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Ethnobotanical study of plants used against onchocerciasis in the far north region of Cameroon

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Despite the multitude of studies which have shown the use of medicinal plants in the management of parasitic diseases, little data was available on the plants used against onchocerciasis. Ethnobotanical surveys were carried out among traditional healers in the Far North region of Cameroon. Studies were conducted from July 2017 to May 2018 through direct interviews using a semi-structured questionnaire taking into consideration the socio-demographic characteristics of the respondents as well as their knowledge in the art of onchocerciasis and parasitic infections treatment using plant recipes. A total of one hundred people were interviewed in villages found in the Far North region of Cameroon: 43 were females and 57 males, among which, 71 were recognized as traditional healers. Adults were the most represented (71 respondents). The study identified 96 plant species belonging to 49 genera divided into 29 families among which the most represented was the Fabaceae (20 quotes). The most represented biotope was savannah (98%) and trees (51) were the most used followed by shrub (41). The leaves (40) are the organs which are mostly demanded and the main preparation method is a decoction (69) and 36 diseases and / or symptoms related to onchocerciasis and helminthiases were recorded. The medicinal plants identified, constitute an undeniable asset and a good database for the biological screening of plant-based antiparasitic molecules, which can lead to the manufacture of improved traditional medicines.

Key words: Onchocerciasis, medicinal plants, ethnobotanical surveys, filariasis, Cameroon.

INTRODUCTION

Parasitic diseases are a significant source of threat to human and animal health and, these include helminthiasis caused by parasitic nematode worms also called helminths. These nematodes are a major public health

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problem in developing countries and affecting approximately two billion people worldwide (WHO, 2017). These infestations are prevalent mainly in deprived areas of the globe, especially in tropical and intertropical areas (Molyneux et al., 2003). They promote growth of poverty rate, thereby compromising child survival and weakening the working population (WHO, 2015). Among these helminthiases are, filariasis which are parasitic infections caused by nematodes. They constitute significant obstacles to the development of underdeveloped and developing countries, in the tropics and particularly in sub-Saharan Africa (Fenwick, 2012). These neglected tropical diseases do not receive as much attention as other endemic diseases, yet they have afflicted mankind for centuries (WHO, 2017). An estimated 1 billion people are at risk of contracting filariasis and about 120 million individuals are infected with filariasis in 73 countries, predominantly in African countries (Marlieke et al., 2006; Hartman et al., 2011). Among these filariasis, there is onchocerciasis, a disease to which more than 90 million people are exposed (Turner et al., 2010). Onchocerciasis is a filariasis caused by *Onchocerca volvulus*, a parasitic nematode of the family Onchocercidae (Despommier *et al*., 1995; Magdi, 2006). It is transmitted by the bite of a blood-sucking black fly belonging to the genus *Simulium* which lives near fast-flowing rivers (Basanez et al., 2008; WHO, 2017). Over 120 million people worldwide are at risk of onchocerciasis, approximately 37 million are infected, 270,000 who are blind and 6.5 million suffer from skin damage (Eze and Malau, 2011; WHO, 2017).

In Cameroon, onchocerciasis is endemic in the ten regions with variable endemicity rates (Zoure et al., 2014). An estimated 10 million people are at risk and 7 million case were reported in which 32,000 are blind and 1.5 million suffer from complications due to the disease (Eze and Malau, 2011). The treatment of onchocerciasis is compromised by the multiple resistances to reference anthelmintics. In recent decades, onchocerciasis has caused economic losses of more than $ 30 million a year due to the abdication of cultivated land in the fertile valleys and the unavailability or absence of work (WHO, 2015). In fact, due to the nuisance of flies and disease, populations are obliged to desert endemic areas which are generally areas with high agricultural potential. The main consequence of this migration is a shortfall in the national economy through a weakening of the agricultural sector. As a result, several means of control have been considered in order to eradicate this disease, such as vector control, nodulectomy and chemotherapy. Currently, Levamisole® and Ivermectin® are the only conventional drugs to control onchocerciasis. Unfortunately, Ivermectin® is only microfilaricide and as the numerous harmful side effects such as asthenia, ataxia, abdominal pain, anorexia, constipation, diarrhea, nausea, vomiting, drowsiness, dizziness, tremors and leukopenia (Borsboom et al., 2003). In addition, after several years of treatment, there is an emergence of resistance as well as a re-invasion of the microfilariae in the treated patients (Kamgno et al., 2008; Tanya et al., 2013). To face problems of chemoresistance of parasites, limited innovations in onchocerciasis therapy, low therapeutic coverage and hotspots, limited funding in the fight, the need to develop new effective and well tolerated anthelmintics is not only important but urgent. Fortunately, traditional medicine could serve as a support given since 75 to 80% of the populations of the developing countries depend closely on the preparations based on local medicinal plants (Adjanohoun, 2000; Dibong et al., 2015); on the other hand, at least 25% of modern medicines derive directly or indirectly from medicinal plants, mainly thanks to the application of modern technologies to traditional knowledge (Biyiti et al., 2004). This interest in traditional medicine and more specifically in medicinal plants has led to ethnobotanical investigations which have proven to be one of the most reliable approaches for the discovery of new drugs (Koné, 2009). Through ethnobotanical studies, many plants have been identified around the world as being useful against onchocerciasis and helminthiasis (Benlamdini et al., 2014; Ndjonka et al., 2018). In Cameroon, although the flora is rich in medicinal plant species, very few investigations to record the use of plants against onchocerciasis have been carried out so far (Ndjonka et al., 2018). The treatment of onchocerciasis remains a big challenge, however, the secondary metabolites of plants have shown a greater and more rapid action than generic drugs in the treatment of many parasitic diseases in general and onchocerciasis in particular (Sereme et al., 2008; Ndjonka et al., 2018). The present study aimed to identify the plants and recipes used against onchocerciasis by the population of the far north region of Cameroon.

MATERIALS AND METHODS

Study site

Figure 1 indicates the region covered in this study. Several factors contributed to the choice of the syrupy sites in the Far North region which is the most populated region, border of Chad and Nigeria with an area of 34,263 km², it has 6 departments, Diamaré, Logone-et-Chari, Mayo-Danay, Mayo-Kani, MayoSava, Mayo-Tsanaga with a population of 3.993 million with a density of 91 inhabitants/km. The study was carried out in the Sudano Sahelian zone with reported high endemicity of onchocerciasis and filariaris (WHO, 2016). Another reason for the choice of the study area is the distribution of the vector of the disease that lives around the rivers, this disease is also called river blindness (Demanou et al., 2003).

