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Ethnopharmacology and anthelmintic screening of some plants used in traditional medicine in the Far-North of Cameroon

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Abstract

Background: The use of traditional medicinal plants in Cameroon for the treatment of intestinal helminthiasis is a common practice among traditional healers and livestock breeders. However, the use of ethnopharmaceutical products for their anthelmintic activities against *Haemonchus contortus* has been poorly addressed in the Far-North region of Cameroon, therefore justifying the need to bridge this gap.

Methods: An ethno-pharmacological survey was conducted among livestock breeders and traditional healers in the Far-North region of Cameroon using a questionnaire to determine different plants used for the treatment of gastrointestinal helminths. Thereafter, aqueous and hydroethanolic extracts of the most used plant (frequency >2%) were evaluated for their anthelmintic activity against the gastrointestinal nematode *Haemonchus contortus in vitro.*

Results: Seventy traditional healers and 36 livestock breeders were surveyed with 22 medicinal plants found to be involved in the treatment of intestinal helminthiasis in the Far-North Region of Cameroon. These plant species are distributed in 15 families with the Fabaceae being the most used (22.6%). The roots (39.6%) and leaves (36.8%) of the plants were the most frequently used parts mainly in the form of decoction (45.3%) and maceration (29.3%). *Aristolochia baetica* (20.8%) was the most used plant. Eleven plants were selected and all exhibited significant ($p < 0.001$) anthelmintic activity on adult *Haemonchus contortus*. The highest anthelmintic activity was observed with the hydroethanolic extract irrespective of the plant species. The hydroalcoholic and aqueous extracts of *Tephrosia pedicellata*, *Aristolochia baetica,* and *Abelmochus esculentus* showed the highest anthelmintic activity with 100% mortality at 1 mg/mL after 24 hours of incubation.

Conclusion: This study allowed us to list the anthelmintic plants used in traditional medicine in the Far North of Cameroon, with the anthelmintic screening sustaining the traditional use of these active plants for the control of helminthiasis in humans and animals.

Keywords: Survey; anthelmintic screening; *Haemonchus contortus.*

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Background

African pharmacopoeia is rich due to the diversity of human groups, languages, customs, and especially differences in agroecological zones [1]. The World Health Organization (WHO) estimated that 80% of the population in developing countries depend on traditional herbal medicine for their primary health needs [2]. Various healthcare systems put in place over the centuries through the use of traditional medicine have shown long lasting and harmless effects on humans and domestic animals [3]. In Cameroon to date, the population largely depends on the use of traditional medicinal plants to meet their health needs. To highly profit from our ethnomedicine, an in-depth descriptive study of medicinal plant recipes is necessary. This will permit the identification and promotion of those plants with therapeutic values. Among those plants with beneficial health properties, are those used in the treatment of gastrointestinal helminthiasis which are of particular interest in our study.

Gastrointestinal helminthiasis is a neglected soil-transmitted tropical disease caused by parasitic worms. They involve major public and veterinary health problems nowadays in tropical countries. Gastrointestinal helminthiasis affects 50% of the human population worldwide, causing great morbidity with hundreds of thousands of deaths [4]. In developing countries, they pose a significant threat to public health and contribute to the increasing prevalence of malnutrition, anemia, eosinophilia, and pneumonia [5]. Helminths also affect millions of livestock, causing considerable economic loss in domestic and farm animals [6]. Parasitic gastroenteritis usually caused by a mixed infection with several species of gastrointestinal worms generally results in body weakness, loss of appetite, weight lost, and decreased productivity [7]. Helminths consume their host's nutrients or blood, causing or exacerbating malnutrition which leads to stunted growth. Therefore, symptoms such as retarded cognitive development, acute or chronic anemia, diarrhea, abdominal pain, and other associated health problems are observed in cases of severe helminthiasis [8].

Most studies on anthelmintic activity are focused on *Haemonchus contortus,* an important parasitic nematode in small ruminant abomasum responsible for haemonchosis, and major production losses in small ruminant farms around the world [9]. The high parasite loads of this blood-sucking parasite cause severe anemia and rapid death in infected animals [10]. This parasite also causes inflammation and bleeding of the mucous membrane leading to digestive disorders with diarrhea and weight loss. It also alters the quality of wool, reproductive capacities, loss of appetite, edemas, deterioration of the general condition of the animal, and deficiency of certain vitamins [11]. A report by WHO shows that an estimated 2 billion persons are infected with gastrointestinal helminths worldwide, resulting in more than 155,000 thousand deaths per year [12]. In Cameroon particularly, more than 10 million individuals suffer from helminthiasis [13]. In the Northern part of Cameroon, more than 75% of small ruminant mortality has been attributed to helminthiasis, particularly with haemonchosis and moniezia [14]. To the best of our knowledge, no study has been conducted in the Far North region of Cameroon on the screening of anthelmintic plants being a region noted as one with a very high production of small ruminants.

