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Diversity, Ethnobotanical Potential and Sustainability Assessment of Plants Used by Traditional Healers to Treat Cancer in Boyo Division, North-West Region, Cameroon

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aims: Cancer is the second leading cause of death globally. Therefore, the knowledge on medicinal plants used to cure human cancer could be of great importance for their widespread use and scientific validation. The present study records information on anticancer plants in Boyo Division, in the western highland of Cameroon.

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Methods: Thirty traditional healers, were interviewed to document their know-how on the type of human cancer allegedly cured, the plant species used as well as their use pattern. Guided field walks were made to the collection sites for plant and its habitat characterization as well as herbarium voucher collection. Ethnobotanical quantitative tools were used to analyze and summarize collected data. Sustainability of harvest was assessed using a vulnerability index based on seven parameters.

Results: A total of 25 medicinal plants cited were identified as belonging to 13 families and 23 genera. The most represented families were Asteraceae (28%), Lamiaceae (16%), Fabaceae (12%) and Acanthaceae (8%). Out of the seven categories of cancer diseases reported, the highest number of plants species were reported to treat stomach, pancreas, liver, skin and breast cancers, with informant consensus factor (ICF) ranging from 0.79 to 0.82. Leaves (60%) and bark (20%) were the major plant parts used mostly in form of decoction (45.45%) and concoction (38.18%). The result of Relative frequency citations (RFCs) revealed that 9 of the 25 plants species cited were the most frequently used with fidelity levels ranging from 92% (*Geniosporum rotundifolium* and *Ocimum tenuiflorum Aframomum melegueta* and *Entada abyssinica*) to 100% (*Coleus blumei, Ocimum gratissimum, Eremomastax speciosa*, and *Dichrocephala integrifolia)*. Six species were assessed as vulnerable (Vi ≥ 2), while two species were rated as highly vulnerable namely *G. rotundifolium* (Vi = 2.71) and *E. abyssinica* (Vi = 2.85).

Conclusion: New traditionally effective anticancer plants were identified in the present study, some of which were already vulnerable for exploitation in their actual habitat. Plants with high ICF, RFCs and FL values should be subjected to further phytochemical and pharmacological investigations for scientific validation while those with high Vulnerability index should be recommended for participatory domestication by the main users.

Keywords: Anticancer medicinal plants; ethnobotany; human cancer categories; medicinal uses; vulnerability assessment.

ABBREVIATIONS

Dst : Development stage at harvesting
ICF : Informant Consensus Factor
FL : Fidelity level
FC : Frequency of citation
GM : Gathering method
HCs : Habitat and conservation status
LF : Life Form
Oh : Organs harvested
Pop : Popularity
PhF : Pharmaceutical form
RFCs : Relative Frequency of Citations
Vi : Vulnerability index

1. INTRODUCTION

According to the World Health Organization, cancer was the second leading causes of death globally responsible for an estimated 9.6 million of death in 2018, 70% of which occurring in low and middle-income countries [1]. There are over 200 different types of cancer but four cancers: lung cancer, breast cancer, prostate cancer and large bowel cancer account for more than half of all cases [2]. Of the 12.4 million new cancer cases in 2008, the most common cancers in terms of incidence were lung (1.52 million), breast (1.29 million) and colorectal (1.15 million) [3]. The International Agency for Research on Cancer estimates of the incidence of mortality and prevalence from major types of cancer, at national level, for 184 countries of the world revealed that there were 14.1 million new cancer cases, 8.2 million cancer deaths, and 32.6 million people living with cancer (within 5 years of diagnosis) in 2012 worldwide [4]. By 2030, it is projected that there will be 26 million new cancer cases and 17 million cancer deaths per year [5]. The types of cancer vary around the world and there is significant variation in the risk of different cancers by geographic area. Most of this global variation is due to exposure to known or suspected risk factors related to lifestyle or environment and provides a clear challenge to prevention [5]. In developed countries, many cancer cases are attributable to an unhealthy diet and inactive lifestyle such as smoking and obesity. Although a third of all cancer deaths are linked to cigarette smoking, obesity is associated with colon, breast, uterine, oesophageal and kidney cancer [3,6]. However, some cancers are caused by biological carcinogens such as infections by viruses (hepatitis B/C and liver cancer and human *Papillomavirus* (HPV) and cervical cancer), bacteria (*Helicobacter pylori* and gastric cancer) and parasites (*Schitosomiasis* and bladder cancer). A large

number of chemopreventive agents are used to cure various cancers, but they produce side effects that prevent their extensive usage. Although more than 1500 anticancer drugs are in active development with over 500 of the drugs under clinical trials, there is an urgent need to develop much effective and less toxic drugs, for which the plant kingdom could play an important role [7]. In recent years, the use of traditional medicine information on plant research has received considerable interest. According to the world Health Organization (WHO) in 2008, about three quarters of the world's population currently use herbs and other forms of traditional medicines to treat diseases [8,9]. It has been reported that 60% of the commercially available anticancer drugs are from natural sources [9]. Treatment by herbal medicines may have some advantages over treatment by single purified chemicals [10]; as herbal medicine are a cocktail of metabolites with therapeutic or preventive properties, and so might be more active than single products alone. Moreover, plant products for cancer treatment could be available, affordable, and relatively cheap with little or no side effects [11,12,13,14]. Despite pharmacological progress, urban and rural populations of Cameroon still depend on medicinal plants for their primary health and many plants species had already been reported for the treatment of various ailments including cancer [15,16]. The country is known to be rich for its plant diversity, culture, language and tradition which contribute to the multiplicity of practices. However, these practices remain poorly documented and less accessible for modern research. Hence, the search for alternative anticancer drugs of plant origin in the country requires a basic ethnobotanical survey in different localities to document diverse knowledge owned by different ethnic groups. Only few workers [17,18], have conducted ethnobotanical survey in some parts of North-West Cameroon. Therefore, very limited ethnobotanical literature is available in the region. Although various ethnobotanical surveys have been conducted in different parts of Cameroon [15,19,20,21,22,23], scientific documentation on plant used to treat human cancer is scarce at the country level. The overuse of plants' organs such as barks, roots, leaves and fruits for medicinal purpose are known to differently affect the species sustainability depending on a set of factors among which are the species morphotype, the part of plant being used, the pharmaceutical form being administered, the harvest frequency and intensity, the characteristics of the species' habitat among others [24,25,26,27]. These factors have been compiled to elaborate a vulnerability index currently applied to raise awareness on species sustainability to harvest [24,28]. Therefore, present survey aimed to provide, the first inventory and sustainability of medicinal plants used by traditional healers and the associated indigenous knowledge for the treatment of cancer affliction in the western highland of Cameroon.

