

# Medicinal plants use in central Togo (Africa) with an emphasis on the timing

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## ABSTRACT

**Background:** Plant-based remedies continue to play a key role in the health care of people in Togo; however, there is a lack of published data in medicinal plants and medical practices of the people in the country. **Objective:** This study was aimed at documenting the plant utilization in the *Tem* folk medicine in the central region of Togo. **Materials and Methods:** An ethnobotanical survey was conducted with traditional healers in the central region of Togo using a semi-structured questionnaire. **Results:** This study demonstrated that local specialists in the central region of Togo tend to agree with each other in terms of the plants used to treat diabetes (ICF = 0.38), infertility, and abdominal pains (ICF = 0.33), but cite a much more diverse groups of plants to treat problems related to arterial hypertension, sickle cell disease, and abscess. They use 144 herbal concoctions made of 72 plants, distributed among 36 botanical families. The Euphorbiaceae family with eight species was best represented in terms of the number of species. The species with the highest use value were *Khaya senegalensis* (Desr.) A. Juss. (Meliaceae) (UV = 0.36), *Anthocleista djalonsensis* A. Chev. (Gentianaceae) (UV = 0.27), *Trichilia emetica* Vahl (Meliaceae) (UV = 0.25), and *Sarcocephalus latifolius* (Sm.) E. A. Bruce (Rubiaceae) (UV = 0.21). They also rely on the timing in the plant processing and the administration of herbal remedies. **Conclusion:** All these findings are based on empirical observations; laboratory screenings are needed to check the effectiveness of these plants.

**Key words:** Chronobiology, chronotherapy, folk medicine, herbal concoctions, plant administration, traditional healers

## INTRODUCTION

Plants have formed the basis of traditional medicine (TM) that was used thousands years ago by human beings. Until today plant-based medicine continues to play a key role in the healthcare systems of the developing countries, where modern drugs are not usually affordable.<sup>[1,2]</sup> Indeed, it has been estimated that up to 80% people only rely on TM for their primarily health care in Africa.<sup>[3]</sup> The massive use of plants is encouraged by their efficiency, their availability, and the low cost of herbal concoctions.<sup>[4,5]</sup> Although many plants have been screened with success for several biological activities,<sup>[6-9]</sup> some plants have proven very toxic.<sup>[10,11]</sup> Recently, our team identified some critical points in the plant processing and several risks related to

the ingestion of contaminated herbal concoctions.<sup>[12]</sup> The adverse effects consecutive to the administration of some plant remedies were also listed although this was only based on the empirical observations of the traditional healers (TH).<sup>[13]</sup>

The studies addressing the toxic effects of herbal concoctions have been often focused on the modification of physiological and histological parameters consecutive to the administration of the drugs regardless to the time of administration.<sup>[14-16]</sup> A few studies have discussed the “timing” factor in the harvest of plant materials, in the preparation, and the administration of the herbal concoctions.<sup>[17,18]</sup> Yet this factor may play an important role in the diagnosis, treatment, healing, and poisoning associated with taking medication.<sup>[19-21]</sup> In fact, in humans and in plants, there are regular successions of high and low biological activities during the 24 h or even during a year.<sup>[22]</sup> The susceptibility of an organ or a tissue depends on the timing of drug administration.<sup>[17,22]</sup> In addition,

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the synthesis of enzymes and active principles in plants evolves in a time-dependent manner.<sup>[15]</sup> For a given drug and for a given organism, there are some moments of less therapeutic effects or toxicity, thus the administration of medicine regardless of the time would expose the patient to undesirable effects.<sup>[21,23]</sup>

The purposes of this study were to document the plant utilization and to evaluate the importance of the “timing” factor in the diagnosis, the harvest of the plant materials and the administration of drugs in the TM of *Tem* tribe native from the central region of Togo.