Therefore, it was important to widen our knowledge of the local plants found in this region which might lead to the discovery of new plants with high probability of having anthelmintic potential to be used in the treatment of helminth infections. It should be noted that the current commercialized anthelminthic drugs are experiencing resistance [15-17]. The aim of this study was to popularize the traditional use of plants for the treatment of intestinal worms in humans and livestock and to screen these local plants for their anthelmintic activity against *Haemonchus contortus*.

Methods

Study site

This study was carried out in the Department of Mayo-Tsanaga, Cameroon (Figure 1). In this part of the country, the climate is of the Sudano-Sahelian type, with an average temperature range between 29°C and 32°C. The average thermal amplitude is 8°C with a high temperature of 44°C in March, April, and May. Lower temperature of 18°C is witnessed in December, January, and February. The average rainfall is 800 millimeters. The prevailing winds are the harmattan from October to April and the monsoon from May to September. This zone belongs to the field of clay-sandy soils in plain, and sandy in mountain. These soils are brown in color and are somehow leached. The mountain area is marked by a mass of granite blocks.

Field survey

Ethno-botanical data were collected between August - October 2018. Information on the plants used for the traditional treatment of gastrointestinal worms in humans and livestock was collected through structured interviews. A questionnaire was designed to collect data on the local names of the plants, plant parts used, harvesting place, harvest season, harvest time, therapeutic indications, modes of preparation, doses, route of administration, side effects, and methods of preservation. Other information such as the name, age, gender, and educational level of the interviewed persons were also recorded. All breeders and traditional healers known by the inhabitants of the studied department were surveyed. Breeders and traditional healers who use plants in the treatment of intestinal helminthiasis were investigated. The collected plants were identified by botanists Prof. Pierre Marie Mapongmetsem and Dr. Fawa Guidawa, of the University of Ngaoundéré, Cameroon, and confirmed at the Cameroon National Herbarium (Yaoundé) by Tadjouteu Fulbert. The corresponding reference numbers of identification are presented in Table 2.

Harvests and preparation of plant powders

Leaves, fruits, bark, and roots of the various plants were harvested in the Far North region of Cameroon and dried in the shade at room temperature for 7 to 10 days. The different plant parts were then crushed in a wooden mortar and sieved using a fine mesh sieve (diameter 0.4 mm). Plant powders from the different plants part obtained were stored in glass bottles away from light.

Preparation of aqueous and ethanolic extract

Preparation of the aqueous and ethanolic extracts was done following the method described by Dikti et al. [18]. For extraction, 50 g of each powder was macerated in 500 mL of distilled water or 70% ethanol for 48 hours at room temperature. The mixture was occasionally stirred with the help of a magnetic stirrer. After 48 hours the macerate was centrifuged (Eppendorf brand centrifuge) at 3500 rpm for 10 min, and supernatant was collected and filtered using a filter paper (5891 black ribbons, ashless from the Schleicher company). The filtrate was then subjected to a rotary evaporator (Buchi brand) at 40°C under reduced pressure

of 175 mbar, lyophilized at -60°C under a vacuum of 1 mm Hg for 48 hours and the resulting powder was stored at 4°C.

Collection of Haemonchus contortus parasite

Adult female *Haemonchus Contortus* worms were collected from the abomasum of infected sheep and goats slaughtered at the slaughterhouse of small ruminants in Ngaoundéré (Cameroon). Immediately after slaughtering the animals, the abomasum was collected and transported to the Applied Zoology Laboratory of the University of Ngaoundéré. *Haemonchus Contortus* worms were collected, washed, and kept in phosphate buffer saline (PBS), pH 7.4 The collected worms were further examined under a dissecting microscope, and only female *H. contortus* worms were stored for *in vitro* analysis.

