Ethnobotanic and Ethnopharmacological survey of herbal products of pharmaceutical importance for chronic wound management in Bankim District of Adamaoua Region of Cameroon.

Abstract

Introduction

In Cameroon, the identification of plants traditionally used to treat diseases remains a necessity. Inflammation from injury leading in some cases to chronic wounds like diabetic ulcer (from Diabetic patients) is increasingly becoming a public health concern in Cameroon. As a low-income country, the population attempts to with alternative treatments through the use of herbal products. Cameroon has a rich biodiversity of herbal flora for exploitation of potential bioactive metabolites of pharmaceutical importance. Therefore, the aim of this study was to identify plants and recipes used by some traditional healers in Bankim of the Adamaoua Region of Cameroon for the management of chronic wounds.

***Methodology*:** After obtaining various administrative and institutional authorizations, an ethnobotanical survey was conducted among the local traditional practitioners between the months of December 2020 to February 2021. The plant samples collected were identified and confirmed by experts of the National Herbarium of Cameroon at Yaoundé. ***Results*:** Thanks to the collaboration of 09 traditional healers, 30 plant species were identified and used in the preparation of 24 recipes. The families Rubiaceae, followed by Caesalpiniaceae, Cucurbitaceae, Euphorbiaceae, Fabaceae and Moraceae were the most represented. Various plant parts were used in the preparation of recipes. Bark (50%), followed by leaves (30%) were the most commonly used drugs. Spraying (63%) and decoction (34%) were the two main ways of preparing the recipes. These preparations were mostly prescribed externally; poultice (40%), washing (27%), sprinkling (20%) and instillation (3%) were the most commonly used application techniques. The species *M. paradisiaca*, *F. exasperata*, *D. edulis* and *P. macrocarpus* were the most cited and were selected as plants of therapeutic interest.

***Conclusion*:** These results constitute an indispensable database for the valorization of traditional medicines through studies aimed at demonstrating the pharmacological activity and safety of these plants used to treat chronic wounds in Bankim.

Keywords: Ethnobotany, medicinal plants, traditional medicine, phytotherapy, chronic wounds, Bankim

Introduction

Chronic wounds, estimated to affect nearly 6 million people worldwide in a 2007 study, are now a growing global health concern [1]. Chronic wounds are responsible for significant morbidity and mortality, particularly among the elderly, diabetics and obese [2]. Moreover, the impact on quality of life can be dramatic in everyday life, depending on the severity of the wound, if it is accompanied by discharge, pain, foul odor, etc. Functional impotence can set in, as well as social isolation and even a reactive depressive state. Very few studies have looked at the epidemiology of wounds in sub-Saharan Africa. In 2007, a multi-country community study (South Africa, Nigeria, Tanzania and Uganda) reported a prevalence of between 12 and 28.3% [3]. In Cameroon, at 2016, injuries, with a proportion of 11%, represented the third cause of death after communicable and cardiovascular diseases [4]. In rural areas of developing countries, injuries are one of the most common reasons for medical consultation [1].

The populations of the Bankim Health District are not left out. This Health District, being one of the seven in the Adamaoua Region, is characterised by a cosmopolitan, poor population suffering from numerous diseases including chronic wounds. Indeed, according to information from the health records of the District Health Service, 139 cases of chronic wounds were recorded at the Bankim District Hospital from January 2019 to December 2021. In addition, more than half of these patients had used the services of recognized traditional healers in the community before or after their stay at the hospital, and most of their treatment was based on the use of herbal recipes. It is therefore evident that despite the advances in modern health care, a significant proportion of the population in developing countries still rely on traditional medicine and herbal remedies to cure their illnesses. Similarly, in developed countries, there is public interest in seeking alternatives to modern wound healing therapies such as antibiotics, corticosteroids, etc., because of their unavailability in rural areas, high costs and side effects [1,5]. The classical systems of traditional African medicine and Cameroonian medicine in particular, use a large number of medicinal plants for the treatment of diseases. The number of plants in the world is between 350,000 and 400,000 species, of which 10% are used today in traditional medicine [6].

Moreover, only a very small number of plant species, among the 600 to 800 species recognized and used in traditional medicine in Cameroon, are associated with an ethno-medical use related to wound healing [7]. This study was undertaken to identify the plants and plant-based recipes used by some traditional healers in Bankim to treat chronic wounds.

Materials and Methods

Given the isolation and poor state of the roads, this study took place from December 2020 to February 2021 (3 months). The study population was made up of community-recognized traditional healers in wound care in the Bankim Health District (Adamaoua, Cameroon). Figure 1 below shows the Bankim Health District and its administrative boundaries.