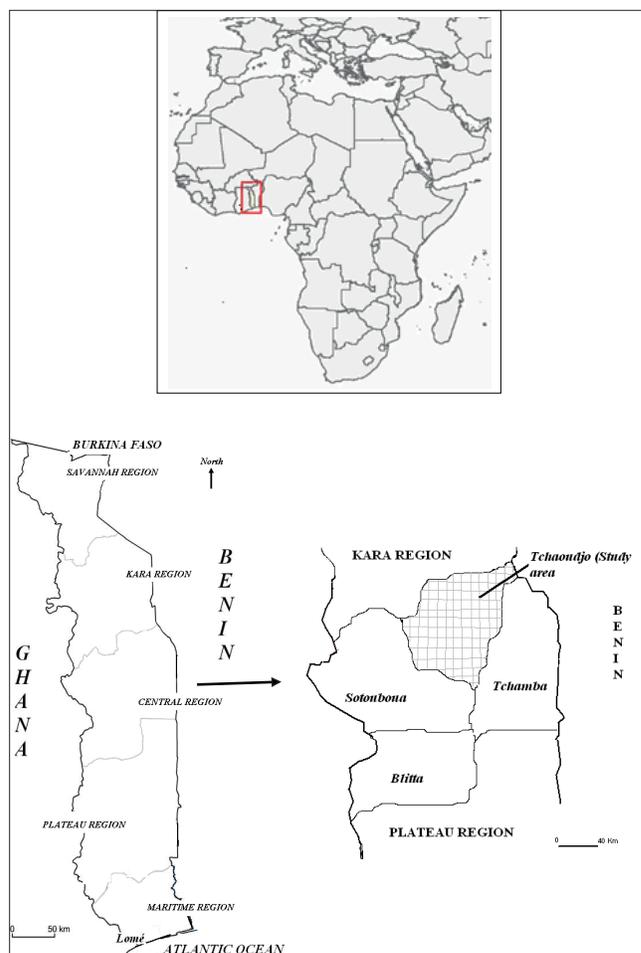
## MATERIALS AND METHODS

### Study area

Togo is a western African country lying between the Republic of Burkina Faso in the north, the Republic of Benin in the east, the Republic of Ghana in the west, and the Atlantic Ocean in the south. The country is divided into five economic regions from the north to the south: the Savannah Region, Kara Region, the Central Region, Plateaux Region, and the Maritime Region. The Central Region is located between 0°15'–1°35' north and 8°–9°15' east. It is made up of four prefectures: Tchaoudjo, Tchamaba, Sotouboua, and Blitta [Figure 1], and is bordered to the north by the Kara Region, to the west by the Republic of Ghana, to the East by the Republic of Benin and to the south by the Plateaux Region. It consists of a total area of 13 430 sq. km and occupies approximately 23.73% of the total 56,6000 sq. km. land area of Togo mainland. The region belongs to the tropical zone with one rainy season from April to October and one dry season from October to March. It receives 1200–1500 mm total rainfall annually. The annual temperatures are between 20 and 32 °C. The vegetation is essentially constituted of tree and bush savannah with excellent biodiversity of medicinal plants. This study was carried out in the Tchaoudjo prefecture. The prefecture is inhabited by 180,400 people, the main ethnic groups being the *Tem* people.<sup>[24]</sup> They are mainly muslims; and agriculture and trade are their principal activities.

### Data collection

Direct interviews with 73 TH were performed between March and July 2009 using a semi-structured questionnaire, after their informed consent. Each TH was asked to sign a consent form certifying his/her agreement with the form which was edited to explain the importance of the information they would provide. All TH were members of the Study and Research in Applied Traditional Medicine Centre of the Central Region in Togo (CERMETRA-RC). CERMETRA-RC is a non-governmental organization created in August 2001. The organization involves TH of the four prefectures of the Central Region in Togo. The