In vitro anthelmintic screening

Anthelmintic screening was carried out according to the method described by Dedehou et al. [19] with some modifications. The test was performed in a 24 wells plate. Plant extracts of concentrations 1, 2 and 5 mg/mL were used to assess their anthelmintic potential against *H. contortus*. A negative and a positive control treatment were applied using aqueous solutions of PBS and levamisole (1 mg/mL) respectively. The effect of each extract and controls at a given concentration was determined on six active and life parasites incubated in 1 mL of extract and controls at 37 °C for 24 hours. The measured parameters were the number of motile (life) and immotile (dead) worms. With respect to this, a dissecting microscope was used to examine and record death worms based on the absence of motility. Treatments were done in triplicate for each concentration. The percentage of mortality of the adult worms was determined using the formula:

% Adult worms' mortality = (Number of dead worms x 100) / Number of worms in culture

Statistical analysis

The questionnaires were developed using Sphinx Plus V5 software. The data were analyzed for the frequency of the socio-demographic characteristics of informants, diversity of medicinal plants used, therapeutic uses, plant parts used, mode of preparation, and administration. For each plant, the experimental design for the anthelminthic study was a factorial design with 3 factors (concentration of the extract, solvent of extraction, and incubation time). Data obtained from the *in vitro* assay were analyzed using GraphPad Prisms 5.0. Mean values of mortality frequencies were compared using either t-test or Duncan multiple range test. $p < 0.05$ was significant and $p < 0.001$ was highly significant.

Results

Demographic information

A total of 106 persons made up of 70 traditional healers and 36 livestock breeders were interviewed in this study, with 90 (84.9 %) males and 16 (15.1%) females.
It was observed that from the total number of breeders and traditional healers, 65 (61.3%) had not been to school, 30 (28.3%) had attained primary education while 11 (10.4%) had reached the level of secondary education. The highest number of breeders and traditional healers were found in the age group of >45 years (76.4%). Based on the marital status in our study area, it was observed that medicinal plants were mostly used by married persons, 90 (84.8%), divorced persons, 8 (7.6 %) and widows or widowers, 8 (7.6%), with no respondent registered from single individuals (Table 1). Most of the information on the use of traditional medicines in the treatment of helminthiasis in livestock and humans was obtained from persons in the age group of >45 years.

Plants used as anthelmintic

A total of 22 medicinal plants distributed into 15 families was recorded during our study in the treatment of gastrointestinal worms in humans and livestock. Of the 22 medicinal plants, the most cited plants were *Aristolochia beatica* (20.8%) followed by *Tephrosia pedicellata* (16%) and *Sarcocephalus latifolius* (14.2%) (Table 2). Plants from the Fabaceae family were the most widely represented in this study with 22.6%. The Annonaceae, Celastraceae, Moraceae, and Myrtaceae families were the least represented, with frequencies of 0.9% each, (Figure 2). The plant's parts used include leaves, roots, bark, seeds, whole plants, and flowers, with the most used parts being the roots (39.6 %), leaves (36.8%), and barks (14.2%) (Figure 3). The methods of preparation of these medicinal plants were mostly by decoction (45.3%), followed by maceration (29.3%) and infusion (20.8 %) (Figure 4). Water was the most used solvent, while a few used millet wines. The plant extracts or medicinal preparations were all administered orally by both breeders and traditional healers. Based on our results, most breeders and traditional healers harvested their plants early in the morning, 44.3% with 19.8% of them carrying out their harvest in the evening and 35.9% during any time of the day (Figure 5). Information on the different plants such as the local name, family, plant parts used, preparation method, frequency of citation, route of administration, dosage, and duration of treatment are presented in Table 2.