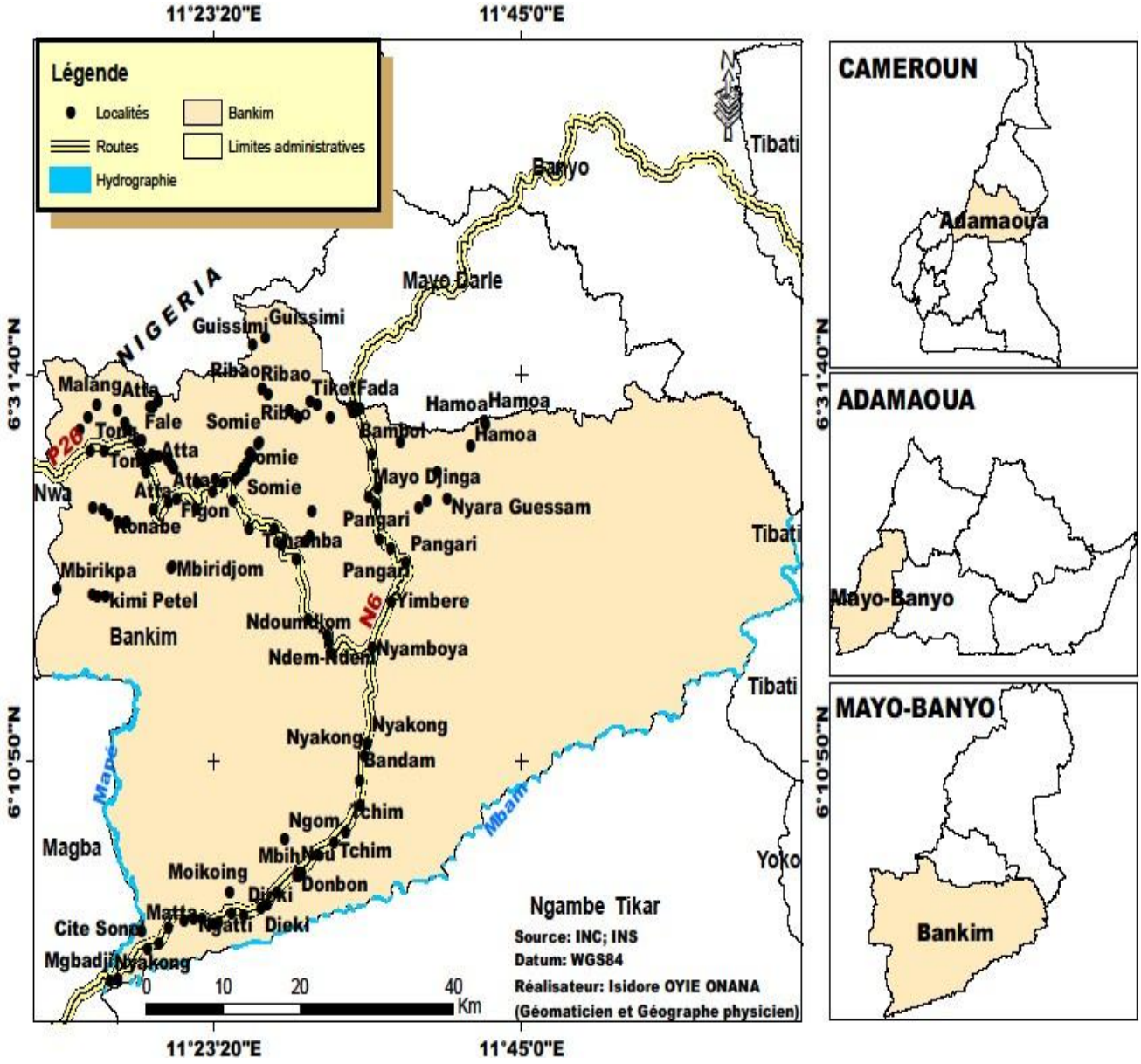

Figure 1: Geographical map of Bankim Health District

Consecutive, non-exhaustive sampling was carried out. The recruitment of traditional healers was done using the snowball method [8]. After drawing up a survey form according to the framework proposed by Adjanahoum et *al.* [9] and its validation by the research team, the

various administrative authorizations were obtained and an ethical clearance was obtained from the Institutional Ethics and Research Committee (CIER) of the Faculty of Medicine and Biomedical Sciences of the University of Yaoundé I. The list of traditional healers available in the Bankim Health District was consulted and contact with them was established thanks to the precious help of Mr Wantong Fidèle and Mr Ngneke Michel Magloire; respectively focal point and deputy focal point of neglected tropical diseases in that district.

The traditional healers were informed of the study objectives and process, and consent was obtained from each of them prior to any interview. Through direct discussions with them about the medicinal plants used in the traditional treatment of chronic wounds, as well as recordings and filming with the consent of each participant, information was collected about plants, organs of plants species collected, and methods of preparation and administration of remedies in order to describe the recipes. Subsequently, plants indicated were photographed and samples collected were checked and identified by comparison with specimens in the National Herbarium of Cameroon at Yaoundé, where the various samples were deposited.

The data obtained was coded and then saved in the Microsoft 2016 Excel spreadsheet. The graphs were produced using pivot tables. The analysis, according to Houndje et *al.* [10]. The analysis of use citations based on the calculation of the relative frequency of citations for a given use allowed the establishment of indicators on the use values attributed to plants identified. The importance of the species was assessed by their citation weight Fc, the number of similarities of use found between different informants and the therapeutic interest index. A plant or a recipe is considered similar when it is used by at least two different informants interviewed. The index of therapeutic interest (IT) was evaluated on the basis of their simple presence or absence in the different recipes indicated by informants.

Results

Characterization and distribution of traditional healers

Of the twenty traditional healers known to be specialized in the treatment of chronic wounds at Bankim, only nine, including four women (44.44%) and five men, with ages ranging from 43 to 70 years, spread over four villages (Koungui, Nyakong, Nyamboya and Ngatti) accepted to share their therapeutic knowledge. Four of the nine traditional healers were Muslims and the other five were Christians. None of the latter had received specific training and five had inherited knowledge from their parents. All of them had a primary school education. Table 1

presents the socio-demographic characteristics of the 09 traditional healers who participated in this study.