Survey methods

The ethnobotanical survey was carried out with practitioners of traditional medicine in the Far North region of Cameroon. They were made by direct interviews using a semi structured questionnaire. The interviewees were to give all the information related to medicinal plants directed against parasitic infections in

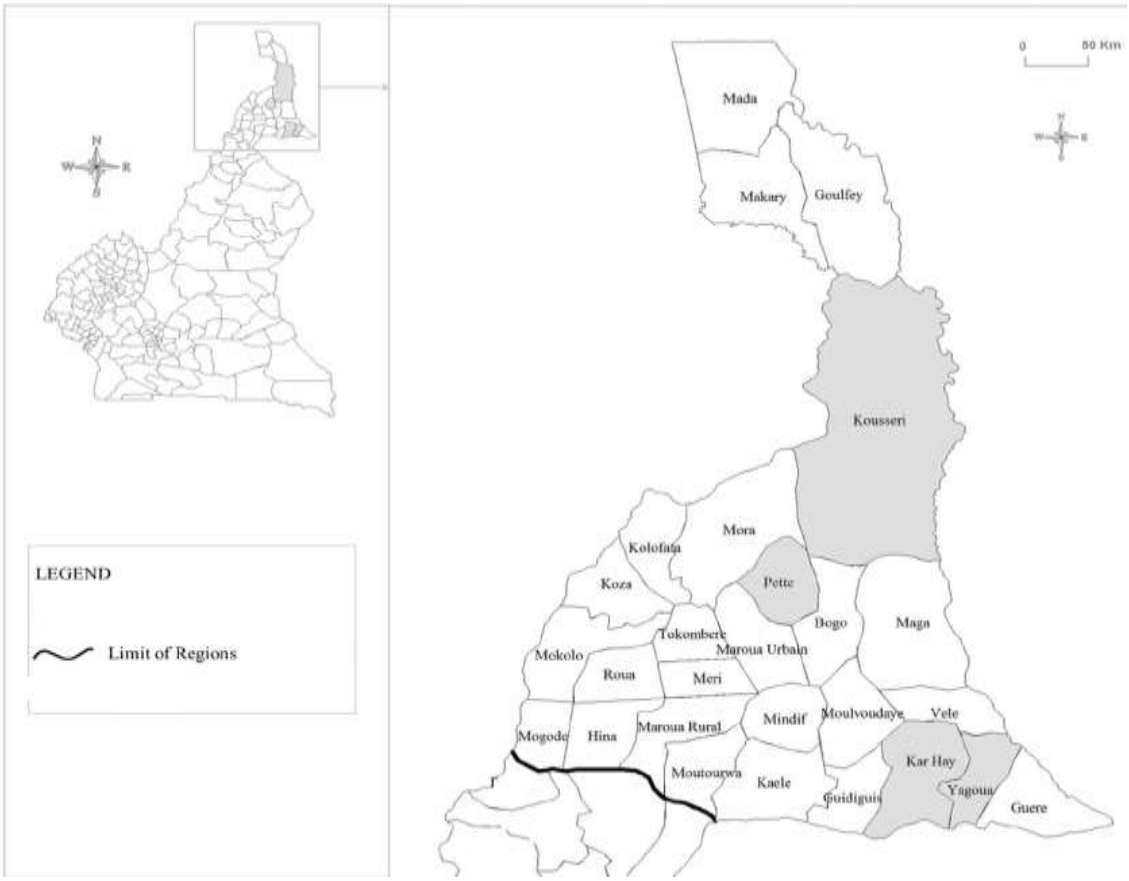

Figure 1. Map showing covered 11° 0'0 "N and 14° 30'0" E in DMS or 11 and 14.5 in decimal degrees: Far North Cameroon (Gounoue-Kamkumo et al., 2015).

general and onchocerciasis in particular. These surveys were prospective and cross-sectional study; they were conducted from July 2017 to May 2018. The main lines of the interview concerned on one hand, the socio-demographic characteristics of the respondents (region of origin, sex, age, ethnicity, profession and experience) and on the other hand, information on the plants used in the recipes of medicinal preparations used against onchocerciasis (symptoms and/or manifestations) and parasitic infections in general (the local name, the scientific name, the family, the provenance, the biotope, the harvest period and method, the plant parts used, the morphological type, the methods of preparation of the recipes, the methods of administration, the modes of conservation, the preparation time, the associations, the quantity and type of solvents, the routes of administration, the nature of knowledge acquisition as well as the other diseases treated by these plants). Interviews of local population were carried out in French and local languages. Access and maintenance in the villages was facilitated by indigenous village guides who also translated local languages into French. The exchanges were facilitated by the purchases of medicinal plants presented by herbalists, traditional healers and users of medicinal plants.

Identification methods

The collection of samples at the study sites was done *in situ* thanks to the knowledge holders, herbalists and traditional healers who made themselves available for the harvest of plants around huts or in the bush. These samples were kept in a control herbarium according to the techniques and methods of Schnell (1960).

The identification was done using appropriate scientific documentation, by comparison of the vernacular and/or trade names obtained from the respondents, samples of the control herbarium with the data available in the literature, the reference documents of the library of the Faculty of Sciences of the University of Ngaoundere and the material available at the Laboratory of Physiology of Plant Organisms of the University of Ngaoundere. The identification was confirmed by the botanists of the Department of Biology of Plant Organisms of the Faculty of Sciences of the University of Ngaoundere and those of the Department of Biology of Plant Organisms of the Faculty of Sciences of the University of Maroua. It was also confirmed by the botanists of the botany and traditional medicine laboratory of the Institute of Medical Research and Studies of Medicinal Plants and equally with the help of the different volumes of flora of Cameroon stored in the national herbarium from Cameroon. The samples collected were characterized by the types of geobotanical distribution, the morphological types, as well as the types of biotopes (Aubreville, 1962; Evrard, 1968; Letouzey, 1985).

Data analysis methods

The data was first analyzed by entering the various recipes and their characteristics by region and by informant on a Microsoft Excel Version 2018 spreadsheet. The variables were presented as