**Figure 1:** Maps Africa showing Togo, Central Region and the study area

goals of CEMETRA-RC are the training and the counseling of the TH about the management of the patients and the preservation of the environment, principally the protection of vulnerable species used in TM. The organization has a centre where the TH follow up their patients and a botanic garden where they grow desired species.<sup>[24]</sup> The organization works in collaboration with researchers of University of Lomé. The interviewed TH were from the Tchaoudjo prefecture [Figure 1]. Questions asked were about:

- i. TH identity, i.e. name and surname, sex, age;
- ii. Educational level;
- iii. Origin of the knowledge;
- iv. Status of the TH, i.e. full time professional TH or partially time professional TH;
- v. The disease, i.e. name of the disease in the local language;
- vi. Remedies, i.e. remedy name, number of plants in the remedy, local names of the plants, used parts, remedy formulation, administration route;
- vii Importance of the timing in the diagnosis, plants collection, medicine administration, and therapy.

## Plant identification

After interviews, preliminary identification of the plants was done in the field by a botanist. Afterwards, herbarium specimens were prepared and photographs were taken to aid in the confirmation of the identity of the plants. Plant identities were confirmed by comparison with available voucher specimens in the Herbarium by Professor Akpagana of the Botany Department, University of Lomé, using taxonomic keys of online databases of the West African Plants Database on the website: [http://www.westafricanplants.senckenberg.de/root/index.php?page\\_id=5](http://www.westafricanplants.senckenberg.de/root/index.php?page_id=5). Nomenclature of species was done using the online data base of the IPNI website: <http://www.ipni.org/ipni/plantnamesearchpage.do>.

## Data analysis

An Excel spread sheet was used to make simple calculations and determine plant frequencies. The informant consensus factor (ICF) was calculated for each category to identify the agreements of the informants on the reported cures for diseases. The ICF was calculated by recording the number of use citations in each category (Nuc) minus the number of species used (Ns), and divided by the number of use citations in each category minus one.<sup>[25,26]</sup>

$$ICF = (Nuc - Ns) / (Nuc - 1)$$

The use value (UV), a quantitative method that demonstrates the relative importance of species known locally, was calculated according to the following formula:<sup>[27]</sup>

$UV = \Sigma U/n$ , where UV is the use value of a species;  $\Sigma U$  is the total number of citations per species, and  $n$  the number of informants. These data are helpful in determining the plants with the highest use, most frequently indicated in

the treatment of an ailment.<sup>[28]</sup>

## RESULTS

### Socio-cultural habits of the traditional healers

A total of 73 TH, 61 men and 12 women were interviewed. The average age of TH was  $53.29 \pm 11.47$  years. The minimum age was 24 years, and the maximum 92 years. All the TH were from the *Tem* tribe, and all of them speak the local language, “*Kotokoli*”, in which interviews were conducted. More than 50% of the TH could read and write French. The majority of them (80%) claimed that they inherited the medicinal practice from their family. They were mainly farmers but the exercise of the TM was their first occupation. Table 1 displays the detailed socio-professional habits of the healers.

### Consensus factor among specialists

The highest ICF values were linked to problems related to diabetes mellitus (0.38), abdominal pains and intestinal parasites (0.33), delivery and female problems (0.31), and male infertility and impotence (0.30). The categories with the lowest ICF value were abscess (0.05), witchcraft and mental illness (0.00), and sickle cell disease (0.00). The number of used species varied considerably among categories. The treatments of abdominal pains and intestinal parasites, malaria and headache, and hemorrhoids required the highest number of species (55.56%, 52.78%, and 43.06%, respectively). A more detailed description of each category is presented in Table 2.