Table 1: Distribution of the 09 traditional healers treating chronic wounds at Bankim

Variables		**Number (N=9)**	**Percentage (%)**
Distribution by village	Kongui	2.0	22.22
	Nyakong	2.0	22.22
	Nyamboya	3.0	33.33
	Ngatti	2.0	22.22
Type	Female	4.0	44.45
	Male	5.0	55.55
Religion	Christian	5.0	55.55
	Muslim	4.0	44.45
Number of years in office	] 1-10]	2.0	22.22
	[11-20]	2.0	22.22
	[21-30]	3.0	33.33
	>30	2.0	22.22
Origins of knowledge	Specific training	0.0	0.0
	Self-training	2.0	22.22
	Family heritage	5.0	55.55
	Revelation	2.0	22.22
Level of study	Primary	9.0	100.0
	Secondary	0.0	0.0
	Superior	0.0	0.0

Plants used in the treatment of chronic wounds at Bankim

The ethnobotanical survey identified 30 medicinal plant species used in the traditional treatment of chronic wounds by the 09 traditional practitioners who agreed to participate in this study. These species are all of different genera and are divided into 23 botanical families of which the most represented are: Rubiaceae (03 species), followed by Caesalpiniaceae, Cucurbitaceae, Euphorbiaceae, Fabaceae and Moraceae (02 species each). Figure 2 shows the number of plant species per botanical family and Table 2, presents the species identified, the different botanical families, the vernacular names and the informants.