2. MATERIALS AND METHODS

2.1 Research Setting/ Description of the Study Area

The study was carried out in Boyo division (Fig. 1). Boyo is about 1557.5 Km^2, and it is situated between 6°09-6°17 North and 10°16-10°20 East. Boyo has four subdivision, which are: Fundong, Njinikom, Belo and Bum, All the four subdivision, well reputed for the competence of their traditional healers in treating many desperate illnesses such as cancer [29] were considered in this study. Temperature ranges from 15°C to 38° C with average temperature of 24.5 to 29.7°C. Average annual rainfall stands at 2400 mm per annum and humidity of 82% with two seasons. The climate is Cameroonian humid tropical type with two seasons (rainy season from mid-march to mid-November, and dry season from mid-November to mid-march) [30]. Boyo division has 128, 425 total population. The population density is about one per 82 per km^2. People mainly depend on agriculture for their livelihoods. This division is characterized by the great diversity of its relief, climate, vegetation and soils [31].

2.2 Ethnobotanical Survey and Data Collection

The primary goal of this survey was to collect ethnobotanical information about medicinal herbs for cancer treatment. The informants were selected among traditional healers members of the Mixed Farmer common Initiative groups (MIFACIGs), a community based organization collaborating with the World Agroforestry Centre (ICRAF) in the framework of the project on participatory domestication of indigenous fruit trees and medicinal plants in the African Humid Tropics region. Therefore, their willingness to participate to the study was very high. The data were collected between the months of May to

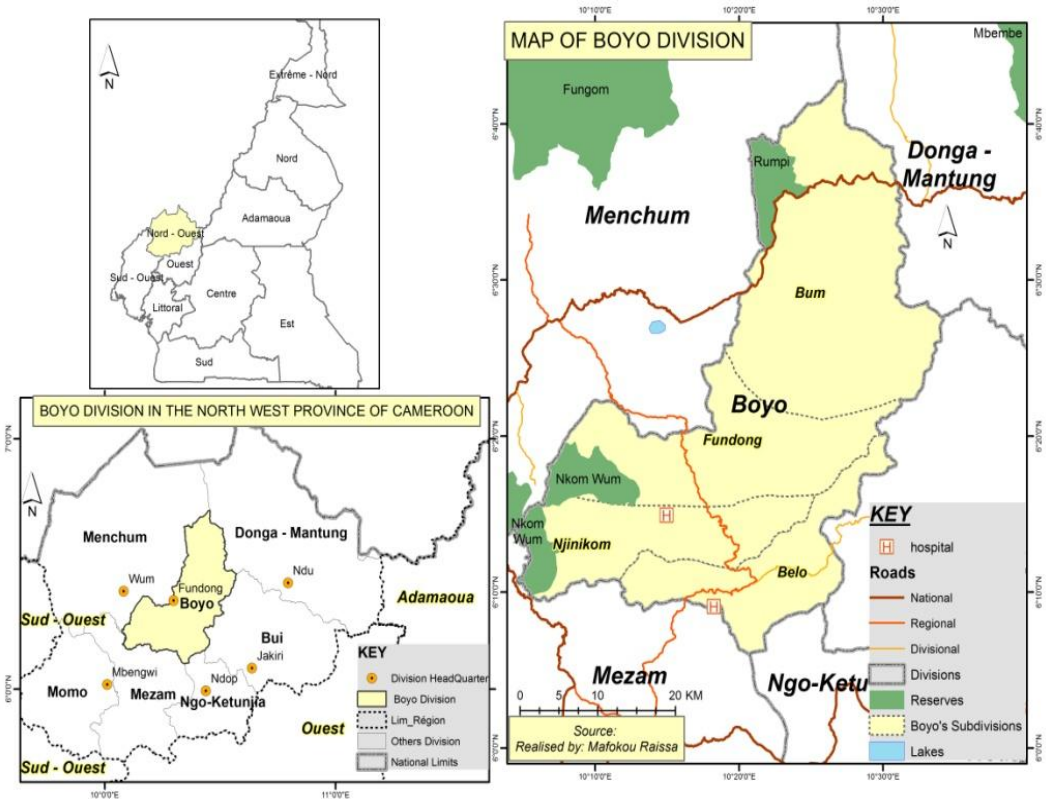

Fig. 1. Map showing the Boyo division in the North-West region of republic of Cameroon

september 2006 Traditional healers were chosen because they are likely to encounter a wide range of cancer patients. Indeed a total of 30 traditional healers were chosen using snowball sampling method [32]. Individual ethnobotanical semi-structured interviewing techniques were used for data collection [33,34]. The questionnaire was constructed in English. However, for ease in communicating with the traditional healers during interviews, *Piging-english* was used. Among the questions asked during the interviews was age, sex, years of experience. Data were also focused on the uses of each cited medicinal plant which incorporated local names, cancer type treated, parts used, preparation methods, administration route, dosage, habits and habitats, and the medicinal plant conservation practices. Guided field walks were conducted with interviewed traditional healers to collect medicinal plant voucher specimens. Further identification and authentication was done by a taxonomist in the Cameroon National Herbarium Yaoundé. Voucher specimens were prepared, labeled and deposited in the Herbarium of Forestry Department, University of Dschang Cameroon.

2.2.1 Vulnerability assessment

Seven (7) criteria were adapted from several studies [28,35,36] and used for the assessment of the vulnerability to harvest for the most common anticancer species cited in the study site. Such criteria included: gathering method, the life form or morphology, the vegetative organ harvested, the popularity of the species in a given site, the pharmaceutical form being used, and the type of habitat and conservation status as well as the development stage at harvesting (Table 1). A scale value from 1 to 3 were assigned to each of the criteria used for the assessment, which affected the survival of the species within a particular habitat type. The overall vulnerability index (Vi) was estimated by calculating the average of the values obtained for all the 7 parameters considered in Table 1, with:

- $1 < Vi \leq 2$, meaning that the plant is not vulnerable and the natural potential is still quite appropriate for exploitation.
- $2 < Vi \leq 2.5$ indicates that the plant is becoming vulnerable in the given environment.