Anthelmintic screening

The mortality frequencies of adult *Haemonchus contortus* using aqueous and hydroethanolic extracts of the different plant species and concentrations are presented in Table 3. From the results, the frequency of mortality significantly increases with the concentration of the extract and the incubation time, irrespective of the plant species. Hydroethanolic extracts were observed to have the highest mortality frequencies.
At the concentration of 1 mg/mL, only the hydroethanolic extract of *Aristolochia baetica, Abelmochus esculentus, Tephrosia pedicellate,* and the aqueous extract of *Tephrosia pedicellata* had 100% mortality after 24 hours of incubation. At the concentration of 5 mg/mL, the species *Euphorbia hirta* and *Vernonia amygdalina* had less than 80% worms' mortality with the hydroethanolic extract and less than 50% worm mortality using the aqueous extracts at the various incubation times. On the other hand, *Aristolochia baetica,* and *Tephrosia pedicellata* exhibited 100% mortality of worms at the dose of 5 mg/mL irrespective of the plant extract used and the incubation time. In the negative control treatment, no mortality was observed during the 24 hours of incubation. On the other hand, the positive control treatment (Levamisole) had high anthelmintic activity against *Haemonchus contortus* compared to most of the plant extracts. At 12 hours of incubation, 88.9 ± 5.6 % and 100% of mortality frequencies were recorded at the concentrations of 1 mg/mL and 5 mg/mL respectively, and at 24 hours of incubation, 100% mortalities were recorded at both concentrations. For the most active hydroethanolic plant extracts (*Tephrosia pedicellata* and *Aristolochia baetica*), at an incubation time of 12 hours, the mortality frequencies observed were 72.2 ± 5.5 and 88.8 ± 5.5%

for *Aristolochia baetica* and *Tephrosia pedicellata* at 1 mg/mL. The respective values at the concentration of 5 mg/mL were 100% of mortality for both plant species at 12 and 24 hours of incubation. Of interest, no significant difference was observed between the aqueous and the hydroethanolic extracts of *Tephrosia pedicellata*.

Figure 6 shows the comparative efficacy of the hydroethanolic plant extracts to the standard Levamisole at the concentration of 1 mg/mL at 24 hours of incubation. It is observed from the graph that 3 plant extracts had similar efficacy to that of levamisole at the experimental conditions: *Aristolochia baetica*, *Abelmochus esculentus*, *Tephrosia pedicellata*.

Discussion

In many parts of Africa, traditional medicine is dominantly practiced by males in the older age group as opposed to the female gender [20- 21]. These findings are in line with our results where out of 106 persons interviewed, 84.91% are male of which 76.4% are in the age group of >45 years. This can be justified since, to treat efficiently in the field of traditional medicine, experience must be gained and acquired with time (age) [22]. Men are generally more oriented towards treating using traditional medicine given that women are more occupied by farm and house activities, while men are more attached to traditions passed on from father to son [23]. However, there are a few older women who have knowledge about herbal medicinal treatment [24]. This situation was also observed in our findings were by out of the total 106 persons interviewed, 16 were females and all of them were in the age group of more than 45 years of age.

It had been reported by Anyinam et al. [25] that, the transmission of knowledge based on traditional medicine from the older to the younger generation has not yet been assured, hence remains a problem especially, in cases where the older generation disappears.

The low percentage of women involved in traditional medicine compared to men had also been reported by Agyare et al. [26] in a field study in Ghana on traditional healers.

As observed in our study, Fabaceae had also been reported by Olajuyigbe and Afolayan [27] as having an important role in the treatment and control of intestinal helminths. This predominance could be explained by the high global number of species (19,400 species) of this family [28] as well as the presence of many species of this family in the study area. Nsekuye [29] also reported that, for many generations, these plants (Fabaceae) were known and used as very effective remedies in the treatment of gastrointestinal diseases with the knowledge orally transmitted between some traditional healers who jealously kept the information as family secrets.

Depending on the agroecological zones, other studies reveal a biodiversity of plants more or less different from those observed in our study. In Cameroun (Benoué), a study carried out by Djoueche et al. [14] reported a similar number of plants, where 23 plants were used for the treatment of intestinal worms in cattle. Among these plants, 6 were like those in our study with 17 of them different. In another study carried out by Ndob et al. [30] in Gabon, 24 plants were used in the treatment of intestinal, cutaneous, and ocular helminthiasis with 3 of the plants like ours and 21 others being different. Further, Agyare et al. [26] in their studies carried out in Ghana, reported 35 plant species as remedies for the treatment of helminthiasis in humans and animals with 5 plants in common and 30 different plants.

Most of the traditional healers and breeders justified that medicinal plants are mostly harvested in the morning because its more effective and gives them time to prepare and sale them in the markets within the day. Others however believe that herbal remedies can be effective at any time of the day.