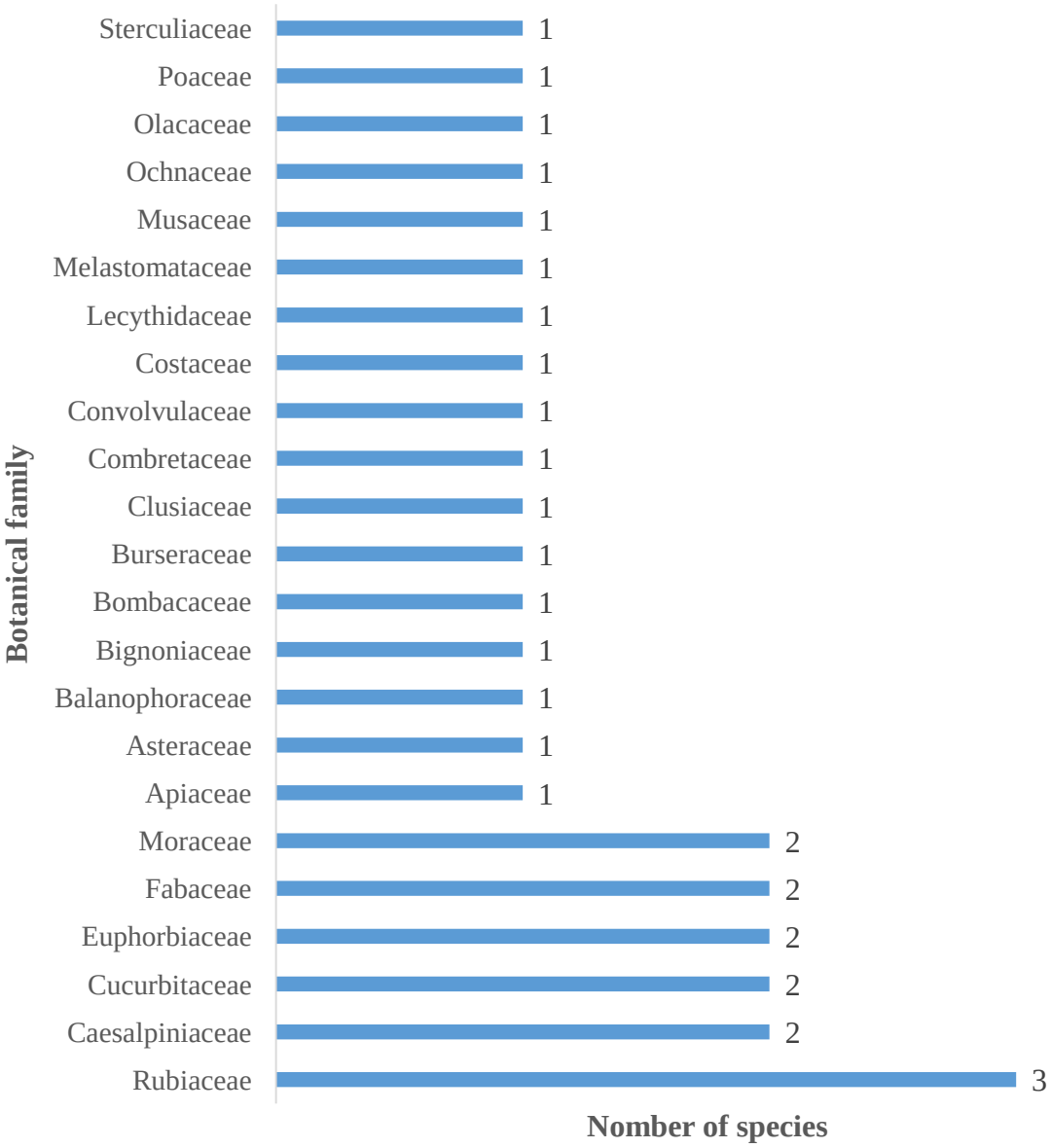

Figure 2: Distribution of species used by botanical family at Bankim

Table 2: List of plants used in Bankim to treat chronic wounds

Species	Botanical families	Local name	Biological type	Drugs	Number Informant	Total Citation
Afzelia pachyloba L.	Caesalpiniaceae	Barbarian (Bansoh) / Pachi	Tree	Barks	2 (1)	1
Albizia gummifera (J.F. Gmel.) C.A. Sm	Fabaceae	Isack	Tree	Barks	5 (1)	2
Ceiba pentandra (L.) Gaerth.	Bombacaceae	Duma	Tree	Barks	6 (1)	1
Citrullus lanatus Thunb.	Cucurbitaceae	Watermelon	Grass	Pericarp	6 and 7 (2)	2
Cogniauxia podolaena Baill	Cucurbitaceae	Mbomvae	Grass	Sheets	5 (1)	1
Costus afer Ker Gawl	Costaceae	Mamman guihiri (Bansoh)	Grass	Fruit	2 (1)	1
Dacryodes edulis H.J. Lam	Burseraceae	Gèem (Tikar)	Tree	Sheets	1, 2 and 5 (3)	2
Dichaetanthera africana (Hook.f.)	Melastomataceae	Kidondong (Bansoh)	Tree	Barks	2 (1)	1
Erythrococca africana Baill.	Euphorbiaceae	Efulkumba	Grass	Sheets	9 (1)	1
Ficus exasperata Vahl	Moraceae	Lewoe (Eton)	Tree	Sheets	6 and 7 (2)	2
Garcinia kola. Heckel	Sterculiaceae	Mbitacola	Tree	Fruit	4 (1)	1
Ipomoea aquatica Forssk.	Convolvulaceae	Mbouglan (Bansoh)	Grass	sheets	2 (1)	1
Jatropha curcas Linn	Euphorbiaceae	Toudampani (Mambila)	Shrub	Stem	1 (1)	1
Lophira lanceolata Var. Tiegh ex Keay	Ochnaceae	Mbéh; Kouéh(Tikar)	Tree	Barks	3 (1)	1
Mammea africana Sabine	Clusiaceae	Abôt/Abod zok	Tree	Barks	8 (1)	1
Melanthera scandens	Asteraceae	Wogwog	Grass	Sheets	7 (1)	1
Melinis minutiflora P. Beauv	Poaceae	Wordji (Bansoh)	grass	Whole plant	2 (1)	1
Milicia excelsa (Welw). C.C. Berg	Moraceae	Iroko	Tree	Barks	2 (1)	1
Mitracarpus scaber	Rubiaceae	Oyem ze	Grass	Sheets	9 (1)	1
Momordica cabraei (Cogn) Jeffrey	Combretaceae	Ekok	Grass	Sheets	1 (1)	1
Musa paradisiaca L.	Musaceae	Ikoane	Grass	Sheets	1,2,3,4,5,6,7, 8 and 9 (9)	16
Naucléa cf latifolia. SM	Rubiaceae	Tchôh (Tikar)	Tree	Barks	2 (1)	1
Olax sp	Olacaceae	Kambo (Tikar)	Tree	Barks	2 (1)	1
Pentaclethra macrophylla Benth.	Fabaceae	Ebaie	Tree	Barks	9 (1)	1

Petersianthus macrocarpus P.Beauv.	Lecythidaceae	Abing	Tree	Barks	6 and 8 (2)	2
Piliostigma thonningii (Schum)	Caesalpiniaceae	Kekame (Tikar)	Tree	Barks	1 (1)	1
Spathodea campanulata P. Beauv	Bignoniaceae	Evouvone	Tree	Barks	7 (1)	1
Steganotaenia araliaceae Hochst.	Apiaceae	Ndzorkaré (Mambila)	Tree	Barks	1 (1)	1
Thonningia sanguinea	Balanophoraceae	Shimkong (Tikar)	Grass	Whole plant	2 (1)	1
Tricalysia sp	Rubiaceae	Zaïe (Tikar)	Tree	Barks	2 (1)	1

Informants (Age, village): 1= Moussa Ribao (52 years, Kongui); 2= Minka Richard Fomze (52 years, Nyakong); 3= Abiba Adamou (63 years, Nyamboya); 4= Aliram Ousmaou (62 years, Nyamboya); 5= Oumarou Djagui (43 years, Nyamboya); 6= Mbongblang Josephine (67 years, Kongui); 7= Plong Olivier (70 years, Nyakong) and 9= Mboumtchi Mariama (48 years, Ngatti).

Diversity of morphological types and biological

Plants identified belonged to various morphological types of the plant kingdom. Woody species were the most represented (63%) compared to herbaceous species (37%). Trees (60%) followed by grasses (37%) and shrubs (3%) were the 03 biological types represented (Figure 3).

