amygdalina* have been shown to be effective against malaria (Ngarivhume *et al.*, 2015; Mèdoatinsa *et al.*, 2016). The harvest of its roots can be avoided.

Distribution of respondents according to declared modes of administration

Different modes of administration of herbal remedies have been identified. The majority of plants are consumed orally (97.40%), followed by the dermal route (52.08%), the rectal route (32.29%), the ocular route (10.94%). The least used routes of administration are nasal (6.77%) and inhalation (4.69%) (Fig. 4).

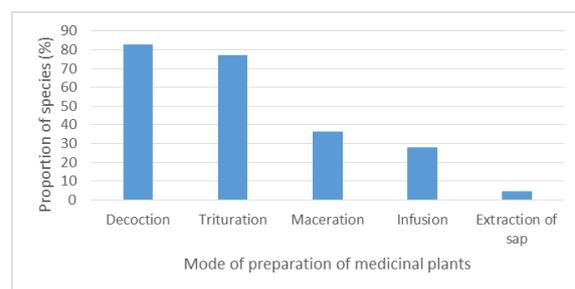


Fig. 4. Modes of administration of medicinal plants.

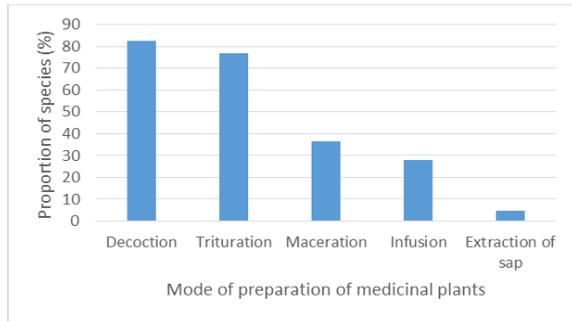


Fig. 5. Modes of preparation of medicinal plants.

The oral mode of administration is commonly used in many herbal treatments in various parts of the world, including India (Bharali *et al.*, 2017), Brazil (Chaves *et al.*, 2017), Nigeria (Aliyu *et al.*, 2017), and Benin (Houmènou *et al.*, 2017). The choice of oral administration may be related to the use of certain solvents or additives such as water and foods that are generally considered a vehicle for carrying the remedies. These additives improve the extraction of bioactive molecules during the preparation of remedies. Additives are also important to minimize discomfort, improve taste and reduce side effects such as vomiting and diarrhea (Tugume *et al.*, 2016).

Distribution of respondents according to the declared methods of preparation

Medicinal plants for the treatment of different conditions are prepared by various methods. Fig. 4 shows that the decoction was frequently used (82.81%), followed by trituration (77.08%), maceration (36.46%), infusion (28.13%) and sap

extraction (4.69%). In this study, the additives used in the preparation of medicinal plants are: ash, salt, alcohol, tea and onions. Salt is used in the remedies for toothache and wounds where it is believed to kill germs. For external application, petrolatum (Vaseline) and paraffin are used to reduce friction when applying the remedy. The majority of recipes for remedies are prepared from fresh plant material (65.34%) only, while other representatives (28.05%) are prepared solely from dry plant material. Very few remedies are prepared from the mixture of fresh and dry plant material (6.61%).

Boiling (or decoction) is effective in extracting plant material and, at the same time, retains herbal remedies for a longer period compared to cold extraction. Infusions and cold extracts do not offer a long shelf life for preparations (Hirt & M'pia, 2008).

Frequency of quotation and preference ranking of medicinal plants

The calculation of the quotation frequencies (FC) of the species allowed to choose the most used species in the locality. Thus, 22 species each with a citation rate greater than 80% were ranked according to the information (main diseases treated by each one) provided by the key informants during interviews and scores were assigned to each of the plants (Table 6).

Table 6. Preference ranking of medicinal plants with citations frequencies greater than 80%.