In general, ethnobotanical studies have shown the use of decoction (hot aqueous extract) of local plants to be a preferential mode of use by traditional healers in preparing traditional medicines [31-32]. These findings correlate with those in our studies where out of the 22 plants collected in the fight against gastrointestinal helminthiasis in the Far North region of Cameroon, 45.3% were prepared and consumed in the form of decoction. In previous studies carried out, some of the plants used in our studied area (10) had been confirmed by other findings to have anthelmintic activity against *Haemonchus contortus*. These plants include *Khaya Senegalensis* [33], *Carica papaya* [34], *Vernonia amygdalina* [35], *Cassia occidentalis* [36], *Parkia biglobosa* [37], *Piliostigma thonningii* [38], *Annona senegalensis* [39], *Securidaca longepedunculata* [40], *Daniella oliveri* [41] and *Maytenus senegalensis* [42]. Other plants such as *Aristolochia baetica, Sarcocephalus latifolius, Téphrosia pedicellata, Abelmoschus esculentus, Clerodendrum scandens, Euphorbia hirta, Waltheria indica, Ficus umbellata, Psidium guajava, Cassia siamea, Acanthospermum hispidum,* to our knowledge possess little or no information regarding their anthelmintic activity on *Haemonchus contortus.* However, some of these plants have already shown anthelmintic activity against other worms. These include the anthelmintic activity of *Psidium guajava* against *Hymenolepis diminutain rats* [43] and against *Caenorhabditis elegans* [44], *Euphorbia hirta* against earthworms (*Pheretimaposthuma*) [45], *Onchocerca ochengi* and *Caenorhabditis elegans*, and *Acanthospermum hispidum* against adult Indian earthworm *Pheritima posthuma* [46] have been shown.

According to literature, phenolic compounds such as tannins and flavonoids are largely responsible for anthelmintic activity which are usually extracted with different solvents such as water and ethanol [47-50]. Ethanol in combination with water allows a better extraction of these phenolic compounds [51- 52]. This could explain why the hydroethanolic extract had higher anthelmintic activity compared to the aqueous extract in this study. Dougnon et al. [53] however reported that pure ethanol is a better solvent for extracting polyphenols than water. The high significant anthelmintic activity observed in the extract of *Tephrosia pedicellata*, *Aristolochia baetica,* and *Abelmochus esculentus*, in our studies might be accounted for by the high presence of phenolic compounds in these plants. In the study of Mounkaila et al. [54], they reported the use of *Tephrosia pedicellata* as well in traditional medicine in the treatment of diseases affecting the nervous system. In a similar study carried out in Morocco, *Aristolochia baetica* was widely used to treat skin diseases and intestinal infections [55]. In ethnomedicine, *Abelmochus esculentus* is used to treat dysentery and acute diarrhea, inflammation and irritation of the stomach, intestines, and kidney infection [56].

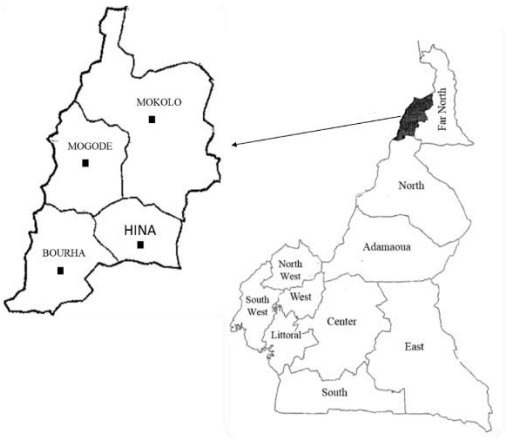

Figure 1. Map of the study area

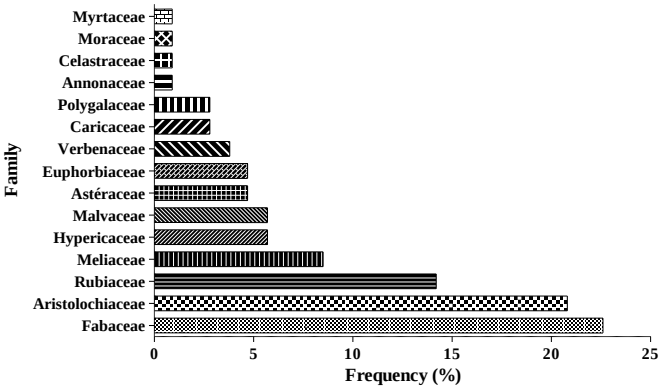

Figure 2. Frequency (%) of different plant families encountered.