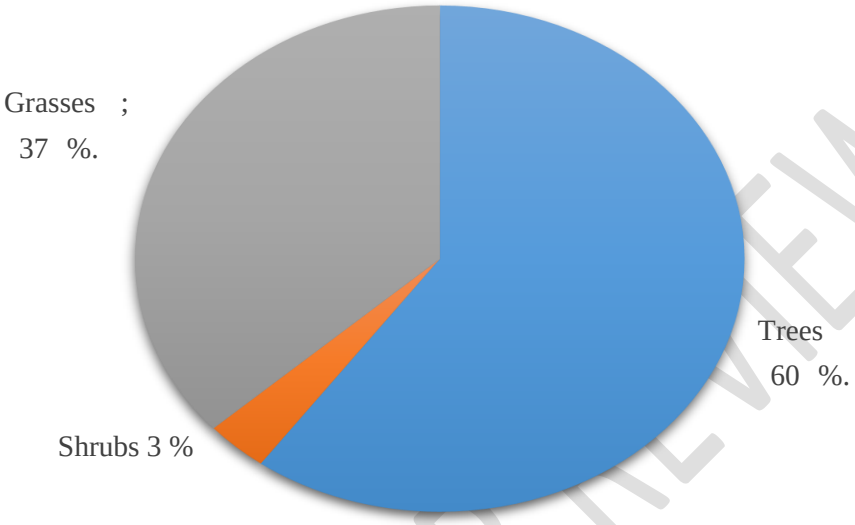

Figure 3: Biological types of plants used at Bankim

Profile of recipes used in the treatment of chronic wounds

Twenty-four recipes (R), whose composition was mono or multi specific were described (Table 3). Seventeen recipes (70.83%) consisted of a single plant species, six recipes (25%) consisted of two species (R2, R3, R5, R6, R7 and R18) and one recipe (4.16%) consisted of three species (R9).

Table 3: Description of the 24 recipes identified by 09 tradi-practitioners inBankim

Preparation procedure	Recipe number	Species	Plant drug	Informant number (No. of informants)	Method of administration
Decoction	1	*Steganotaenia araliaceae* Hochst. Var. araliaceae	Barks	1 (1)	Oral (1 glass 200ml×2/day)
	2	*Afzelia pachyloba* L		2 (1)	
		Milicia excelsa (Welw). C.C. Berg			
	3	*Nauclea* cf *latifolia*. SM		2 (1)	Washing (1 time/2days)
		Olax sp			
	4	*Pentaclethra macrophylla*		9 (1)	
	5	*Ceiba pentandra*		6 (1)	
		Petersianthus macrocarpus			
	6	*Spathodea campanulata*		7(1)	
		Albizia gummifera			
	7	*Petersianthus macrocarpus*		8 (1)	
		Mammea africana			
	8	*Albizia gummifera* (J.F. Gmel.) C.A. Sm.		5 (1)	
Spraying	9	*Costus afer* Ker Gawl	Fruit	2 (1)	Instillation (1 time/2days)
		Ipomoea aquatica Forssk.	Sheets		
		Thonningia sanguinea	Sheets		
	10	*Dacryodes edulis* H.J. Lam	Sheets	1,2 and 5 (3)	Cataplasm (1 time/2days)
	11	*Ficus exasperata* Vahl	Sheets	6 and 7 (2)	
	12	*Citrullus* lanatusThunb.	Pericarp	6 and 7 (2)	
	13	*Melanthera scandens*	Sheets	7 (1)	
	14	*Erythrococca africana*	Sheets	9 (1)	
	15	*Mitracarpus scaber*	Sheets		
	16	*Dichaetanthera africana* (Hook.f.) Jacq.Fel	Sheets	2 (1)	

	17	*Cogniauxia podolaena Baill*	Sheets	5 (1)	
	18	*Milicia excelsa (Welw). C.C. Berg*	Barks	2 (1)	Sprinkling (1 time/2 days)
		Tricalysia sp			
	19	*Melinis minutiflora* P. Beauv	Sheets	2 (1)	
	20	*Lophira lanceolata* Var. Tiegh ex Keay	Barks	3 (1)	
	21	*Garcinia kola. Heckel*	Fruit	4 (1)	
	22	*Piliostigma thonningii* (Schum) Milue-Redh	Barks	1 (1)	
Blaze	23	*Musa paradisiaca* L.	Sheets	1,2,3,4,5,6,7,8 and 9 (9)	Cataplasm (1 time/2days)
No	24	*Jatropha curcas* Linn	Stem (sap)	1 (1)	Instillation (1 time/2days)

Informants: 1= MOUSSA RIBAO; 2= Minka Richard Fomze; 3= Abiba Adamou; 4= Aliram Ousmaou; 5= Oumarou Djagui; 6= Mbongblang Joseph; 7= Plong Olivier and 9= Mboumtchi Mariama.

Plant drugs used in the preparation of recipes

Various plant parts were used in the preparation of recipes. Bark (50%), followed by leaves (30%) are the most commonly used plant drugs. Fruits (10%), the whole plant (7%) and the stem (3%) are the least used plant organs (Figure 4).