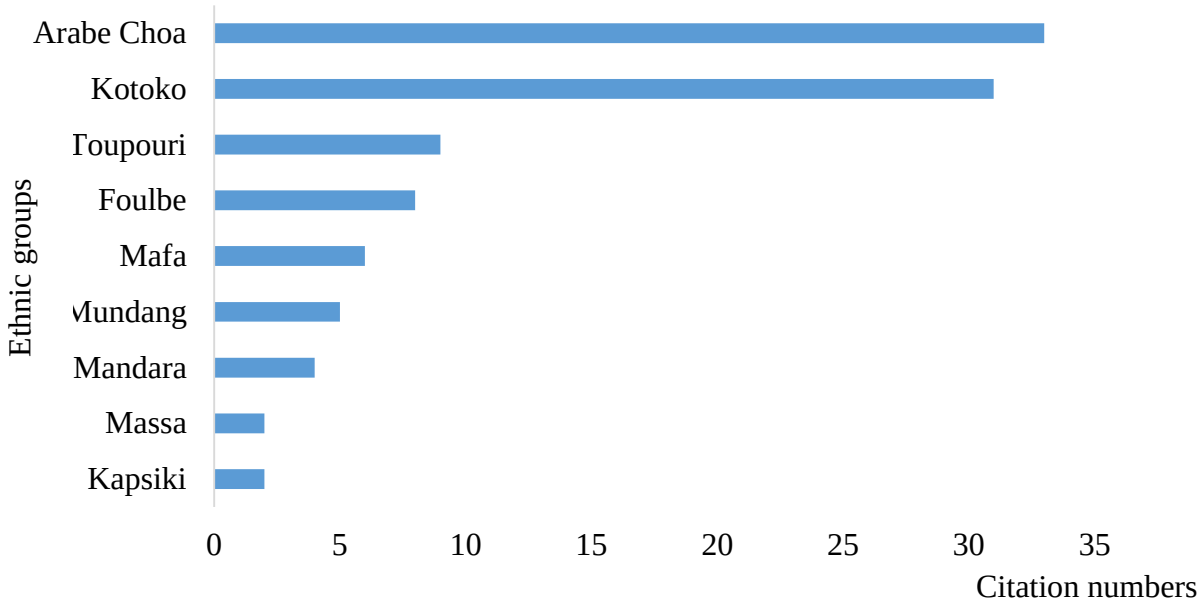

Figure 2. Histogram of the ethnic groups encountered in the Far North according to the number of citation.

Table 1. Socio-demographic characteristics of interviewed interviewees (N = 100).

Demographic characteristics (total score)	Variable	Score (%)
Gender (100)	Women	43
	Men	57
Profession (100)	Herbalists	13
	Heraldists	16
	Traditional healers	71
Age group (100)	Youth	06
	Adults	71
	Old	23
Experience (100)	Novice	11
	Averagely experience	18
	Well experienced	71

percentages in tables and in a graph form.

RESULTS

Socio-demographic characteristics of the respondents

One hundred (100) people in the Far North region were interviewed on the traditional knowledge and importance of medicinal plants used in the treatment of onchocerciasis. The most represented ethnic groups were Araba choa (38) and Kotoko (31) (Figure 2). The sociodemographic characteristics of this study are listed in Table 1.

Floristic characteristics of plants directed against onchocerciasis

The floristic inventory identified 96 plant species belonging to 49 genera and divided into 29 families. The most represented families being those of Fabaceae (20 citations), followed by Apocynaceae (12) and Combretaceae (9). The most represented genera were *Acacia* (4). The 96 medicinal plants listed mainly came

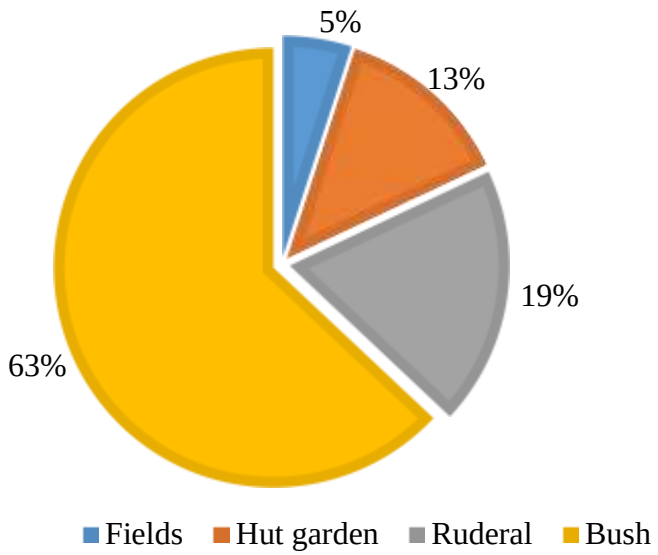

Figure 3. Diagram of provenance of plant organs in percentage.

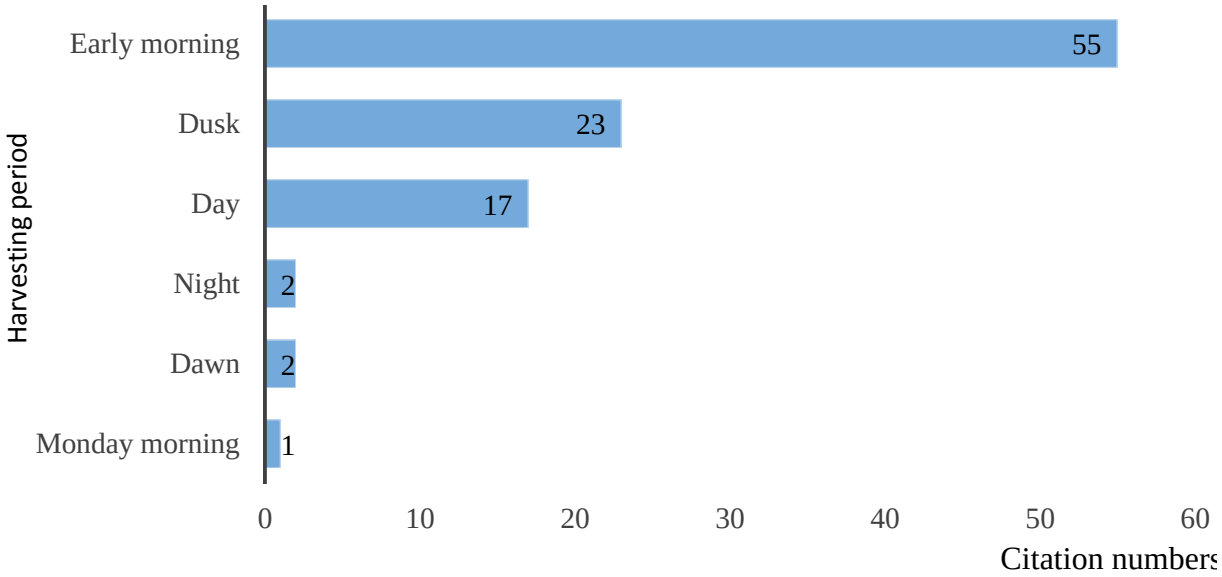

Figure 4. Histogram of the harvest periods of plant organs according to the citation numbers. Four morphological types are recorded: Trees (51) followed by shrubs (41), Herbaceous plants (6) and shrubbery (2) (Figure 5).

from the bushes (63) followed by ruderal species (19), the case gardens (13) and field species (5) (Figure 3).

The identified species have two types of biotopes: Savannahs (98) and meadows (2). The registered plants were mainly harvested at dawn (57) followed by dusk (23), day (17), night (2) and Monday morning (1) (Figure 4).