**Table 1: Socio professional data of the traditional healers**

Sex	Males	Females		
Respondents	61	12		
Percentages	83.56	16.44		
Ages groups	20–30 years	31–40 years	41–50 years	≥51 years
Respondents	6	9	21	37
Percentages	8.22	12.33	28.77	50.68
Educational level	Illiterates	Primary	Secondary	University
Respondents	32	27	13	1
Percentages	43.83	36.99	17.81	1.37
Origin of the knowledge	Familial heritage exclusively	Divine revelation exclusively	Initiation from a TH exclusively	Other
Respondents	61	7	3	2
Percentages	83.56	9.59	4.11	2.74
Status of the TH	Full time TH professional	Partially TH professional		
Respondents	65	8		
Percentages	89.04	10.96		
Religion of the TH	Moslem	Animist		
Respondents	62	11		
Percentages	84.93	15.07		

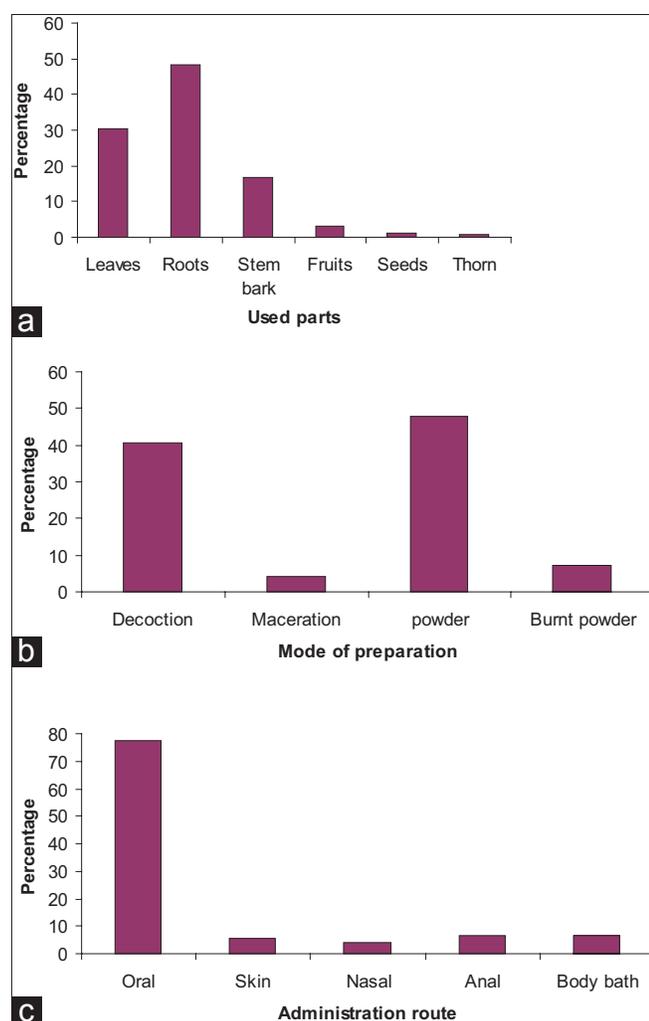
**Table 2: Informant consensus factor categorized by medicinal use**

Categories	Species	% All species	Citations	% All use citations	ICF
Abdominal pains and intestinal parasites	40	55.56	59	18.50	0.33
Hemorrhoids	31	43.06	40	12.54	0.23
Malaria and headache	38	52.78	43	13.48	0.12
Epilepsy	22	30.56	28	8.78	0.22
Delivery and female problems	19	26.39	27	8.47	0.31
Abscess	21	29.17	22	6.90	0.05
Witchcraft and mental illness	28	38.89	28	5.33	0
Sickle cell disease	14	19.44	14	4.39	0
Male infertility and impotence	8	11.11	11	3.45	0.30
Hypertension	10	13.89	11	3.45	0.10
Diabetes	6	8.33	9	2.82	0.38

### Local specialists and medicinal plants

This study allowed the identification of 144 herbal concoctions made of 72 plants, distributed among 36 botanical families. The Euphorbiaceae family, with eight species was best represented in terms of the number of species, followed by Fabaceae—Mimosoideae (five species), Fabaceae—Caesalpinoideae, Fabaceae—Faboideae and Meliaceae (four species each). When analyzing the number of citations for the plant parts used to prepare local remedies, a preference for the use of roots (48.21%), leaves (30.36%), and stem bark (16.67%) was noticeable [Figure 2]. The use of seeds, fruits, and thorn was less common. With regard to the formulation, the use of powders had the highest relative value (47.60%), followed by the use of decoctions (40.87%). The main route of administration is oral, accounting for 70.55% remedies. The other routes such as anal, body bath, and direct application on the skin account for less than 10% each [Figure 2].