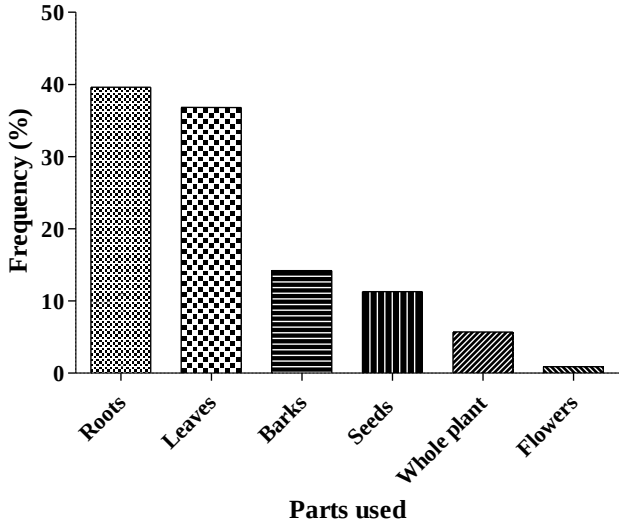

Figure 3. Frequency (%) of different medicinal plants parts used.

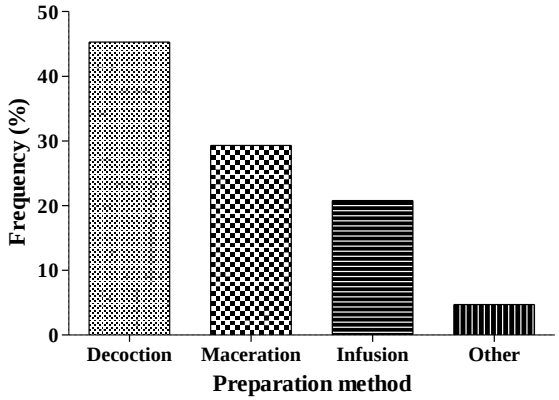

Figure 4. Frequency (%) of preparation methods for medicinal plants

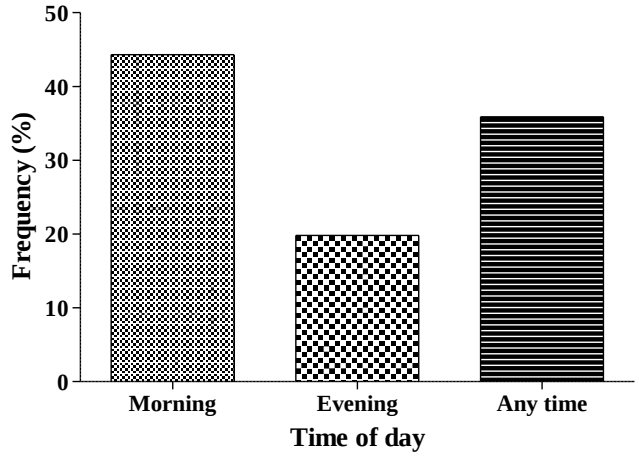

Figure 5. Frequency periods of the day for harvesting medicinal plants.

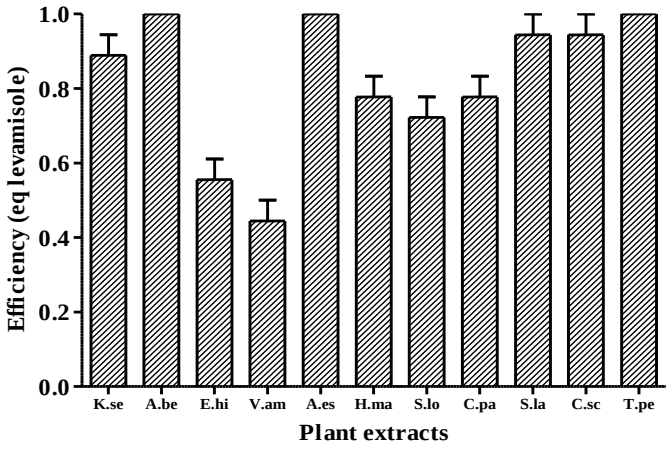

Figure 6. Equivalent levamisole efficacy of the various hydroethanolic plant extracts at 24 hours of incubation.
K.se: *K. senegalensis*; A.be: *A. baetica*; E.hi: *E. hirta*; V.am: *V. amygdalina*; A.es: *A. esculentus*; H.ma: *H. madagascariensis*; S.lo: *S. longepedunculata*; C.pa: *C. papaya*; S.la: *S. latifolius*; C.sc: *C. scandes*; T.pe: *T. pedicellata.*