Plant species	Plant part used	Illness treated	FC	Key informant (N =15)															Total /150	Rank
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
<i>Eremomastax speciosa</i>	Le, St	Nappy rash, diarrhea, typhoid, anemia, headache, dysmenorrhea, dysentery	94,51 (4 th)	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	150	1
<i>Aloe vera</i>	Le, St	Malaria, typhoid, stomach ache (gastric ulcer), diarrhea	91,76 (8 th)	9	10	10	9	10	10	9	9	10	10	9	10	9	10	10	144	2
<i>Ageratum conyzoides</i>	Le, St, Sd, Ap	Malaria, typhoid, stomach ache (gastric ulcer), diarrhea diabetes, rash	97,80 (1 st)	10	10	8	9	9	9	9	9	9	10	9	9	9	9	9	137	3
<i>Cleome ciliata</i>	Le, Ap, Wp	Gastric ulcer, spleen, measles, cough, diabetes, hemorrhoids, headache, helminthiasis	87,36 (13 th)	8	9	10	9	8	9	9	9	8	7	9	9	8	9	8	129	4
<i>Justicia secunda</i>	Le, St	Anemia, hypertension, dysmenorrhea, gastric pain	90,11 (10 th)	8	9	9	6	7	8	9	8	7	8	9	9	7	10	8	122	5
<i>Cympobogon citratus</i>	Le, Ap	Malaria, colds, cough, typhoid, hypertension	96,70 (2 nd)	7	8	8	8	7	9	8	7	8	6	9	7	8	7	9	116	6
<i>Persea americana</i>	Bk, Le, Fr	Malaria, diabetes, hypertension, stomach ache	92,86 (5 th)	6	6	8	6	6	7	6	6	8	6	8	8	8	7	9	105	7
<i>Moringa</i>	Le, Fr	Malaria, stomach ache,	89,01	9	8	7	7	7	4	7	6	8	5	4	6	7	8	6	99	8

species for the treatment of malaria, typhoid, gastric pain and diarrhea while its frequency of quotation (91.76%) comes in eighth position.

The same is true for *Cleome ciliata*, which ranks 4th in the treatment of gastric ulcers, spleen, measles, diabetes, hemorrhoids, helminthiasis, headaches and cough; *Justicia secunda* which ranks 5th and is used for the therapy of anemia, dysmenorrhea, gastric pain and hypertension; *Cympobogon citratus* occupies the 6th place respectively to treat malaria, colds, cough, typhoid and hypertension.

However, *Euphorbia hirta* and *Kalanchoe coccinea* occupy the last positions in this ranking, respectively 21st and 22nd, because despite their FC > 80% the information given on the different diseases they treat are not consistent among the key informants chosen for the study. According to the informants consulted, their effectiveness and accessibility are relative.

Diseases treated in the study area

Among the listed medicinal plants, the greatest number (81 species) are prescribed in the treatment of diabetes, 80 species in the treatment of malaria, 56

species in the treatment of diarrhea, 49 species in the treatment of bronchitis/cough, 47 species in the treatment of gonorrhea/STI, 45 species in the treatment of gastric/stomach ache, 44 species in the treatment of helminthiasis, wounds/wounds and fever, 48 species in the treatment of constipation and abdominal pain, 40 species in the treatment of headache, 37 species in the treatment of dermatological diseases, 35 species in the treatment of anemia and hypertension, 33 species in the treatment of female infertility, 31 species in the treatment of dysentery, 30 species in the treatment of jaundice and hemorrhoids.

Also treatment of kidney failure, jaundice, stress/depression, elephantiasis, dog bite/rabies, hematuria, menopausal disorders, urinary retention, oral cancer, tonsillitis, the dirty belly of women is ensured each by two medicinal plants. Goiter, hiccups, meningitis, prostate, blood clotting, polio, myopia, thrombosis, trembler, postpartum hemorrhages, body aches, canker sores, anal itching, cramps, nausea, hypotension, are treated by a single medicinal plant (Table 7).

Table 7. Number and percentage of plants used to treat different affections.