Table 1. Parameters used for the assessment of the vulnerability index (Vi) of the common anticancer plant's species of the Boyo Division, Northwest province Cameroon

Parameters	Vulnerability scales		
	Weak (Scale 1)	**Medium (Scale 2)**	**High (Scale 3)**
Life form (LF)	Herbs	Shrub	Tree
Popularity (Pop)	Not popular (RFL<20%)	Less popular (20% <RFL<60%)	Popular (RFL>60%)
Organ (s) harvested (Oh)	Leaves	Fruits	Bark, roots and wood
Gathering methods (GM)	Leaves harvesting/ ground picking of the fruits	Fruits and seeds Harvesting	Debarking and felling
Pharmaceutical forms (PhF)	crush concoction	Powder/crush concoction	Decoction/maceration
Habitat and conservation status (HCs)	cultivated	Preserved in human managed systems	wild
Development stage at harvesting (Dst)	Mature	growing stage	juvenile

- Vi ≥ 2.5 shows that the plant is highly vulnerable and need sustainable management strategies.

2.3 Data Analysis

All the recorded data values were tabulated by using Microsoft Excel 2010. Three ethnobotanical parameters were calculated i.e., relative frequency of citation (RFCs), fidelity level (FL) and Informant's consensus Factor (IFC). Relative frequency of citation reveals the importance of each species and is calculated on the basis of the frequency of citation (FC) (the number of informants mentioning the use of species), by using the following formula: RFCs= FCs / N (the FC value is divided by total number of informants participating in the survey (N), without considering the use-categories. Where, FCs is the number of informants who mentioned the use of a plant species and N is the total number of informants [37,38]. Fidelity level (FL) was calculated to determine the percentage of informants which reported the uses of a medicinal plant as a remedy for the same major ailment using the formula: FL= (I_p / I_u)x 100, where I_p is the number of informants who independently indicated the use of a species for the same major ailment and I_u the total number of informants who mentioned the plant for any major ailment [39].

The informant consensus factor (ICF) was calculated to determine the agreements of the informants on each remedy using the formula: ICF= Nur-nt/ Nur-1, where number of use citations in each category (Nur) minus the number of species used (nt), divided by the number of use citations in each category minus one, where Nur is the number of use citations and nt is the number of species used [40]. IFC values range between 0 and 1, "1" indicates the highest level of consensus. Thus, high IFC can be used to identify important plant species for search of novel bioactive compounds [41].

3. RESULTS

3.1 Informant's Characteristics

The informants interviewed in this study had received the lowest levels of formal education. The majority had attained only primary education (83.33%), and 16.67% had not attained any formal education. The occupation of the Informants was healing jobs and crop farming. All the 30 key informants were males; they were well-known in the locality due to their long practice in providing services related to traditional health care. Their ages ranged from 37 to 79 years, with 53% of them having more than 60 years old. All informants reported that, majority of their knowledge was received from their family members secretly, and sometime by dream. Yet, if it is not practiced secretly, they think that the potential of the medicinal values of the plants will be weakened.

3.2 Plants Reported as Anticancer and Relative Frequency Citation

A total of 25 medicinal plant species belonging to 13 families were documented as being used by traditional healers in Boyo division, north-west Cameroon (Table 2). These were reported to be useful in controlling seven categories of cancer diseases. The families Asteraceae, Lamiaceae, Fabaceae and Acanthaceae were represented by seven, four, three and two anticancer plants respectively, and the rest by one anticancer plant each. One of the species recorded (*Prunus africana*) is also listed in the IUCN (International Union for Conservation of Nature) red list as vulnerable to extinction [42,43]. Most of the reported anticancer plants were herbs (68%), followed by tree (24%) and shrubs (8%). Leaves were the most preferred plant part (60%) used in herbal drug recipe, followed by barks (20%), fruits (10%), whole plant (6.67%) and stem (3.33%) (Table 2). The most frequently cited anticancer plant species were *Coleus blumei, Ocimum gratissimum, Geniosporum rotundifolium, Ocimum tenuiflorum, Eremomastax speciosa, Dichrocephala integrifolia, Aframomum melegueta*, *Entada abyssinica* and *Setaria barbata*. The RFCs of the reported species ranged from 3.33 to 96.66%, with the highest values obtained for *Coleus* spp (96.66), *Ocimum gratissimum* (93.33), *Geniosporum rotundifolium* (83.33), *Ocimum tenuiflorum* (73.33), *Eremomastax speciosa* (63.33), *Dichrocephala integrifolia* (63.33) and *Aframomum melegueta* (40). These plants species were reported by a maximum number of traditional healers, therefore having high frequency of citation. Traditional healers assigned vernacular names to all of the documented medicinal plants (Table 2).

3.3 Preparation, Dosage and Mode of Treatment

The most common mode of preparation were decoction (45.45%) and concoction (38.18%). All the treatments were prepared from a mixture of four to ten dry or fresh plants. Treatments were mainly taken orally and topically twice or three times in a day until recovery. The dosages were measured using a cup of about 50 – 100 ml. Solvent were water, raphia wine, palm oil and castor oil. Some additive substances such as salt and honey were mixed during preparations and administrations.

3.4 Informant's Consensus Factor for Each Cancer Category and Fidelity Value of Recorded Medicinal Plants

Cancer affliction was divided into seven categories, namely: Breast cancer, skin cancer, liver cancer, stomach cancer, pancreas cancer, lung cancer and brain cancer. From the informant consensus factor analysis computed for each cancer category, it was shown that stomach cancer scored the highest ICF value (0.82) followed by skin, pancreas and liver cancer (0.81 each). The least values of ICF were found in lung cancer (0.16) and brain cancer (0.54) (Table 3).

Eight medicinal plants scored highest FL values: These were *Coleus* spp, *Ocimum gratissimum, Eremomastax speciosa*, and *Dichrocephala integrifolia* ranked first with the highest score of FL value (100% each); followed by *Geniosporum rotundifolium* and *Ocimum* sp (92% each) ranked second, *Aframomum melegueta* and *Entada abyssinica* ranked third with FL value (91.67% each) (Table 4).

Moreover, the highest number of plant species (more than 20 species) were cited for the treatment of five out of the seven cancer categories recorded, namely skin cancer, liver cancer, stomach cancer, pancreas cancer and breast cancer (Fig. 2).