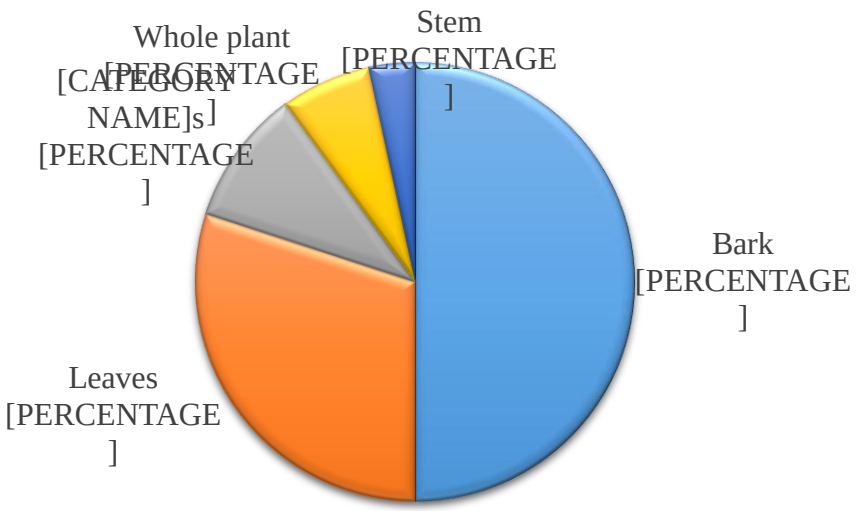

Figure 4: Proportion of plant drugs used

Preparation of recipes

Figure 5 shows the different ways in which the recipes were prepared. Several techniques were used by the 09 informants to prepare the different recipes. Spraying (63%) and decoction (34%) were the two main methods of preparing the herbal recipes. However, there are recipes that do not require any prior preparation before administration (3%).

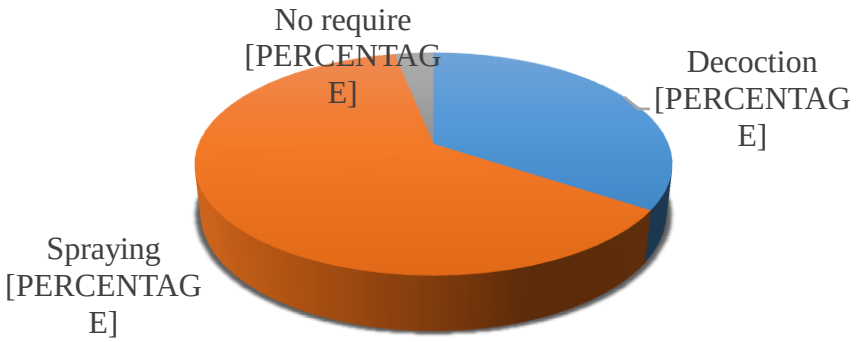

Figure 5: Recipe preparation techniques

Methods of administration of preparations

Various methods of administration of the preparations were used (Figure 6). The external route was the main means of administration. Thus, poultice (40%), washing (27%), sprinkling (20%) and instillation (3%) were the most commonly used application techniques.

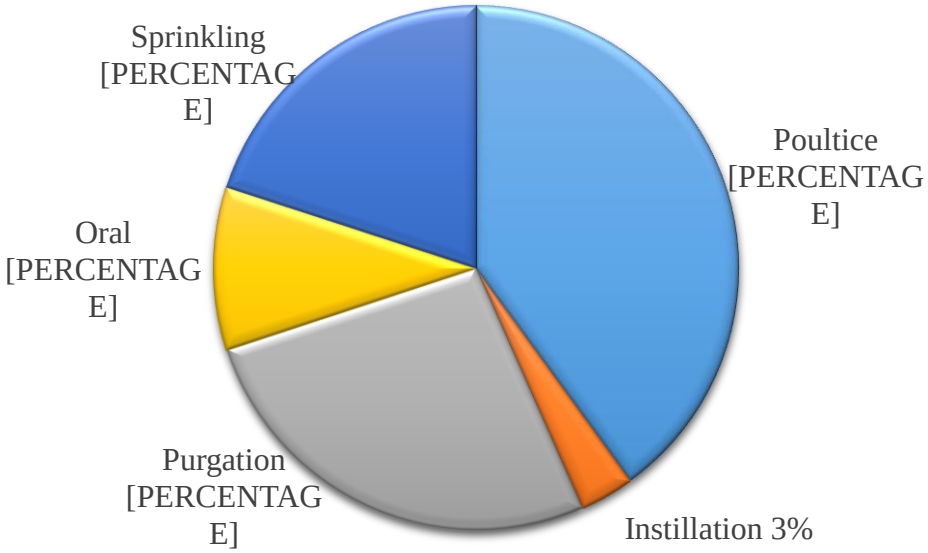

Figure 6: Diversity of routes of administration of herbal preparations

Analysis of the therapeutic value of plants used for the treatment of chronic wounds according to the 09 informants

Of the 30 species recorded, five appeared to be important because they were used by at least two informants: *Musa paradisiaca* (09 informants), *Petersianthus macrocarpus*, *Ficus exasperata*, *Dacryodes edulis* and *Citrullus lanatus* (two informants respectively). Each of the other 25 species was used by only one informant (Table 3). A total of 51 citations were recorded. The most cited species were *M. paradisiaca* (16 citations), followed by *D. edulis* (03 citations), *F. exasperata*, *P. macrocarpus*, *C. lanatus* and *A. gummifera* (with 2 citations respectively). The other 24 species were mentioned only once (Table 2). The analysis of the therapeutic interest (TI), based on the simple presence or absence of species in the recipes (Table 4), makes it possible to retain two species of interest, as they are used in at least two recipes and have a TI index > 0.04. These are: *Milicia excelsa* and *Petersianthus macrocarpus* (IT= 0.09 for each). However, these species are among those used in the preparation of multispecific recipes.