Illnesses treated	Number of plants used	Percentage of plants used (%)
Diabetes	81	42.19
Malaria	80	41.67
Diarrhea	56	29.17
Bronchitis / cough	49	25.52
gonorrhea, Sexually Transmitted Infections	47	24.48
Gastric pain / stomach ache	45	23.44
Fever, wounds, helminthiasis	44	22.92
Abdominal pain, constipation / purgative / intestinal wash	41	21.35
headaches	40	20.83
Dermatological diseases	37	19.27
Anemia, hypertension	35	18.23
Female Infertility/Clogged Trunks	33	17.19
Dysentery	31	16.15
Jaundice, hemorrhoid	30	15.63
Asthenia/tonic, difficult delivery	28	14.58
Dysmenorrhea, cancers/tumors	27	14.06
Sore throat/angina, toothache/tooth decay/gingivitis, male infertility/azoospermia, gastrointestinal diseases/dyspepsia, inflammation	26	13.54
Splenomegaly/spleen	24	12.50
Rash/hives/mange/eczema, snake bite, general pain, inflammation	23	11.98
Fontanelle	22	11.46
Asthma, flu/cold, agalactia	21	10.94
Measles	20	10.42
Renal failure, boils/abscess, syphilis	19	9.90
Leucorrhea	18	9.38
Amenorrhea, convulsions, heart disease, poisoning, digestive disorders/indigestion, infection (antibiotic)	17	8.85

Illnesses treated	Number of plants used	Percentage of plants used (%)
Typhoid, umbilical hernia, carminative/flatulence	16	8.33
Diaper rash, cyst/fibroma / myoma, sore eyes, diuretics	15	7.81
Wires, otalgia/otitis, pregnancy, respiratory diseases, liver diseases	14	7.29
Obesity, Abortion Threats, Arthritis	13	6.77
Lumbar pains, fractures/sprains, antioxidant	12	6.25
Kidney disease/nephritis, neuralgia/nerve pain, viral hepatitis, tuberculosis, mental disorders, vulvovaginal infections, ulcers	11	5.73
Panaris, chicken pox, mycosis/ringworm/scabs, epilepsy	10	5.21
Urinary tract infections, pneumonia, conjunctivitis, fungal infections	9	4.69
Skin cancer, abortion	8	4.17
Haemorrhage, cholera, palpitations, edema, wounds and umbilical cord scarring, osteoarthritis, postpartum pain, pulmonary congestion, anorexia, urological diseases	7	3.65
Herpes, chlamydia, gastric cancer, hyperglycemia, shingles, vomiting, burns, yellow fever, kidney stones, mastodynia	6	3.13
Contraception, healing of wounds and wounds, chronic metritis, chest pain/chest, vertigo, gynecological diseases, scorpion sting, cataract, cystitis, ascites, appendicitis, breast cancer	5	2.60
Insomnia, towards women, enteritis, bile, drops (goutte), metrorrhagia, placental retention, pelvic pain, umbilical colic, nasal bleeding, colorectal cancer, bacteria, hyper cholesterolemia	4	2.08
Sexual weakness / aphrodisiac, baldness, amoebiasis, sinusitis, bad luck / sorcery, menorrhagia, madness, candidiasis, blood purification, leprosy, throat cancer	3	1.56
Women's dirty belly, kidney failure, jaundice, stress/depression, lung disease, elephantiasis, swelling, dog/rabies bite, hematuria, memory loss, hypoglycemia, antiseptic, uterine cancer	2	1.04
ENT disorders, goiter, anal itching, cramps, menopausal disorders, myopia, insecticide, thrombosis, oral cancer, urinary retention, eclampsia, poliomyelitis, tonsillitis, hiccups, hypotension, body aches, canker, blood clotting, tremor, meningitis, prostate, hemorrhage postpartum, nausea	1	0.52

Fidelity index of favorite medicinal plants

Among the citation frequencies of each species, the 22 species with a percentage greater than or equal to 80% (the most used in the locality) were selected for the calculation of fidelity indices or "fidelity level" (FL). Seventeen plants have levels of fidelity greater than 50%. This highlights the importance of these species in the treatment of the diseases mentioned in the study area (Table 8). However seven species

namely: *Eremomastax speciosa*, *Justicia secunda*, *Annona muricata*, *Zingiber officinale*, *Kalanchoe coccinea*, *Ageratum conyzoides* and *Vernonia amygdalina* have a fidelity level of 100% in the treatment of diaper rash, anemia, sore throat nerves, cough, otitis, headache, malaria and helminthiasis respectively. The high levels of FL for these species indicate their preference and outstanding efficacy in treating these listed diseases.

Table 8. Frequency of quotations and fidelity indices of the preferred medicinal plants.