The most common preparation method was decoction (69) followed by maceration (16) and infusion (15). For the various preparations, the most widely used solvent was water (97). Drug are mostly warmed (73) but the different recipes were preferably reheated and stored at cold (17) followed by ambient temperature (10). The most widely used route of administration has been the oral route (76) followed by the dermal and oral route (14), dermal route (9), oral and rectal route (1). Eighteen plant organs were used to prepare the various traditional recipes. The most represented were the leaves (40) and the leaf-bark-root mixture (25). The herbal medicines identified made it possible to obtain two hundred recipes with their method of preparation and administration for 36 diseases and or symptoms related to parasitic infections

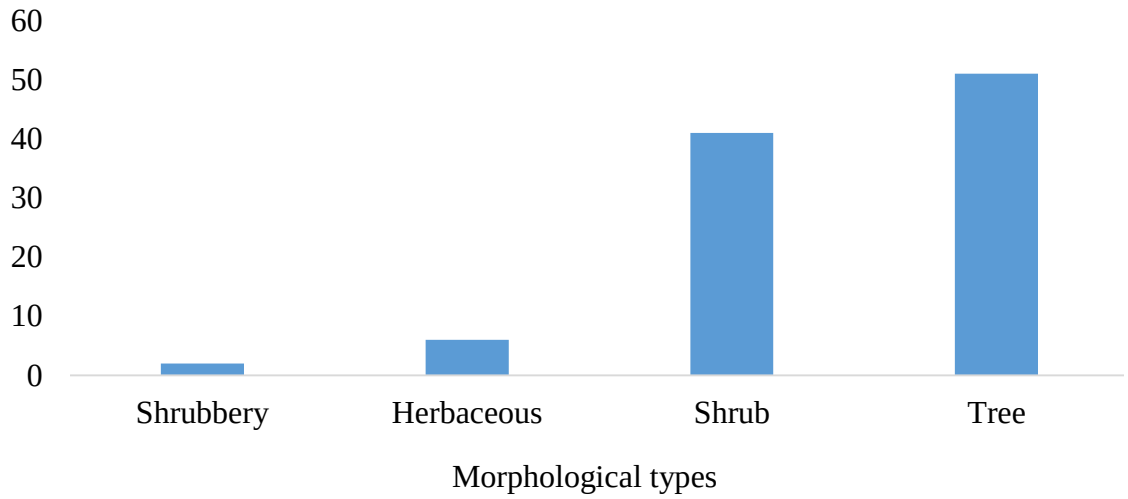

Figure 5. Histogram of the citations number according to the morphological types used in the treatment of helminthiasis in the Far North region of Cameroon.

in general and onchocerciasis in particular (Table 2).

DISCUSSION

In Africa, traditional medicine contributes up to nearly 80% of primary health care among rural populations. In this study, out of 100 interviewed, 43 women were identified; similarly, study conducted in Pakistan revealed that women were afraid of exchange with strangers and particularly the male gender (Umair et al., 2017). This is also due to the inability of women to enter forests for plant samples collection, although they hold the same traditional knowledge. On the other hand, ethnobotanical surveys carried out in the coastal region of Cameroon showed rather a high proportion of women compared to men (Ladoh Yemeda et al., 2016). In this present investigation, 75% of respondents were adults. This could be linked to the fact that the practice of traditional medicine requires an initiation and that is often acquired over time. Besides, it is from a certain age that practitioners are credible and able to exercise like mastering of the use of plants in the treatment of vaginal infections (Ndjib et al., 2017). Although all age groups were involved in the present surveys carried out, the age group greater than 60 (23%) no longer seems interested in the transmission of traditional knowledge. In addition, only a few young people under the age of 29 (06%) follow and exercise the medicinal practices and traditional knowledge transmitted by adults. This is also the case in a study carried out in Nigeria in which young people were less represented because they are very attached to modern life (Bouasla and Bouasla, 2017) and this constitutes a high risk of ancestral knowledge loss in Africa (Ndjib et al., 2017). That situation was also reported from Nepal (Joshi and Edington, 1990). The transmission of knowledge about medicinal plants is most often by inheritance from grands-parents to the descendants. Thus, the fact that young people are losing the interest in traditional medicine for the benefit of their education and various other hobbies, might lead to a risk of a permanent loss of therapeutic uses of medicinal plants in rural areas, or in the national territory (Mpondo et al., 2017). The Foulbe and Choa Arab ethnic groups are the most represented in this present study. This may be explained by the fact that these ethnic groups migratory cattle-breeders living in pasture zones, exposed to high risk of onchocerciasis and for treatment, they use medicinal plants. Traditional healers were the most represented in this study (71%). This could be explained by the fact that traditional healers were more opened to people inquiries compared to heraldists or holders of rural knowledge who exercise in addition, other activities. The important proportion of respondents (71%) possessed a large experience more than 10 years of practice in the exercise and knowledge of the use of medicinal plants. The studied population inherited knowledge from their ascendants. The traditional use of herbal medicines, transmitted in by inheritance, forms the basis of medicine for the treatment of onchocerciasis in populations living in the areas studied. Knowledge about the practice of traditional medicine is transmitted from the ascendants to the descendants but also empirically, each individual holds a secret which was transmitted to him either by his ancestors, or during the training with the holders or what he has acquired over the years of experience, but communication between individuals remains a priority. In fact, in Africa, the practice of traditional medicine remains a family affair. Some authors reported that knowledge is traditionally and empirically transmitted from father to son (Dibong et al., 2015; Adjanohoun, 2000). From Figure 5, the ethnobotanical

Table 2. Ethno-medical characteristics of the recipes identified in the treatment of onchocerciasis in the Far North region of Cameroon.