3.5 Threats and Vulnerability Assessment of Medicinal Plants used as Anticancer in the Study Area

Most of the plant species were collected in the wild (76%), while 24% were cultivated. Some of these wild medicinal plants are considered as threatened due to expansion of agriculture and overgrazing.

Furthermore, according to reports of informants and field observation, two of the anticancer plants, *E. abyssinica* and *G. rotundifolium* are becoming rare in the nearby areas and as a result traditional healers needed to travel longer distances to harvest them. The assessment of the vulnerability to harvest indicated that out of the eight common medicinal plants used in the treatment of cancer, six were found vulnerable with vulnerability index (Vi) varying from 2 (*D. integrifolia* and *Aframomum melegueta*.) to 2.42 (*E. speciosa* and *Ocimum gratissimum*). Two of them, namely *G. rotundifolium* and *E. abysssica* were assessed as highly vulnerable with Vi value of 2.71 and 2.82 respectively (Table 5).

Table 2. Anticancer medicinal plants characteristics, parts used and preparations by traditional healers in Boyo Division

Scientific name/ Family	Local name	Habit	Plant status	Medicinal uses	Parts used	Preparation & administration	Dosage	RFCs (%)
Acanthus montanus **Acanthaceae**	Nyo I nyo i	Herb	W	Skin cancer, liver cancer, stomach and pancreas cancer	Leaves	Decoction/**I**, concoction of leaves powder with palm oil /**I** & **E**	2 - 3 cups a day of decocted or 2 - 3 spoons of concocted drug are taken orally and concoction mixture is rubbed on areas where pain felt	3.33
Aframomum melegueta **Zingiberaceae**	Fessuifegang	Herb	W	Breast cancer, skin cancer, liver cancer, stomach cancer, pancreas and brain cancer	Leaves, fruits	Decoction/**I**, concoction of leaves powder with palm oil /**I** & **E**	2 - 3 cups a day of decocted or 2 - 3 spoons of concocted drug are taken orally and concoction mixture is rubbed on areas where pain felt	40
Ageratum conyzoides **Asteraceae**	Abve akedjem	Herb	W	Breast cancer, skin cancer, liver cancer, stomach and pancreas cancer	Whole plant	Decoction/**I**, concoction of leaves powder with palm oil /**I** & **E**	2 - 3 cups a day of decocted or 2 - 3 spoons of concocted drug are taken orally and concoction mixture is rubbed on areas where pain felt	3.33
Albizia gummifera **Fabaceae**	Fowoom	Tree	W	Breast cancer, skin cancer, liver cancer, stomach	Barks	Decoction/**I**, Crush/**I** & **E**	2 - 3 cups a day of decocted or crushed extract are taken orally	10

Scientific name/ Family	Local name	Habit	Plant status	Medicinal uses	Parts used	Preparation & administration	Dosage	RFCs (%)
				cancer, pancreas and lung cancer			and crushed extract is rubbed on areas where pain felt	
Aloe vera **Asparagaceae**	Aloe	Herb	C	Breast cancer, skin cancer, liver cancer, stomach and pancreas cancer	Leaves	Decoction/**I**, concoction of leaves powder with palm oil /**I** & **E**	2 - 3 cups a day of decocted or 2 - 3 spoons of concocted drug are taken orally and concoction mixture is rubbed on areas where pain felt	3.33
Aspilia africana **Asteraceae**	Ahovesse	Herb	W	Breast cancer, skin cancer, liver cancer, stomach cancer, pancreas and brain cancer	Whole plant	Decoction/**I**, concoction of leaves powder with castor oil /**E**	2 - 3 cups a day of decocted drug are taken orally and concoction mixture is rubbed on areas where pain felt	3.33
Bidens pilosa **Asteraceae**	Fesse enou	Herb	W	Breast cancer, skin cancer, liver cancer, stomach cancer, pancreas and brain cancer	Leaves	Decoction/I, concoction of leaves powder/I	2 - 3 cups a day of decocted or 2 - 3 spoons of concocted drug are taken orally and concoction mixture is rubbed on areas where pain felt	6.66
Chromoleana odorata **Asteraceae**	Tchakassala	Herb	W	Breast cancer, skin cancer, liver cancer,	Leaves	Decoction/I, concoction of leaves powder with palm oil	2 - 3 cups a day of decocted or 2 - 3 spoons of	3.33

Scientific name/ Family	Local name	Habit	Plant status	Medicinal uses	Parts used	Preparation & administration	Dosage	RFCs (%)
				stomach and pancreas cancer		/I & E	concocted drug are taken orally and concoction mixture is rubbed on areas where pain felt	
Cleome viscosa **Capparidaceae**	Y bany be	Herb	W	Breast cancer, skin cancer, liver cancer, stomach and pancreas cancer	Leaves	Decoction/**I**, concoction of leaves powder with palm oil /**I** & **E**	2 - 3 cups a day of decocted or 2 - 3 spoons of concocted drug are taken orally and concoction mixture is rubbed on areas where pain felt	3.33
Coleus blumei **Lamiaceae**	Banguim femelle	Herb	W	Breast cancer, skin cancer, liver cancer, stomach cancer, pancreas cancer, lung and brain cancer	Stems	Decoction/**I**, concoction of leaves powder with palm oil /**I,** Crush/**I** & **E**	2 - 3 cups a day of decocted or 2 - 3 spoons of concocted drug and crushed extract are taken orally and crushed extract rubbed on areas where pain felt	96.66
Dichrocephala integrifolia **Asteraceae**	Fessuifesse	Herb	W	Breast cancer, skin cancer, liver cancer, stomach cancer, pancreas cancer, lung and brain	Leaves	Decoction/**I**, concoction of leaves powder/**I**	2 - 3 cups a day of decocted or 2 - 3 spoons of concocted drug are taken orally and concoction mixture is rubbed on areas	63.33