	Plant species	Illnesses treated	F.C	Np	N	FL (%)
1	<i>Eremomastax speciosa</i>	Nappy rash	94.51	172	172	100
2	<i>Justicia secunda</i>	Anémia	90.11	164	164	100
3	<i>Annona muricata</i>	Nerves	95.60	174	174	100
4	<i>Zingiber officinale</i>	Cough	84.62	154	154	100
5	<i>Kalanchoe coccinea</i>	Otitis	87.36	159	159	100
6	<i>Ageratum conyzoides</i>	Malaria	97.80	178	178	100
7	<i>Vernonia amygdalina</i>	Helminthiasis, malaria	92.31	148	168	100
8	<i>Ocimum gratissimum</i>	Diarrhea	85.16	126	155	81.29
9	<i>Aloe vera</i>	Skin rash	91.76	131	167	78.44
10	<i>Cleome ciliata</i>	Gastric ulcer	87.36	121	159	76.10
11	<i>Persea americana</i>	Diabetes	92.86	124	169	73.37
12	<i>Cympobogon citratus</i>	Cold	96.70	122	176	69.32
13	<i>Scoparia dulcis</i>	Gastric pain	84.62	103	154	66.88
14	<i>Moringa oleifera</i>	Hypertension	89.01	104	162	64.20
15	<i>Carica papaya</i>	Typhoid	84.62	86	154	55.84
16	<i>Senna alata</i>	Fungal/sores	92.31	90	168	53.57
17	<i>Bidens pilosa</i>	Rheumatism	85.16	80	155	51.61
18	<i>Mangifera indica</i>	Jaundice	80.22	72	146	49.32

19	<i>Euphorbia hirta</i>	amoebiasis	87.91	78	160	48.75
20	<i>Alchornea cordifolia</i>	Anemia, STI	82.97	71	151	47.02
21	<i>Costus afer</i>	Varicella	87.36	68	159	42.77
22	<i>Acmella caulirhiza</i>	Fontanelle, spleen	90.66	68	165	41.21

F.C: frequency of quotation; Np: number of informants who suggest the use of the plant for the treatment of a specific disease; N: total number of informants who mentioned this plant species for any other purpose; FL: "Fidelity Level"; STI : Sexually Transmittable Infections.

The plant species with very high fidelity indices for some diseases, are used for several other diseases, probably because of a wide range of bioactive compounds in their organs (Tugume *et al.*, 2016; Bayengue *et al.*, 2017). These high fidelity indices also indicate that these species are considered to have great cultural significance in the study area. The 100% choice by key informants to use these species for the treatment of the diseases listed above is an indicator of the potential of the various medicinal properties contained in the extracts of these plants. These results show the high potential of these species to be considered as sources of new drugs. Other medicinal properties of these plants have been identified.

Conclusion

This work was initiated with the aim of updating the database of medicinal plants in the city of Douala. To do this, an ethno-pharmacological survey with semi-structured interviews with traditional healers and other resource persons was conducted. The results of the ethno-pharmacological survey showed that the local populations and traditional healers of the city of Douala use a varied flora in the treatment of various diseases and possess rich traditional knowledge in medicinal plants. In fact, 192 species of plants distributed among 139 genera and 55 families are listed as medicinal plants in this locality. These plants are used in the preparation of 403 treatment recipes for 175 diseases. The families *Asteraceae*, *Fabaceae-Papilionoideae* and *Poaceae* are the most represented reported diseases were grouped into 23 categories. The highest score of the Informant Consensus Factor (ICF) is obtained in the treatment of the group of infectious and endocrino-metabolic diseases (FCI = 0.86 for each). *Eremomastax speciosa*, *Justicia secunda*, *Annona muricata*, *Zingiber officinale*, *Kalanchoe coccinea*, *Ageratum conyzoides* and *Vernonia amygdalina* each had a fidelity index (FL)

of 100% in the respective treatment of diaper rash, anemia, nerves, cough, otitis, headaches, malaria and helminthiases. Leaves are the most used part of plants (43.50%) for the preparation of remedies. The decoction (82.81%) is the main method of preparation while the oral route (97.40%) is the main mode of administration of plants. Valuable information on medicinal plants should be kept during written inquiries. In addition, this documentation of medicinal plants can serve as a basis for future studies on new medicinal resources.

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