Table 4: Therapeutic value of plants used in the traditional treatment of chronic wounds at Bankim

	Nb Cit	**Nb Inf**	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**	**R12**	**R13**	**R14**	**R15**	**R16**	**R17**	**R18**	**R19**	**R20**	**R21**	**R22**	**R23**	**R24**	**Total**	**IT**
Afzelia pachyloba	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0,04
Albizia gummifera	2	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0,04
Ceiba pentandra	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0,04
Citrullus lanatus	**2**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0,04**
Cogniauxia podolaena	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0,04
Costus afer	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0,04
Dacryodes edulis	**3**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0,04**
Dichaetanthera africana	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0,04
Erythrococca africana	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0,04
Ficus exasperata	**2**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0,04**
Garcinia kola	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0,04
Ipomoea aquatica	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0,04
Jatropha curcas	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0,04
Lophira lanceolata	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0,04
Mammea africana	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0,04
Melanthera scandens	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0,04

Melinis minutiflora	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0,04
Milicia excelsa	**1**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0,09**
Mitracarpus scaber	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0,04
Momordica cabraei	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0,04
Musa paradisiaca	**16**	**9**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**0,04**
Naucléa cf latifolia	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0,04
Olax sp	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0,04
Pentaclethra macrophylla	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0,04
Petersianthus macrocarpus	**2**	**2**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2**	**0,09**
Piliostigma thonningii	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0,04
Spathodea campanulata	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0,04
Steganotaenia araliaceae	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0,04
Thonningia sanguinea	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0,04
Tricalysia sp	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0,04
Total	51	9	1	2	2	1	2	2	2	0	3	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	32	1,40

Therapeutic interest (TI) = presence (1) / absence (0) in recipes that do not share the same plants; C = citation in absolute frequency; R = recipe; Nb Cit= Number of citations; Nb Inf= Number of informants.

DISCUSSION

The aim of this study was to contribute to the valorization of plants used by traditional therapists at Bankim to treat chronic wounds in humans. There were many difficulties in carrying out this work, including the reluctance of the informants despite the assurances and explanations given. The traditional healers were very reserved about the information about the plants and recipes. Some had asked to be compensated before participating; others had refused to participate in the study because their knowledge was a trade or family secret.

The ethnobotanical survey was possible thanks to the collaboration of many actors, including nine traditional healers in four villages of the Bankim Health District. The age of these traditional healers ranged from 30 to 70 years, which is similar to the work carried out by Togola et *al*. [11] and could be justified by the fact that the majority of the elected officials become or inherit traditional knowledge only after the death of their mentors who, for the most part, are relatives, as in the present study where 55.55% of the traditional medical knowledge emanated from an ascendant. This would reflect the fact that knowledge of traditional medicine is transmitted from generation to generation in a much more oral manner and thus acquisition by inheritance is the most common process. This oral transmission could be explained by the low level of education, or even the absence of it, as noted in the present study where 100% of the respondents had a primary level of education. Thus, the lack of writing could be a danger for the durability of this ancestral medical knowledge, hence the need to initiate such research.

These traditional healers specialized in the treatment of chronic wounds at Bankim use a rich and diversified phytopharmacopoeia. The families Rubiaceae (03 species), followed by Caesalpiniaceae, Cucurbitaceae, Euphorbiaceae, Fabaceae and Moraceae (02 species each) were the most represented; these families are among those with a high representation of medicinal plants according to the results of numerous ethnopharmacological studies [12,13]. Among the 30 plant species identified and traditionally used in the preparation of 24 recipes for the treatment of chronic wounds, *M. paradisiaca* (16 citations), followed by *F. exasperata*, *D. edulis* and *P. macrocarpus* (with 2 citations each) were the most cited. All these medicinal species are well known in traditional medicine in Cameroon and Africa in general and are used to treat many ailments and or manifestations (symptoms) such as: malaria, diabetes, jaundice, scabies, headache and fevers, wounds, ascites, epilepsy, skin rashes, gonorrhoea, intestinal worms, hypertension, typhoid [14,15]. However, it is important

to note that the healing activity of four plants among the thirty listed has been demonstrated through numerous study models; these are *J. curca* (barks and leaves), *M. paradisiaca* (stem and fruit), *N. latifolia* (barks) and *S. campanulata* (barks) [12].

The therapies proposed by the Bankim traditional healers are diversified. Twenty-four (24) recipes based on one or more plants or plant parts were described. Various plant parts were used in the preparation of the recipes. Bark (50%), followed by leaves (30%) were the most commonly used plant drugs. The interest in barks would find an explanation in the fact that they are the storage site of secondary metabolites or basic materials that protect the organism and are responsible for the biological properties of the plant; in comparison to the leaves which, on the other hand, are the biosynthesis (Photosynthesis) site of secondary metabolites [16]. The preponderance of barks and leaves in the recipes proposed at Bankim is a characteristic feature, also noted by some similar studies in Cameroon or in Africa [13,15]. The importance of these plant drugs in the preparation of recipes can be directly related to the morphological types of species used, which showed a clear dominance of woody species over herbaceous ones and for which the most exploited organs are the barks followed by the leaves.