C.R.O.	Eth.G.	V. N.	Sc.N.	F.	P. U.	T.D. and/or M.S.	M.P.	Do.	M. C.	P.T.	M.T.	R.A.	N.K.A.
FN1	Kotoko	Kinkéliba	*Combretum micranthum*	Combretaceae	L., Se., R.	1, 31	Dec.	Bath 3 times /day	War.	15 to 20 min	Shr.	Cu.	Her., Emp.
FN2	Kotoko	Ngkwalé	*Boscia senegalensis*	Capparaceae	Ba., L., R.	1, 28	Dec.	1 glass 3 times/day for 3 days	War.	45 min	Sh.	Or.	Her., Emp.
FN3	Kotoko	Dorot	*Terminalia avicennioides*	Combretaceae	Ba., L., R.	4, 6	Mac.	1 glass 2 times /day for 3 days	War.	300 min	Sh.	Or.	Emp.
FN4	Mundang	Kamalen	*Entada africana*	Fabaceae	Ba., L.	32, 8	Dec.	1 glass 2 times/day for 7 days	War.	20 min	Sh.	Or.	Her., Emp.
FN5	Mundang	Tefamme	*Calotropis procera*	Apocynaceae	Ba., L.	6	Dec.	bath for 7 days, 1 glass 2 times/day for 7 days	War.	10 min	Sh.	Cu.	Emp.
FN6	Arabe Choa	Habil	*Combretum glutinosum*	Combretaceae	L.	6	Dec.	1 glass 3 times/day for 7 days, bath for the same number of days	War.	30 min	Sh.	Cu., Or.	Her.
FN7	Foulbe	Chebe	*Croton zambesicus*	Euphorbiaceae	L.	6	Dec.	1 glass 3 times/day for 3 days, bath 3 times /day for 3 days	War.	30 min	Tr.	Cu., Or.	Emp.
FN8	Arabe Choa	Choc	*Acacia sieberiana*	Fabaceae	L.	6	Dec.	Bath and drink 1 glass for 7 days	War.	15 min	Tr.	Cu., Or.	Emp.
FN9	Arabe Choa	Suridj	*Bombax costatum*	Malvaceae	L.	6	Dec.	1 glass/ 2 times/day for 7 days, bath 3 times /day	War.	10 to 15 min	Tr.	Cu., Or.	Emp.
FN10	Foulbe	Giligandja	*Moringa oleifera*	Moringaceae	L., Fl., R.	6	Dec.	2 glasses/day for 3 days	War.	15min	Tr.	Or.	Emp.
FN11	Toupouri	Baaré	*Tamarindus indica*	Fabaceae	Fr.	6, 1	Inf.	2 glasses 2 times/day for 7 days and bath for 7 days	War.	25à30min	Tr.	Cu., Or.	Her., Emp.
FN12	Kotoko	Ardep	*Tamarindus indica*	Fabaceae	Fr.	6, 1	Dec.	1 glass /day for 3 days in fasting and bath 2 times /day	War.	15 min	Tr.	Cu., Or.	Emp.
FN13	Toupouri	Mirjja	*Acacia albida*	Mimosaceae	L.	6, 5, 1	Inf.	1 glass 2 times /day for 7 days	War.	10 min	Tr.	Or.	Emp.
FN14	Toupouri	Mbaga	*Balanites aegyptiaca*	Zygophyllaceae	Ba., L., Fr.	7, 8	Dec.	1v/jr pendant7jr	War.	30 to 45 min	Tr.	Cu., Or.	Her., Emp.
FN15	Kotoko	Oshar	*Calotropis procera*	Apocynaceae	L., S.	36, 1	Inf.	3 glasses/day for 30 days	Col.	20 min	Sh.	Or.	Emp.
FN16	Kotoko	Ganié	*Azadirachta indica*	Meliaceae	Se.	2	Mac.	1 glass 3 times/ day for 7 days	Col.	1440 min	Sh.	Or.	Her., Emp.
FN17	Kotoko	Swoswo	*Mimosa pigra*	Fabaceae	L.	9, 8	Dec.	1 glass 2 times/day for 3 days	War.	30 to 45 min	Sh.	Or.	Emp.
FN18	Arabe Choa	Angorne	*Pterocarpus lucens*	Fabaceae	L.	33, 23	Dec.	bath 2 times/day for 10 days	War.	30 min	Sh.	Cu.	Emp.
FN19	Kotoko	Fii	*Ziziphus mauritiana*	Rhamnaceae	Ba., L., R.	10	Dec.	Bath 2 times /day	War.	45 min	Sh.	Cu.	Her., Emp.
FN20	Massa	Mbelenjena	*Acacia nilotica*	Mimosaceae	L.	11	Mac.	Rub 2 times/day after bath	Ro.T.	2880 min	Sh.	Cu.	Her.
FN21	Kotoko	ou marulz	*Sclerocarya birrea*	Anacardiaceae	L.	11	Dec.	1 glass 2 times/day for 7 days	War.	15 min	Tr.	Or.	Emp.
FN22	Arabe Choa	Hidjelij	*Balanites aegyptiaca*	Zygophyllaceae	L.	11, 1	Dec.	1 glass/day for 3 days	War.	10 min	Tr.	Or.	Emp.

Table 2. Contd.

FN23	Arabe Choa	Tamur	*Phoenix dactylifera*	Arecaceae	Fr.	11, 1	Dec.	1 glass 3 times/day for 15 days	Ro.T.	10 min	Tr.	Or.	Her., Emp.
FN24	Mundang	Amsalum	*Leptadenia hastata*	Apocynaceae	L.	11, 1	Dec.	1 galss 2 times/day for 10 days	War.	15 min	He.	Or.	Emp.
FN25	Kotoko	Smo	*Balanites aegyptiaca*	Zygophyllaceae	Ba., L., Fr.	11, 1	Inf.	1 glass/day in fasting for 7 to 10 days	Ro.T.	60 min	Tr.	Or.	Her., Emp.
FN26	Kotoko	Helio	*Leptadenia hastata*	Apocynaceae	Ba., L., R.	12, 8	Mac.	1 glass 2 times / day	Fra.	1440 min	He.	Or.	Emp.
FN27	Arabe Choa	Sere	*Maerua angolensis*	Capparaceae	Ba., L., Fr.	1	Dec.	1 glass/day for 7 days	Réch.	30 min	Tr.	Or.	Her.
FN28	Arabe Choa	Chii	*Borassus aethiopium*	Arecaceae	Fr.	1	Mac.	1 glass 2 times / day	T.am.	15 to 20 min	Tr.	Or.	Her.
FN29	Arabe Choa	Msguele	*Capparis fascicularis*	Capparaceae	Ba., L., R.	1	Dec.	1 glass 2 times/day for 7 days	War.	30 to 45 min	Sh.	Or.	Emp.
FN30	Arabe Choa	Gana,Kamoro	*Oxytenanthera abyssinica*	Poaceae	L.	1	Dec.	2 glasses/day for 7 days	War.	60 min	Tr.	Or.	Emp.
FN31	Arabe Choa	Karague	*Faidherbia albida*	Fabaceae	Ba., L., R.	1	Dec.	bath 7 days/ 2 times	War.	30 min	Tr.	Cu.	Emp.
FN32	Kotoko	Msguele	*Capparis fascicularis*	Capparaceae	L.	1	Dec.	bath 3 times/day, 1 glass 3 times/day for 7 days	Ro.T.	120 min	Sh.	Cu., Or.	Her., Emp.
FN33	Mandara	Dorot	*Terminalia avicennioides*	Combretaceae	Ba., L.	1	Dec.	1 glass 3 times/day for 5 days	War.	30 min	Sh.	Or.	Her.
FN34	Arabe Choa	Safarmot	*Eucalyptus camaldulensis*	Myrtaceae	Ba., L.	1	Mac.	1 glass/day for 7 days and bath for tha same number of day	Ro.T.	30 min	Tr.	Cu., Or.	Her.
FN35	Foulbe	Kuulaahi	*Terminalia avicennioides*	Combretaceae	Ba., L., R.	1	Dec.	1 glass/day in fasting 3 days	War.	10 min	Sh.	Or.	Her.
FN36	Mafa	Duvunohw	*Acacia polycantha*	Mimosaceae	L.	1	Dec.	Bath 2 times for 7 days	War.	10 min	Sh.	Cu.	Her., Emp.
FN37	Arabe Choa	Chalab	*Strychnos spinosa*	Loganiaceae	L.	1	Dec.	1 glass/day for 3 days	War.	15 min	Sh.	Or.	Emp.
FN38	Kotoko	Blangou	*Kigelia africana*	Bignoniaceae	L., Fl.	1	Dec.	1 galsss/day for 1 day	Col.	30 min	Tr.	Or.	Her., Emp.
FN39	Arabe Choa	Oshar	*Calotropis procera*	Apocynaceae	L., Fl., S.	1	Mac.	1 glass 2 times/ day for 3 days and scrub body for 3 days	Ro.T.	1440 min	Sh.	Cu., Or.	Her.
FN40	Foulbe	Karub	*Piliostigma recticulatum*	Fabaceae	Ba., L.	13	Inf.	Bath for 7 days	War.	15 min	Sh.	Cu.	Her., Emp.
FN41	Kotoko	Amdugulgul	*Vitex diversifolia*	Lamiaceae	L.	13	Mac.	1 glass/day for 7 days	Col.	2880 to 4320 min	Sh.	Or.	Her.
FN41	Toupouri	Poole	*Calotropis procera*	Apocynaceae	L., S.	14, 6	Dec.	Bath 2 times/day and drink 1 glass 2 times/day for 7 days	War.	30 min	Sh.	Cu., Or.	Emp.
FN43	Kotoko	Arat	*Entada africana*	Fabaceae	L.	14, 15, 16	Mac.	1 glass/day for 3 days	Col.	1440 min	Sh.	Or.	Her., Emp.
FN44	Arabe Choa	Djimeyz al ahamar	*Ficus platyphylla*	Moraceae	Ba., L., R.	14, 15, 8	Mac.	1 glass 2 times/day for 10 days	Col.	30 min	Tr.	Or.	Her.