Scientific name/ Family	Local name	Habit	Plant status	Medicinal uses	Parts used	Preparation & administration	Dosage	RFCs (%)
				cancer			where pain felt	
Entada abyssinica **Fabaceae**	Feloung	Tree	W	Breast cancer, skin cancer, liver cancer, stomach cancer, pancreas and lung cancer	Leaves, Barks	Decoction/**I**, concoction of leaves powder/**I** & **E**	2 - 3 cups a day of decocted drug or 2 - 3 spoons of concocted drug are taken orally and concoction mixture is rubbed on areas where pain felt	40
Eremomastax speciosa **Acanthaceae**	Banguim male	Herb	C	Breast cancer, skin cancer, liver cancer, stomach cancer, pancreas cancer, lung and brain cancer	Leaves	Decoction/**I**, concoction of leaves powder/**I**	2 - 3 cups a day of decocted or 2 - 3 spoons of concocted drug are taken orally and concoction mixture is rubbed on areas where pain felt	63.33
Geniosporum rotundifolium **Lamiaceae**	Feungui	Herb	W	Breast cancer, skin cancer, liver cancer, stomach cancer, pancreas and brain cancer	Leaves	Decoction/**I**, concoction of leaves powder with palm oil /**I** & **E**	2 - 3 cups a day of decocted or 2 - 3 spoons of concocted drug are taken orally and concoction mixture is rubbed on areas where pain felt	83.33
Kigelia Africana **Bignoniaceae**	Atem	Tree	C	Breast cancer, skin cancer, liver cancer, stomach and	Leaves, fruits	Decoction/**I**, concoction of leaves powder with palm oil /**I**, Crush/**I** & **E**	2 - 3 cups a day of decocted or 2 - 3 spoons of concocted drug	10

Scientific name/ Family	Local name	Habit	Plant status	Medicinal uses	Parts used	Preparation & administration	Dosage	RFCs (%)
				pancreas cancer			and crushed extract are taken orally, and crushed extract rubbed on areas where pain felt	
Lannea kerstingii **Anacardiaceae**	Feuga'ah	Tree	W	Breast cancer, skin cancer, liver cancer, stomach cancer, pancreas and lung cancer	Barks	Decoction/**I** concoction of leaves powder with palm oil /**I** Crush/**I** & **E**	2 - 3 cups a day of decocted or 2 - 3 spoons of concocted drug and crushed extract are taken orally and crushed extract rubbed on areas where pain felt	6.66
Ocimum gratissimum **Lamiaceae**	Afato'oh	Herb	C	Breast cancer, skin cancer, liver cancer, stomach cancer, pancreas and brain cancer	Leaves	Decoction/**I** concoction of leaves powder/**I** & **E**	2 - 3 cups a day of decocted or 2 - 3 spoons of concocted drug are taken orally and concoction mixture is rubbed on areas where pain felt	93.33
Ocimum tenuiflorum **Lamiaceae**	Tongloan	Herb	C	Breast cancer, skin cancer, liver cancer, stomach cancer, pancreas and brain cancer	Leaves	Decoction/**I** concoction of leaves powder/**I** & **E**	2 - 3 cups a day of decocted or 2 - 3 spoons of concocted drug are taken orally and concoction mixture is rubbed on areas where	73.33

Scientific name/ Family	Local name	Habit	Plant status	Medicinal uses	Parts used	Preparation & administration	Dosage	RFCs (%)
							pain felt	
Prunus africana **Rosaceae**	Prunus	Tree	C	Breast cancer, skin and lung cancer	Barks	Decoction/**I** concoction of leaves powder with palm oil /**I** Crush/**I** & **E**	2 - 3 cups a day of decocted or 2 - 3 spoons of concocted drug and crushed extract are taken orally and crushed extract rubbed on areas where pain felt	3.33
Sesbania grandiflora **Fabaceae**	Y-yes	Shrub	W	Breast cancer, skin cancer, liver cancer, stomach and pancreas cancer	Leaves	Decoction/**I** concoction of leaves powder with palm oil /**I** Crush/**I** & **E**	2 - 3 cups a day of decocted or 2 - 3 spoons of concocted drug and crushed extract are taken orally and rubbed on areas where pain felt	6.66
Setaria barbata **Poaceae**	Fedjan fegué	Herb	W	Breast cancer, skin cancer, liver cancer, stomach and pancreas cancer	Leaves	Decoction/**I** concoction of leaves powder/**I** & **E**	2 - 3 cups a day of decocted or 2 - 3 spoons of concocted drug are taken orally and concoction mixture is rubbed on areas where pain felt	16.66
Solanum aculeastrum **Solanaceae**	Fugnah	Shrub	W	Breast cancer, skin cancer, liver cancer, stomach and	Leaves, fruits, barks	Decoction/**I** concoction of leaves powder with palm oil /**I** & **E**	2 - 3 cups a day of decocted or 2 - 3 spoons of concocted drug	16.66

Scientific name/ Family	Local name	Habit	Plant status	Medicinal uses	Parts used	Preparation & administration	Dosage	RFCs (%)
				pancreas cancer			are taken orally and concoction mixture is rubbed on areas where pain felt	
Vernonia calvoana **Asteraceae**	A tong tong	Herb	W	Breast cancer, skin and lung cancer	Leaves	Decoction/I Crush/I & E	2 - 3 cups a day of decocted or crushed extract are taken orally and rubbed on areas where pain felt	6.66
Vernonia amygdalina **Asteraceae**	Afessan	Herb	W	Breast cancer, skin and lung cancer	Leaves	Decoction/I Crush/I & E	2 - 3 cups a day of decocted or crushed extract are taken orally and rubbed on areas where pain felt	3.33
Vitex agnus-castus **Verbenaceae**	Afeuh	Tree	W	Breast cancer, skin and lung cancer	Barks	Decoction/I Crush/I & E	2 - 3 cups a day of decocted or crushed extract are taken orally and rubbed on areas where pain felt	3.33

E: External; I: Internal; C: Cultivated; W: Wild; RFCs: Relative frequency citations

Table 3. Informant Consensus Factor (ICF) value of cancer category for anticancer plants in Boyo division, Cameroon