Several techniques were used to prepare the different recipes. Spraying (63%) and decoction (34%) were the two main methods of preparing the herbal recipes. Decoction was the only preparation method for bark and water was the only solvent used for this process. Indeed, water is ranked as one of the best extraction solvents and appears to be the solvent for extracting the majority of chemical constituents from a plant [17]. The work of Kouadjo *et al*. in Côte d'Ivoire [13] and Bayaga et *al*. in Cameroon [18] also underline the preponderance of this method of preparation, which seems to have the advantage of extracting the maximum amount of soluble, non-heat-sensitive plant substances. Moreover, according to the traditional therapists surveyed, the decoction was intended for disinfecting the wound and thus allowed the preparation to be kept longer, compared to a cold process such as maceration, for which the recipes were prepared without the addition of solvent and used immediately.

The preparations were mostly prescribed externally; poultice (40%), washing (27%), sprinkling (20%) and instillation (3%) were the most commonly used application techniques. This observation is similar to the results of Bayaga et *al*. at Akonolinga [18] and contrary to those of many other authors [13,15] who have shown that the oral route is the most popular route of administration in traditional medicine. This difference could be explained by the fact

that wound treatment mainly requires local management of the lesion, with antibiotics and other parenteral oral treatments only used in case of complication or necessity.

Seven of the 24 recipes were multi-species, consisting of at least two plant species. Several studies carried out on traditional treatments in Africa highlight this complexity in the preparation and content of traditional remedies, which rarely include a single plant. However, this form of association of various medicinal species in treatments could present risks of interactions or toxicity according to Yemoa *et al*. [19]. In contrast, Fleurentin et *al*. [20] emphasized that the real therapeutic activities of medicinal plants cannot be explained by the presence of one or other of the constituents alone. Indeed, in these complex mixtures of molecular soups of extracts of various plants, it is the association or synergy between the constituents that is very often responsible for the desired effect. For these authors, whatever the medicinal plant considered, it can be stated without error that its effects are never due to a single molecule acting on a single target; it is always a cocktail of molecules of very diverse chemical structures acting at several levels in combination, some of which are indirectly active or facilitate the activity, and which participate directly in the observed effect. These mixtures of complex, potentially synergistic molecules have always been difficult to work with, but recently, the ethnopharmacological approach, equipped with new conceptual paradigms and new analytical tools, can now once again rethink the activity of remedies as complex, interactive ensembles. This ethnopharmacological reasoning, which has a predominant place in the search for new treatments of tomorrow, is therefore placing increasing emphasis on mixtures, synergies, pro-drugs, and all molecules with activity-modulating effects, with the main challenge being to take an interest in complex preparations and what they can provide in terms of new avenues for devising multi-component treatments or multi-therapies, which are more effective and less iatrogenic compared to the current synthetic medicines.

Thus, taking into account the use and the therapeutic objective of each recipe on the one hand, and on the other hand, the probable interactions that may exist between the different plant species involved in their preparation, *Musa paradisiaca, Ficus exasperata, Dacryodes edulis* and *Citrullus lanatus* were selected as plants of interest whose extracts should be the subject of

Phytochemical and Pharmacological studies in order to justify their use in the treatment of numerous ailments such as wounds. Various parts of *D. edulis* are used in the treatment of several diseases in different regions. In Gabon, the bark of the plant is used to treat wounds

[21] In Gabon, the bark of the plant is used to treat wounds; a decoction of the bark is taken orally for the treatment of leprosy and also used as a gargle and mouthwash for the treatment of tonsillitis in the Democratic Republic of Congo [22]; leaf sap has been reported to be used as an ear drop to treat otitis and the steam produced by decoction of the leaves is used to treat fever and headaches [22,223]. The resin from the bark is used in Nigeria to treat parasitic skin diseases [24]. The leaves are often crushed and the juice is used to treat generalized skin diseases such as ringworm, scabies, rashes, etc. while the stem and twigs are used as chewing sticks for oral hygiene [25]. The seed is chewed by the Tiv people (Nigeria) as a remedy for digestive disorders such as diarrhoea, dysentery, etc [26]. Many studies have revealed that all parts of *M. paradisiaca* have medicinal uses [27,28]. The flowers are used to treat diabetes, bronchitis, dysentery, menorrhagia and ulcers [29]. The astringent sap of the plant is administered in hysteria, epilepsy, leprosy, fevers, haemorrhages, dysentery and diarrhoea, and is applied to haemorrhoids, insect bites and stings and others. The young leaves are placed in a poultice on burns and other skin conditions. The astringent ashes of the unripe skin and leaves are taken in dysentery and diarrhoea and are also used against malignant ulcers. The roots are administered in digestive disorders, dysentery and other ailments. The plant is also used against inflammation, pain and snakebite. In traditional medicine, various parts of *Ficus exasperata* are used as analgesic, anti-arthritic, diuretic, antioxidant, anti-cancerous, healing, antiparasitic, abortifacient, anti-haemorrhoidal, anti-diabetic and for the treatment of venereal diseases [30,31]. Many studies have revealed the use of *Citrullus lanatus* in traditional medicine. The fruit is used as a tonic, aphrodisiac and blood purifier while the seeds are used to treat urinary tract infections, enuresis, dropsy and kidney stones [32-35].

CONCLUSION

In the traditional management of chronic wounds at Bankim, the nine volunteer traditional healers used 30 plant species divided into 23 botanical families. These plant species are used in the preparation of 24 single or multi-specific recipes. *Musa paradisiaca*, *Ficus exasperata*, *Dacryodes edulis* and *Citrullus lanatus* were selected as plants of interest whose extracts should be the subject of phytochemical and pharmacological studies in order to justify their traditional use.

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