Table 2. Contd.

FN45	Kotoko	Ganié	*Azadirachta indica*	*Meliaceae*	L., Se.	17, 8	Dec.	1 glass 2 tmes/day and cover yourself with a blanket	Can. Prox.	10 to 23 min	Sh.	Or.	Emp.
FN46	Mafa	Tsenad	*Khaya senegalensis*	Meliaceae	L., Se.	17, 8	Dec.	1 glass/day for 7 days , seeds in the form of suppositories	Ro.T.	10 min	Tr.	Or., Rec.	Emp.
FN47	Arabe Choa	Am nabak	*Ziziphus mauritiana*	Rhamnaceae	Ba., L., R.	18, 6	Inf.	2 glasses/day for 30 days	War.	30 min	Sh.	Or.	Emp.
FN48	Kotoko	Keuchi	*Calotropis procera*	Apocynaceae	Ba., L., Fl., Fr., R.	18, 6, 13, 8	Mac.	1/2 glass 2 to 3 times/day for 1 month, 1 drop in the eye morning and evening	Col.	30 min	Sh.	Or.	Her., Emp.
FN49	Kotoko	Musabi	*Daniellia oliveri*	Caesalpiniaceae	L.	18, 8	Dec.	2 glasses/day for 5 days, bath 3 times/days	War.	120 to 180 min	Tr.	Cu., Or.	Her., Emp.
FN50	Arabe Choa	Mbage	*Khaya senegalensis*	Meliaceae	R.	19, 1, 6	Dec.	Bath, 1 glass/day for 3 days	Col.	15 to 25 min	Tr.	Cu., Or.	Emp.
FN51	Arabe Choa	Girli	*Prosopis africana*	Fabaceae	Ba., L., R.	19, 1, 6	Dec.	1 glass 2 times/day for 15 days	War.	30 min	Tr.	Or.	Emp.
FN52	Kotoko	Basam	*Dalbergia melanoxylon*	Fabaceae	Ba., L., R.	19, 20, 6	Dec.	1 glass 2 times/day for 7 days	War.	60 to 120 min	Sh.	Or.	Her., Emp.
FN53	Mandara	Arak	*Salvadora persica*	Salvadoraceae	Ba., L., R.	20, 13	Dec.	1 glass /day for 7 days	War.	30 min	Sh.	Or.	Her., Emp.
FN54	Toupouri	Mirjja	*Acacia albida*	Fabaceae	Ba., L.	21	Inf.	1 glass /day for 7 days	War.	10 to 15 min	Tr.	Or.	Emp.
FN55	Massa	Tomborie	*Mitragyna inermis*	Rubiaceae	Ba., L., R.	21	Dec.	1 glass/day for 7 days	War.	90 to 120 min	Tr.	Or.	Emp.
FN56	Arabe Choa	Ambleca	*Ximenia americana*	Olacaceae	Ba., L., R.	21, 6	Dec.	1 galss 1 time/day for 7 days	Col.	30 min	Sh.	Or.	Emp.
FN57	Kotoko	Msguele	*Capparis fascicularis*	Capparaceae	L.	21, 6	Dec.	1 glass 2 tmes/day for 7 days	War.	10 to 15 min	Sh.	Or.	Emp.
FN58	Arabe Choa	Ambor	*Annona senegalensis*	Annonaceae	L.	21, 6, 1	Dec.	1/2 galss 2 to 3 times / day for 1 month	Col.	10 min	Sh.	Or.	Emp.
FN59	Arabe Choa	Kulkul	*Bauhinia reticulata*	Caesalpiniaceae	L.	21, 6, 1	Inf.	1 galss 2 times/day for 10 days	War.	30 min	Tr.	Or.	Her.
FN60	Kapsiki	AM salup	*Leptadenia hastata*	Apocynaceae	L.	21, 12	Dec.	1 glass/day for 5 days	War.	15 min	He.	Or.	Her., Emp.
FN61	Toupouri	Mesket	*Prosopis juliflora*	Mimosaceae	L.	21, 12	Dec.	1 galss /day for 3 days	War.	60 min	Sh.	Or.	Emp.
FN62	Kotoko	Ardep	*Tamarindus indica*	Caesalpiniaceae	L., Fr.	21, 11	Mac.	1 glass in fasting for 7 days	Col.	1440 min	Tr.	Or.	Her.
FN63	Mundang	Mapew	*Adansonia digitata*	Bombacaceae	L., Se.	21, 11	Dec.	1 glass 3 times/day for 3 days	War.	15 to 20 min	Tr.	Or.	Her., Emp.
FN64	Mafa	Karague	*Faidherbia albida*	Fabaceae	Ba., L., R.	21, 1	Dec.	2 glasses 2 times/day for 7 days	War.	10 to 20 min	Tr.	Or.	Emp.
FN65	Arabe Choa	Gana,Kamoro	*Oxytenanthera abyssinica*	Poaceae	L.	21, 12, 1	Mac.	1glass/day until healing	Col.	720 min	Tr.	Or.	Her., Emp.
FN66	Kotoko	Mblgo	*Capparis sepiaria*	Capparaceae	L.	21, 8	Dec.	1 glass 3 times/day for 15 days	War.	60 min	Sh.	Or.	Her., Emp.