Use category	Plant species	Number of use citation	% of all citations	ICF value
Breast cancer	*Coleus blumei* (13), *Ocimum gratissimum* (12), *Geniosporum rotundifolium* (14), *Ocimum* sp. (11), *Eremomastax speciosa* (13), *Dichrocephala integrifolia* (9), *Aframomum melegueta* (7), *Entada abyssinica* (7), *Setaria barbata* (3), *Solanum aculeastrum* (2), *Kigelia africana* (2), *Albizia* gummifera. (2), *Bidens pilosa* (3), *Vernonia calvoana* (2), *Sesbania grandiflora* (1), *Lannea kerstingii* (2), *Vitex* sp. (1), *Prunus africana* (1), *Aegeratum conyzoides* (1), *Cleome* viscosa. (1), *Chromoleana odorata* (1), *Aspilia africana* (1), *Aloe vera* (1), *Vernonia amygdalina* (1)	111	18.65	0.79
Skin cancer	*Coleus* blumea. (15), *Ocimum gratissimum* (13), *Geniosporum rotundifolium* (15), *Ocimum* sp. (13), *Eremomastax speciosa* (16), *Dichrocephala integrifolia* (11), *Aframomum melegueta* (7), *Entada abyssinica* (8), *Setaria barbata* (5), *Solanum aculeastrum* (2), *Kigelia africana* (2), *Albizia* sp. (3), *Bidens pilosa* (3), *Vernonia calvoana* (2), *Sesbania* spp (1), *Lannea kerstingii* (2), *Vitex* sp. (1), *Prunus africana* (1), *Aegeratum conyzoides* (1), *Cleome viscosa* (1), *Chromoleana odorata* (1), *Aspilia africana* (1), *Aloe vera* (1), *Vernonia amygdalina* (1), *Acanthus montanus* (1)	127	21.34	0.81
Liver cancer	*Coleus* blumea (12), *Ocimum gratissimum* (14), *Geniosporum rotundifolium* (13), *Ocimum* sp. (11), *Eremomastax speciosa* (12), *Dichrocephala integrifolia* (10), *Aframomum melegueta* (6), *Entada abyssinica* (7), *Setaria barbata* (6), *Solanum aculeastrum* (2), *Kigelia africana* (2), *Albizia gummifera*. (2), *Bidens pilosa* (3), *Sesbania* spp (1), *Lannea kerstingii* (1), *Aegeratum conyzoides* (1), *Cleome viscosa*. (1), *Chromolaena odorata* (1), *Aspilia africana* (1), *Aloe vera* (1), *Acanthus montanus* (1)	108	18.15	0.81
Gastrointestinal cancer	*Coleus blumea* (13), *Ocimum gratissimum* (15), *Geniosporum rotundifolium* (12), *Ocimum* sp. (12), *Eremomastax speciosa* (13), *Dichrocephala integrifolia* (11), *Aframomum melegueta* (7), *Entada abyssinica* (7), *Setaria barbata* (6), *Solanum aculeastrum* (2), *Kigelia africana* (2), *Albizia gummifera*.(2), *Bidens pilosa* (3), *Sesbania* sp. (1), *Lannea kerstingii* (1), *Ageratum conyzoides* (1), *Cleome viscosa*. (1), *Chromolaena odorata* (1), *Aspilia africana* (1), *Aloe vera* (1), *Acanthus montanus* (1)	113	18.99	0.82
Pancreas cancer	*Coleus blumea*. (12), *Ocimum gratissimum* (14), *Geniosporum rotundifolium* (12), *Ocimum tenuiflorum* (11), *Eremomastax speciosa* (12), *Dichrocephala integrifolia* (10), *Aframomum melegueta* (6), *Entada abyssinica* (7), *Setaria barbata* (5), *Solanum aculeastrum* (2), *Kigelia africana* (2), *Albizia gummifera* (2), *Bidens pilosa* (3), *Sesbania* sp. (1), *Lannea kerstingii* (1), *Aegeratum conyzoides* (1), *Cleome viscosa*. (1), *Chromoleana odorata* (1), *Aspilia africana* (1), *Aloe vera* (1), *Acanthus montanus* (1)	106	17.81	0.81
Lung cancer	*Coleus blumei*. (1), *Eremomastax speciosa* (1), *Dichrocephala integrifolia* (1), *Entada abyssinica* (1), *Albizia gummifera*. (2), *Lannea kerstingii* (1)	7	1.18	0.16
Brain cancer	*Coleus blumei* (4), *Ocimum gratissimum* (3), *Geniosporum rotundifolium* (2), *Ocimum* sp.(3),	23	3.86	0.54

Use category	Plant species	Number of use citation	% of all citations	ICF value
	Eremomastax speciosa (4), *Dichrocephala integrifolia* (2), *Aframomum melegueta*. (1), *Albizia gummifera*. (1), *Bidens pilosa* (1), *Aspilia africana* (1), *Acanthus montanus* (1)			

Numbers in parenthesis indicate the number of citations of that plant species by traditional healers against a particular ailment category, ICF: Informant Consensus Factor

Table 4. Fidelity Level (FL) values for common medicinal plants used against some cancer categories in Boyo division by local traditional healers

Plant species	Disease category	Ip	Iu	FL%
Coleus blumei.	Breast cancer, skin cancer, liver cancer, stomach cancer, pancreas cancer, lung cancer & brain cancer	29	29	100
Ocimum gratissimum	Breast cancer, skin cancer, liver cancer, stomach cancer, pancreas cancer & brain cancer	28	28	100
Geniosporum rotundifolium	Breast cancer, skin cancer, liver cancer, stomach cancer, pancreas cancer & brain cancer	23	25	92
Ocimum tenuiflorum	Breast cancer, skin cancer, liver cancer, stomach cancer, pancreas cancer & brain cancer	23	22	92
Eremomastax speciosa	Breast cancer, skin cancer, liver cancer, stomach cancer, pancreas cancer, lung cancer & brain cancer	19	19	100
Dichrocephala integrifolia	Breast cancer, skin cancer, liver cancer, stomach cancer, pancreas cancer, lung cancer & brain cancer	19	19	100
Aframomum melegueta.	Breast cancer, skin cancer, liver cancer, stomach cancer, pancreas cancer, lung cancer & brain cancer	11	12	91.67
Entada abyssinica	Breast cancer, skin cancer, liver cancer, stomach cancer, pancreas cancer & lung cancer	11	12	91.67
Coleus blumei.	Breast cancer, skin cancer, liver cancer, stomach cancer, pancreas cancer, lung cancer & brain cancer	29	29	100
Ocimum gratissimum	Breast cancer, skin cancer, liver cancer, stomach cancer, pancreas cancer & brain cancer	28	28	100
Geniosporum rotundifolium	Breast cancer, skin cancer, liver cancer, stomach cancer, pancreas cancer & brain cancer	23	25	92
Ocimum tenuiflorum	Breast cancer, skin cancer, liver cancer, stomach cancer, pancreas cancer & brain cancer	23	22	92
Eremomastax speciosa	Breast cancer, skin cancer, liver cancer, stomach cancer, pancreas cancer, lung cancer & brain cancer	19	19	100
Dichrocephala integrifolia	Breast cancer, skin cancer, liver cancer, stomach cancer, pancreas cancer, lung cancer & brain cancer	19	19	100
Aframomum melegueta.	Breast cancer, skin cancer, liver cancer, stomach cancer, pancreas cancer, lung cancer & brain cancer	11	12	91.67
Entada abyssinica	Breast cancer, skin cancer, liver cancer, stomach cancer, pancreas cancer & lung cancer	11	12	91.67