Table 1. Demographic data on distribution of respondents

Parameter	Variables	Gender		Number	Frequency (%)
		Male	**Female**		
Age	< 30 years	2	0	2	1.9
	30 – 45 years	23	0	23	21.7
	> 45 years	65	16	81	76.4
	Total	90	16	106	100
Level of education	Without level	56	9	65	61.3
	Primary	23	7	30	28.3
	Secondary	11	0	11	10.4
	Total	90	16	106	100
Marital status	Married	84	6	90	84.8
	Divorced	2	6	8	7.6
	Widow/widower	4	4	8	7.6
	Total	90	16	106	100

Table 2. Plants used for the treatment of helminthiasis in human and cattle by traditional healers and breeders in the Far-North of Cameroon

N°	Scientific name and voucher	Local name	Frequency of citation (%)	Route of administration / Dosage / Duration treatment
1	*Aristolochia beatica* 67464/HNC	Catabora	20.8	Oral: 1/4 to 1 glass in the morning and evening for 03 to 05 days
2	*Téphrosia pedicellata* 67001/HNC	Wourwouren	16	Oral: 1/3 to 1 glass morning and evening for 03 to 4 days
3	*Sarcocephalus latifolius* 20144/ HNC	Maroussen	14.2	Oral: 1/2 to 1 glass in the morning and evening for 05 to 07 days
4	*Khaya senegalensis* 49688/ HNC	Dalehi	8.5	Oral: 1/4 to 1 glass in the morning and evening for 05 days
5	*Harungana madagascariensis* 4224 HNC	Bahiwan	5.7	Oral: 1/3 to 1 glass in the morning and evening for 03 to 05 days
6	*Euphorbia hirta* 46002/HNC	Ouaouan	4.7	Oral: 1/2 to 1 glass in the morning and evening until for 4 to 10 days
7	*Abelmochus esculentus* 42825/ HNC	Bascodjé	3.8	Oral: 1 to 2 glass in the morning noon and evening until healing
8	*Clerodendrum scandens* 48344/ HNC	Lirguin	3.8	Oral: 1 glass in the morning in an empty stomach until healing
9	*Carica papaya* 18 647/ HNC	Doukoudjé	2.8	Oral: 1/2 to 1 glass in the morning and evening for 03 to 5 days
10	*Vernonia amygdalina* 9535 SRF/CAM	Nkouanguaraguin	2.8	Oral: 1/2 to 1 glass in the morning and evening for 03 days
11	*Securidaca longepedunculata* 10410/ SRF/CAM	Gnagna	2.8	Oral use: 1 pinch in water in the morning and evening for 01 to 02 weeks
12	*Acanthospermum hispidum* 6581/SRF-CAM	Katchiyaw	1.9	Oral: 1/2 to 1 glass in the morning and evening for 03 to 04 days
13	*Cassia occidentalis* 7848/ HNC	Bavouivoui	1.9	Oral: 1 glass in the morning and evening for 05 days
14	*Daniella oliveri* 14890/SRF-CAM	Ririgan	1.9	Oral: 1/2 to 1 glass in the morning noon and evening until healing
15	*Waltheria indica* 8994/SRFK	Kadamarouan	1.9	Oral: 1/4 to 1/2 glass in the morning and evening for 02 to 03 days
16	*Annona senegalensis* 7783/SRF-CAM	Moyingan	0.9	Oral: 1 pinch in water in the morning and evening for 03 to 07 days
17	*Ficus umbellata* 99/HNC	Kourban	0.9	Oral: 1 glass in the morning noon and evening until healing
18	*Maytenus senegalensis* 1972 SRFK		0.9	Oral: 1 pinch in water morning and evening for 02 weeks
19	*Parkia biglobosa* 58980/HNC	Naredji	0.9	Oral: 1 glass in the morning noon and evening for 03 days
20	*Piliostigma thonningii* 36376/HNC	Spatan	0.9	Oral: 1 glass in the morning and evening for 05 days
21	*Psidium guajava* 65619/HNC	Gouéva	0.9	Oral: 1 glass in the morning and evening until healing
22	*Cassia siamea* 25661/HNC	Daden	0.9	Oral: 3 tablespoons every morning in an empty stomach for one month

Table 3. Efficacy of aqueous and hydroethanolic extracts of some plants against adult *Haemonchus contortus*.