Table 2. Contd.

FN67	Mafa	Nénezlé	*Leptadenia hastata*	Apocynaceae	L.	21, 8	Inf.	1 glass/day for 7 days	War.	25 min	He.	Or.	Her.
FN68	Mandara	Gana,Kamoro	*Oxytenanthera abyssinica*	Poaceae	Ba., L., R.	21, 8	Dec.	1 glass/day for 7 days	War.	60 min	Tr.	Or.	Emp.
FN69	Arabe Choa	Chebe	*Croton zambesicus*	Euphorbiaceae	L.	34, 35, 5	Inf.	1 glass/day for 3 days	War.	10 min	Tr.	Or.	Her.
FN70	Mundang	Mapew	*Adansonia digitata*	Malvaceae	Ba., L., R.	5, 1, 29	Mac.	1 glass/day for 3 days in fasting	Col.	4320 min	Tr.	Or.	Emp.
FN71	Kotoko	Sehet	*Combretum aculeatum*	Combretaceae	L.	23, 24, 25	Dec.	1 glass/day for 7 days	War.	10 min	Sh.	Or.	Emp.
FN72	Arabe Choa	Fel	*Acacia nilotica*	Fabaceae	Se.	8, 1	Dec.	Bath 2 times/days	War.	45 min	Tr.	Or.	Her., Emp.
FN73	Foulbe	Chembal	*Cissus quadrangularis*	Vitaceae	L.	26	Dec.	Bath 2 tmes /day for 5 days	War.	45 min	He.	Cu.	Her., Emp.
FN74	Arabe Choa	Salfou	*Piliostigma recticulatum*	Fabaceae	Ba., L., Fr., R., Br.	26, 3	Dec.	1 glass 2 times/day	War.	60 min	Sh.	Or.	Her., Emp.
FN75	Mafa	Ala	*Celtis integrifolia*	Ulmaceae	Ba., L., R.	8, 22	Inf.	1 glass 3 times/ day for 10 days	War.	25 min	Tr.	Or.	Her.
FN76	Foulbe	Geelewki	*Guiera senegalensis*	Combretaceae	L.	8, 31	Dec.	1 glass 3 times /day for 3 days	War.	20 to 30 min	Sh.	Or.	Emp.
FN77	Arabe Choa	Karsa	*Securinega virosa*	Euphorbiaceae	Ba., L.	8	Dec.	1 glass 3 times/day for 7 days	War.	15 min	Tr.	Or.	Her., Emp.
FN78	Toupouri	Mbambayklum	*Parkinsonia aculeata*	Fabaceae	L.	8	Dec.	1 galss/day for 30 days in fasting	War.	60 min	Tr.	Or.	Emp.
FN79	Kotoko	Pastèque sauvage	*Citrullus lanatus*	Cucurbitaceae	L., Fr.	8	Mac.	1 glass/ day for 5 days	Col.	1440 min	He.	Or.	Her.
FN80	Kotoko	Ardep	*Tamarindus indica*	Fabaceae	L., Fr., R.	8	Dec.	NTR	War.	NTR	Tr.	Or.	Emp.
FN81	Kotoko	Oshar	*Calotropis procera*	Apocynaceae	L., S.	8	Dec.	1 glass/day and purge for 2 days	War.	10 to 15 min	Sh.	Or.	Her., Emp.
FN82	Kotoko	Tamur	*Phoenix dactylifera*	Arecaceae	Fr.	8	Dec.	1 glass/day for 3 days	War.	10 min	Tr.	Or.	Emp.
FN83	Foulbe	Banbambi	*Calotropis procera*	Apocynaceae	Ba., L., R.	8	Dec.	1 glass/day for 3 days	War.	10 min	Sh.	Or.	Her.
FN84	Arabe Choa	Karague	*Faidherbia albida*	Fabaceae	Ba., L., R.	8	Inf.	1glass/day/ 1 time for 7 days	War.	10 min	Tr.	Or.	Her., Emp.
FN85	Arabe Choa	Karague	*Faidherbia albida*	Fabaceae	Ba., L., R.	8	Dec.	1 glass 2 times /day for 3 days	War.	30 min	Tr.	Or.	Her., Emp.
FN86	Mafa	Tsekerak	*Gardenia ternifolia*	Rubiaceae	Ba., L., R.	8	Dec.	1 glass 2 times/day for 10 days	War.	10 min	Sh.	Or.	Emp.
FN87	Kotoko	Amdzo	*Tamarindus indica*	Caesalpiniaceae	Ba., L., R.	8	Dec.	1 glass 1 time/day for 10 days	War.	90 min	Sh.	Or.	Her., Emp.
FN88	Kotoko	Karub	*Piliostigma recticulatum*	Caesalpiniaceae	L.	8	Inf.	1 glass 2 time/day for 3 days	War.	180 to 240 min	Sh.	Or.	Her., Emp.
FN89	Kapsiki	Keete	*Boswellia papyrifera*	Burseraceae	L.	8	Dec.	2 glasses 2 times/day for 5 days	War.	Until boiling	Tr.	Or.	Emp.
FN90	Arabe Choa	Muray	*Khaya senegalensis*	Meliaceae	L.	8	Dec.	1 glass /day for 3 days	War.	60 min	Tr.	Or.	Her., Emp.

Table 2. Contd.

FN91	Mandara	Kulkul	*Bauhinia reticulata*	Caesalpiniaceae	L.	8	Dec.	1 glass 3 times /day for 7 days	War.	15 min	Tr.	Or.	Her., Emp.
FN92	Toupouri	Basum	*Grewia bicolor*	Malvaceae	L.	8	Dec.	1 galss/day for 7 days	War.	15 to 20 min	Sh.	Or.	Her.
FN93	Arabe Choa	Djimmis	*Ficus glumosa*	Moraceae	L.	8	Dec.	1 glass 2 times/day for 10 days	Ro.T.	25 to 30 min	Tr.	Or.	Emp.
FN94	Kotoko	Sehet	*Combretum aculeatum*	Combretaceae	L.	8	Dec.	1glass 2 times/ day for 7 days	War.	15 min	Tr.	Or.	Her.
FN95	Arabe Choa	Sehet	*Combretum aculeatum*	Combretaceae	Ba., L., R.	8	Inf.	1 glass 2 times / day for 3 days	War.	60 min	Sh.	Or.	Her.
FN96	Arabe Choa	Gulum	*Capparis tomentosa*	Capparaceae	L.	8	Dec.	3v/jr pendant3jr	War.	30 min	Sh.	Or.	Her., Emp.
FN97	Toupouri	Poole	*Calotropis procera*	Apocynaceae	L.	8,18, 27	Mac.	2 glasses /day for 10 days	Col.	1440 min	Sh.	Or.	Her., Emp.
FN98	Foulbe	Delep	*Strychnos spinosa*	Loganiaceae	Ba., L., R.	8, 18, 22	Dec.	1 glass 2 times/day for 10 days	War.	15 min	Sh.	Or.	Emp.
FN99	Kotoko	Gana,Kamoro	*Oxytenanthera abyssinica*	Poaceae	Ba., L., Fr., R.	8, 21,30	Inf.	Bath 3 times /day for 1 month and drink 1 glass in fasting for 15 days	War.	30 min	Tr.	Cu., Or.	Her.
FN100	Arabe Choa	Gawa	*Cassia occidentalis*	Fabaceae	L., Se.	8, 21, 1	Dec.	1 glass/day for 7 days	Ro.T.	20 min	Shr.	Or.	Her., Emp.