I_p: number of informants who independently indicated the use of the species for the same major ailment; I_u: the total number of informants who mentioned the plant for any major ailment

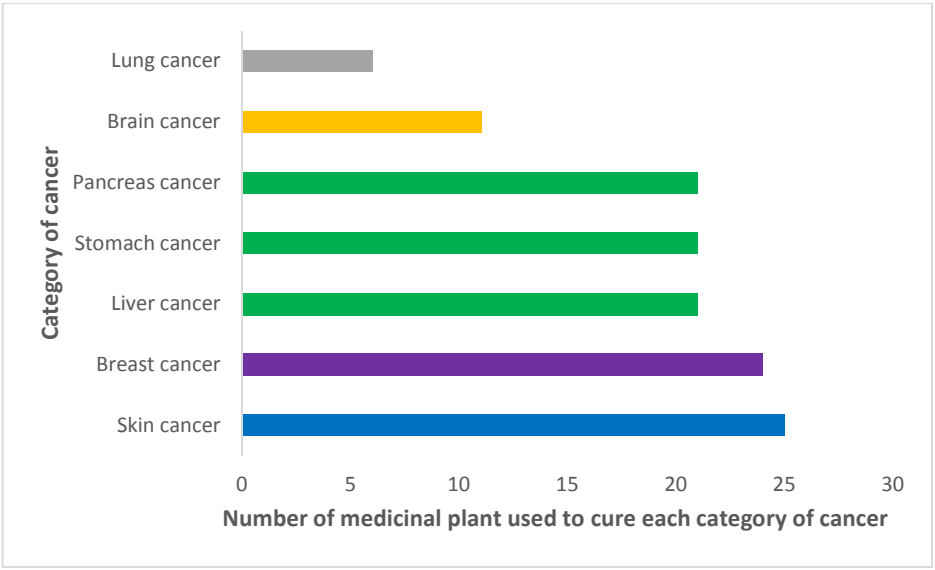

Fig. 2. Distribution of medicinal plants recorded for each cancer category in Boyo Division, Northwest region Cameroon

Table 5. Vulnerability indices for common anticancer medicinal plants used by traditional healers in Boyo Division, Cameroon

Parameters / Species	LF	HCs	Pop	Oh	Dst	GM	PhF	Total	Vi
Coleus blumei	1	2	3	1	2	3	3	15	2,14
Ocimum gratissimum	1	2	3	1	2	3	3	15	2,14
Geniosporum rotundifolium	2	2	3	3	3	3	3	19	2,71
Ocimum tenuiflorum	1	2	3	3	2	3	3	17	2,42
Eremomastax speciosa	1	2	3	3	2	3	3	17	2,42
Dichrocephala integrifolia	1	1	3	1	2	3	3	14	2
Aframomum melegueta	1	2	2	1	2	3	3	14	2
Entada abyssinica	3	3	2	3	3	3	3	20	2,85

LF: Life Form; HCs: Habitat and conservation status; Pop: popularity; Oh: organs harvested; Dst: development stage at harvesting; GM: gathering method; PhF: Pharmaceutical form, Vi: Vulnerability Index

4. DISCUSSION

Indigenous people of different localities have their own specific knowledge on plant use, management and conservation [44]. Various anticancer plant species have been assessed for their efficacy and tolerability. Some of these plant species including *Taxus baccata*, *Podophyllum peltatum*, *Camptotheca acuminata* and *Vinca rosea*, *Curcuma zedoaria*, *Typhonium flagelliforme*, *Phaleria macrocarpa*, *Catharanthus roseus*, *Selaginella corymbosa*, *Taraxacum mongolicum, Brucca javanica, Allium sativum, Smilax china, Helianthus annus, Solanum nigrum, Coix lachryma-Jobi, Asparagus cochinchinensis*, and others are used to manufacture anticancer drugs [9,45].

The fact that all informants claimed they had acquired their knowledge from their family members secretly and sometime by dream, is in agreement with those of Eyssartier et al. (2008) in Northwestern Patagonia, [46] in Western Region of Ghana, [23] in Bamboutos Division West Cameroon. It was pointed out that in China, traditional medicinal knowledge and practices are passed orally from generation to generation [47]. This pattern of knowledge transfer and the tendency of secrecy are also reported in similar studies elsewhere [48,49,50]. The high illiteracy level (83.33%) may explain why knowledge of medicinal properties and uses of plants are still oral and yet not written down [47].

Some of the anticancer plants reported during the current study were found to be also used in