Plants	Conc (mg/mL)	Mortality (%)			
		12 hours incubation		24 hours incubation	
		Aqueous extract	Hydro-ethanolic extract	Aqueous extract	Hydro-ethanolic extract
Khaya senegalensis	1	11.1 ± 5.5	44.4 ± 5.6	72.2 ± 5.6	88.8 ± 5.6
	2	38.8 ± 5.6	77.7 ± 5.6	94.4 ± 5.6	100
	5	50	88.8 ± 5.5	100	100
Aristolochia baetica	1	61.1 ± 5.6	72.2 ± 5.5	94.4 ± 5.6	100
	2	77.8 ± 5.6	94.4 ± 5.5	100	100
	5	100	100	100	100
Euphorbia hirta	1	0	0	44.4 ± 5.5	55.5 ± 5.5
	2	11.1 ± 5.5	16.6 ± 5.5	61.1 ± 5.5	72.21 ± 5.6
	5	27.7 ± 5.5	33.3	72.2 ± 5.5	77.77 ± 5.6
Vernonia amygdalina	1	0	0	44.4 ± 5.5	44.44 ± 5.6
	2	0	5.5 ± 1.52	50	61.1 ± 5.5
	5	0	5.5 ± 1.52	61.1 ± 5.5	66.6
Abelmochus esculentus	1	33.3 ± 5.6	55.5 ± 5.6	88.8 ± 5.5	100
	2	55.5 ± 5.5	77.7 ± 5.5	100	100
	5	88.8 ± 5.5	100	100	100
Harungana madagascariensis	1	27.7 ± 5.5	38.8 ± 5.6	77.7 ± 5.6	77.7 ± 5.6
	2	44.4 ± 5.6	55.6 ± 5.6	88.8 ± 5.6	94.4 ± 5.6
	5	61.1 ± 5.5	66.6	100	100
Securidaca longepedunculata	1	5.5 ± 1.5	16.6 ± 3.5	72.2 ± 5.5	72.2 ± 5.5
	2	44.4 ± 5.5	55.5 ± 5.5	83.3	83.33± 9.6
	5	83.3	83.3	94.4 ± 5.6	100
Carica papaya	1	22.2 ± 5.6	27.7 ± 5.5	61.1 ± 5.5	77.7 ± 5.5
	2	50	66.6 ± 5.6	94.4± 5.6	100
	5	77.7 ± 5.54	72.2 ± 5.6	100	100
Sarcocephalus latifolius	1	0	0	94.4 ± 5.6	94.4 ± 5.6
	2	5.5 ± 1.5	11.1 ± 5.5	100	100
	5	5.5 ± 1.52	11.1 ± 5.5	100	100
Clerodendrum scandens	1	33.3 ± 5.5	44.4 ± 5.5	88.8 ± 5.5	94.4 ± 5.5
	2	66.6 ± 9.6	88.8 ± 5.5	94.4 ± 5.6	100
	5	94.4 ± 5.6	100	100	100
Tephrosia pedicellata	1	83.33	88.8 ± 5.5	100	100
	2	100	100	100	100
	5	100	100	100	100

Conclusion

From our findings, 22 local medicinal plants used for the treatment of intestinal helminthiasis were identified from traditional healers and breeders. These plants belong to 15 families among which the Fabaceae and Malvaceae were the most represented. This inventory constitutes a source of information that contributes to knowledge of medicinal flora and the safeguarding of the local population's competence. It also constitutes a database for the promotion of medicinal plants with a view to discovering new active principles usable in pharmacology. The anthelmintic activity of 11 selected plants evaluated against *Haemonchus contortus* showed that all 11 plants had anthelmintic activities compared to the negative control (PBS). The hydroethanolic extract of most of the plants showed higher anthelmintic activity compared to the aqueous extract. These results confirm the use of these local plants by the population in the treatment of intestinal helminthiasis in humans and animals.

Abbreviations

ENSAI : Ecole Nationale Supérieure des Sciences Agro-Industrielle
WHO: World Health Organization
PBS: Phosphate buffered saline

Authors' Contribution

IH carried out experiments and analyzed the results with the help of NNN, AA, and EDA. DN and NYN supervised the work. All authors participated in the writing of this article.

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Conflict of interest

The authors declare no conflict of interest.

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