FN: Far North; C.R.O.: Code of region of origin: A: Adamaoua; C: Center; EN: Extreme North; N: North; V.N.: Vernacular name; M.P.: Method of preparation: Decoction: Dec.; Trituration: Tri.; Infusion: Inf.; Pow.: Powder; Mac.: Maceration; Eth. G: Ethnic Group; Sc.N.: Scientific name; F.: Family; T.D. and/or M.S.: Treated diseases and/or Major symptoms; M.C.: Method of conservation; War.: Warming; Ro.T: Room temperature; Col.: Cold; Can. Prox.: Canary proximity; Dri.: Dried; P.T.: Preparation time (min): Noting to Report: NTR; Do: Dosage; /: Per; M.T.: Morphological types; Tr.: Tree; He. Herb; Sh.: Shrub; Shr.: Shrubbery; R.A.: Route of administration; Cu.: Cutaneous; Or.: Oral; Oc.: Ocular; Sub.: Sublingual; Rec.: Rectal; N.K.A.: Nature of knowledge acquisition; Emp.: Empiric; Her.: Hereditary; P.U.: Parts Used; Leaves: L.; W.P.: Whole Plant; Seed: Se.; La. Latex; B.: bulb; Ba.: Bark; Fl.: Flowers; R.: Roots; Fr.: Fruit; S.: Sap; Sh.: Shell; Br.: Branch; T.D. and/or M.S.:Treated diseases and/or Major symptoms: 1: Filariasis; 2: Amoebiasis; 3: Anemia; 4: Conjunctivitis ; 5: Wound; 6: Itching; 7: Diabetes; 8: Intestinal worms; 9: Skin rashes; 10: Fibrosis; 11: yellow fever; 12: Typhoide fever; 13: Scabies; 14: Gastritis; 15: Magico-religious usage; 16: Stomatitis; 17: ovarian cyst ; 18: Eye defects; 19: Bad luck; 20: Mouth odour ; 21: Malaria; 22; Ulcer; 23: Measles; 24: Mycosis; 25: Paralysis; 26: Woman's worms; 27: Antibiotics; 28: Dewormer; 29: Stomach disorder; 30: Hemorrhoids; 31: Deteriore breast milk ; 32: Constipation; 33: Nappy rash; 34: White discharge; 35: Infections; 36: Diarrheas.

survey carried out in the Far North region of Cameroon identified 96 species divided into 29 families belonging to 49 genera. In the department of Lom and Djerem in eastern Cameroon, 115 species, belonging to 59 families and grouped into 105 genera were reported (Etame-Loe et al., 2018). It emerges from this study that the diversity of plant species obtained is linked to the degree of knowledge and use of plants by populations who are accustomed to their use and benefiting from them for their well-being. Botanical identification has shown that from the 29 families identified, Fabaceae (20 species); also called legumes, is the one that people masters best because it provides most of their plant food. Besides this, the preponderance of this family accounts for its importance in traditional medicine. Fabaceae family is well-known in Africa and contributes to the treatment of several diseases such as hemorrhoids (Dibong et al., 2015), vaginitis (Ndjib et al., 2017), helminthiasis (Bajin Ba Ndob et al., 2016). The similarity between the predominant families elsewhere and those of the regions studied, testifies to the richness of these areas flora. The savannah represents the main type of biotope, characteristic of agro-ecological zones representing the Far North region. This result shows that people use the plants around their environments to treat onchocerciasis. This is comparable to the study carried out in Haut Nkam where the populations had mentioned semi-mountainous species, characteristic of the region of West Cameroon (Mpondo et al., 2017). The plants used in this study are preferably harvested at dawn. Indeed, the harvest period plays an important role when it comes to the nature of

compounds which gives them medicinal importance. Dibong et al. (2015) reported that plants harvested at dawn are the most therapeutic in traditional medicine. By grouping the medicinal plants identified in this study, trees mainly represented the morphological type. This is particular because they provide the necessary materials (leaves, bark, fruit, roots, etc.) which are used to prepare medication recipes, but also because they last for several years (Tsabang et al., 2017).

The administration of herbal drugs was made easier by the different preparation methods. Decoction is the most mode of preparation of the drugs employed in this study. Indeed, boiling is the method which allows the extraction of the maximum active ingredients and also sterilizes the drug. Decoction has been mentioned in a multitude of ethnobotanical studies, it could be the best mastered mode by local populations (Dibong et al., 2015; Mpondo et al., 2017). The best solvent is water; this could be justified by the fact that water is not only more accessible but also better controlled and would not exhibit any interaction with drugs derived from the plant (Ndjib et al., 2017; Kidik Pouka et al., 2015). The oral route is the most used in the traditional treatment of onchocerciasis. This could be justified by the fact that assimilation is easier after consumption (Ghedadba et al., 2014; Lougbégnon et al., 2015). The drugs prepared in the treatment of onchocerciasis are often warmed before being consumed but also kept cool and at room temperature; this is also the case for drugs prepared for the treatment of diseases such as hemorrhoids and vaginitis (Dibong et al., 2015; Ndjib et al., 2017). The leaves are the parts which are mostly used in the areas studied and harvested by simple cutting. That plant part is the seat of secondary metabolites responsible for the biological properties of the plant. The bioactive compounds are synthesized in the leaves and stored in the roots; these organs constitute the storage places of basic materials, protectors of the organism thus promoting a high yield in the capacity to treat (Mangambu et al., 2014; Ngoule et al., 2015).

Conclusion

Ethnobotanical surveys of the populations of the Far North region of Cameroon have revealed that several medicinal plants are used for the treatment of diseases and symptoms similar to helminthiasis (Figure 5). Indeed a total of 96 plant species grouped in 49 genera and belonging to 29 families were identified. Trees mainly found in Savannah and belonging to Fabaceae and Apocynaceae families were the most represented. Plant parts commonly used included roots and mostly the leaves. Decoction constituted the prevailing preparation method. In these regions, population knowledge on medicinal plants was inherited from the ancestors. One hundred recipes treating 36 diseases, symptoms and/or uses for therapeutic or preventive purposes, related to parasitic infections were identified. These findings may constitute a relevant Cameroonian database for biological screening in the search for plant-based antiparasitic molecules, especially for antihelminthiasis purposes.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interest.

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