other countries for the treatment of cancer ailments. These included *Aloe vera* [6], *Entada abyssinica, Ocimum gratissimum, Prunus africana, Albizia gummifera* [51]. Some of the listed species in this work have also been earlier reported in the same study area to be useful in curing of other ailments [18]. Furthermore, *Coleus blumei., Ocimum gratissimum, Geniosporum rotundifolium, Ocimum tenuiflorum, Eremomastax speciosa, Dichrocephala integrifolia, Aframomum melegueta*, *Entada abyssinica* and *Setaria barbata* were the most frequently cited plants in the study area and thus, may indicate their effectiveness. Some genus or plant species listed in this work have also been clinically verified and were found to be quite effective. This is the case for *Entada abyssinica, Ocimum gratissimum, Prunus africana, Albizia gummifera, Vernonia lapiosus* and *Aloe volkensii* [51]. In addition, phytochemical analysis of these plant extracts did by [52], revealed the presence of alkaloids, anthraquinones, xanthines, valepotriates, cardioactive glycosides, flavonoids, essential oils, coumarins, lignans, saponins and arbutin compounds. These bioactive compounds are known to possess important pharmacological actions [51]. For instance, Phenolic compounds such as flavonoids have been previously shown to have anti-apoptosis, anti-aging, anti-carcinogenic, anti-inflammatory, anti-atherosclerotic, and cardiovascular protective activities [52]. Flavonoids in plants comprise a vast array of biologically active compounds which have been used in traditional medicine for many years and have majorly antioxidant and antiproliferative effects especially against chronic inflammatory and allergic diseases, breast cancer and coronary artery disease [53]. [54] has reported evidence of flavonoids having antimutagenic activity of quercetin that was shown to inhibit the mutagenic activity of benzo(α)pyrene, a polyaromatic hydrocarbon carcinogen. Besides they have shown effectiveness as antioxidants and strong anticancer activities [55]. Thus, the use of our plant species for the treatment of various cancer categories in the study area might be due to their richness in bioactive constituents. From this study, it is shown that more than three plant species are used in the treatment of each cancer category for example skin cancer is treat by 25 plant species and breast cancer by 24 plant species. Multiple plant species used to treat ailments have been confirmed by [15,22,23] in Cameroon and [56] in Thailand. The utilization of medicinal plant species belonging to Asteraceae, Lamiaceae, Fabaceae and Acanthaceae families was in line with ethnomedicinal flora reported from other parts of Cameroon [15,17,22,23] and in other areas of the world [44,57]. This may be due to the wide distribution of plant belonging to Asteraceae, Lamiaceae, Fabaceae and Acanthaceae families and their traditional uses known by the indigenous communities living in different parts of the world. Moreover, the wide utilization of species from these families might be related to the presence of effective bioactive secondary metabolites that work against reproductive health-related infections [58,59,60,61,62]. For example, studies have reported that the Asteraceae family is rich in monoterpenes, sesquiterpenes, sesquiterpene lac-tones, diterpenes, triterpenes, polyacetylenes, benzofuranes, and phenyl-propanes that help to treat various diseases [63]. Most medicinal plants used in the area were herbs. This finding is in line with results from other studies in Cameroon [15,17,20,23]. This could be relate to the fact that herbs are usually more readily available than shrubs and trees that are often harvested from forest patches always distant from residential areas. It could also be due to the fact that our informants live in shrubby savannas and grass-lands where herbs abound [17]. Our observation agrees with the general pattern of dominance of herbaceous species seen in most medicinal plant inventories in Cameroon [18,20], and in other African countries like Ethiopia [64,65] and Uganda [60]. Moreover, the frequent use of herbs by traditional healers may be due to their accessibility and high efficacy in the treatment of cancer compared to other life forms [66,67,68]. Leaf was the most commonly used plant part in the area, the harvest of which does not normally causes significant harm to survival of individuals as compared to other parts such as the stem, bark and root. This could be explained by the fact that leaves are sites where more phytochemicals are produced via photosynthesis [69,70]. This finding is in agreement with those of certain others [15,17,18]. Furthermore, plants were reported to be used in various forms such as dry and fresh; however, preference was given to those that were freshly collected. This could be an indication that medicinal activities of plants are readily available when the plants are freshly collected as some of their metabolites may be volatile and could be lost through evapotranspiration. This corroborates the findings of [22,23,69,71] who reported that fresh plant material was used to prepare remedies as mixtures of multiple ingredients from different plants. The number of plants in mixture ranged

from four to ten. The informants in the study area perceived that use of multiple plants in preparation of traditional drugs adds up the curing potential and confer synergetic actions. On the other hand, the use of multiple plants to cure an ailment could be an indication of the prevalence and severity of that illness in the locality. This finding is in affinity with the study of [72]. Anticancer drugs in the study area were prepared in form of decoction and concoction, which is in concordance with results of a study conducted by [23,73]. Oral and topical were the only administration route. Oral route was also reported in many studies in Cameroon [17,22,23] and elsewhere [72,73,74] and may reflect the low toxicity of the plant extract for human being. Informants used additive such as honey in order to improve taste and flavor and therefore facilitate oral administration [23]. The use of water, palm wine, palm oil and castor oil as solvent may be due to their ability to better extract active compounds present in the plant than other solvents.

It was observed in this study that informants assigned local names to all the medicinal plants species used in the cancer treatment, indicating the existence of a very close interaction between the traditional healers and their plant resources. According to [75,76], the importance of plants in local culture is usually shown by the proportion of plants that can be identified by local people and in vernacular names. Furthermore, species such as *Coleus blumei*, *Ocimum gratissimum*, *Eremomastax speciosa*, *Dichrocephala integrifolia*, *Geniosporum rotundifolium*, *Ocimum tenuiflorum*, *Aframomum melegueta* and *Entada abyssinica* in the present work scored the highest FL and could be therefore subjected to phytochemical and pharmacological investigation to prove their efficacy [77]. Moreover, the ICF results proved that breast, skin, liver, pancreas and stomach cancers had higher informant consensus factor values, indicating that traditional healers share the knowledge of the most important medicinal plants species used to treat cancer ailments. Nevertheless, most medicinal plants claimed by traditional healers for cancer treatment have least relative frequency citations, which could not necessary mean that they are less effective in the treatment. This could be because the knowledge on medicinal plants is still very secret [78].

The majority of medicinal plants used to treat cancer diseases in the study area was harvested from the wild. Similar results were obtained by [59] in Uganda, Yineger et al. [79] in Ethiopia and [23] in Cameroon. Moreover, the vulnerability assessment revealed that the most frequently used plant species were becoming vulnerable in these wild habitats. This could be explained either by the exploitation pressure on these species, or by the fragility of the savannah grassland extensively converted to cropping and grazing lands. In order to ensure availability of these species for future generations and improve their use and pharmaceutical valorization, alternative sources of supply should be developed in more closely human-managed systems such as homegardens and food crop farms. Informants have expressed their willingness to participate in the domestication process of these species and some of them had started planting multiple used species such as *Ocimum tenuiflorum.* These initiatives need to be strengthened through capacity building for medicinal gardens creation and management as well as nursery techniques.

5. CONCLUSION

The present study documented 25 medicinal plants species and their uses, of which many had already been reported to content active ingredient against symptoms of various categories of cancer. Furthermore, reported plant species can serve as a basis for formal analysis of active constituents and validation of results. However, the threat reported for some of these species need to be urgently addressed to ensure their long term availability.

CONSENT AND ETHICAL APPROVAL

Interviews with traditional healers were done following mutual contentment as they were participating in the domestication programme leaded by the World Agroforestry Centre (ICRAF).

AVAILABILITY OF DATA AND MATERIALS

All data are available from CHS. Herbarim voucher specimen is deposited in the Department of Forestry of the Faculty of Agronomy and Agricultural Sciences, University of Dschang.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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