Table 3 displays the used species, the use values, and the



**Figure 2:** Used parts, mode of preparation and mode of administration of herbal concoctions in the Tem folk medicine

mode of administration. The species with the highest use value was *Khaya senegalensis* (Desr.) A. Juss., local name “Frimou”, with an UV value of 0.36. The main importance of the plant is related to its use in the treatment of hemorrhoids, malaria, sickle cell, stomachache, hypertension, epilepsy, female infertility, and diabetes. The roots, the stem bark, and the leaves of the plant are used in the form of decoction or powder, administrated by anal or oral rout. *Anthocleista djalonenis* A. Chev., called “Assoubobissaou” had the second highest UV (0.27). Its main medicinal uses are the treatments of hypertension, hemorrhoids, syphilis, female infertility, diabetes, hernia, and male infertility. The roots, the stem bark, and the leaves of the plants are used in concoctions including powders, decoctions, and macerations. The main mode of administration includes the oral, anal, and body bath. *Trichilia emetica* Vahl, locally known as “Adjindjinkpizou” was ranked third with UV of 0.25. The plant is used in the treatment of hemorrhoids, mental illness, epilepsy, abscess, typhoid fever, malaria, hypertension, witchcraft, and the trouble of sight. The main used parts are the leaves and the roots in the form of powder, decoction, and maceration. The concoctions are administrated by oral rout or direct application on the skin or by body bath. *Sarcocephalus latifolius* (Sm.) E. A. Bruce known as “Kidjitchilou” with an UV value of 0.21 was ranked fourth. The plant is used in the treatment of epilepsy, hemorrhoids, sinusitis, sickle cell, witchcraft, female infertility, abscess, abdominal pain, and malaria. The concoctions involved the roots, the fruits, and the leaves of the plants in the form of powder and decoction administrated by direct application on the skin, by oral rout or body bath.

### The “timing” factor in the development clinical symptoms of several diseases

According to the interviewed TH, the peak of clinical symptoms varies in the time and according to the disease [Table 4]. The appearance of a repetitive clinical symptom at a particular moment of the day and/or the year may be important to diagnose the disease. Six diseases were cited for this purpose. According to Table 4, the peak of the harmful effects of epilepsy is in the full moon and the occurrence of the symptoms seems to follow a circamensual rhythm. The peak of harmful effects of abscesses and mental illnesses occurs in the middle of the night resting phase, following a circadian rhythm. The same is true for the development of hypertension and asthma with an acrophase at the end of the resting phase at night. A seasonal peak characterizes the evolution of the clinical manifestations of the sickle cell disease.

### The “timing” factor in the harvesting of medicinal plants

According to our investigations, for the same plant, the

**Table 3: Medicinal plants and therapeutic indications**

Scientific name	Voucher specimen number	Local name	UV	Organs	Mode of preparation	Route	Indications
AMARANTHACEAE							
<i>Alternanthera pungens</i> Kunth	1815*	Sowasowa	0.03	L	Dec/mac	Oral	Malaria, hemorrhoids
ANACARDIACEAE							
<i>Anacardium occidentale</i> L.	4692FDS/UL	Atcha	0.01	R	Pw	Oral	Epilepsy
<i>Mangifera indica</i> L.	01797TG Cit/AK	Mango	0.04	Sb L	Dec Dec	Oral Oral	Witchcraft, stomachache Malaria
ANNONACEAE							
<i>Annona senegalensis</i> Pers.	2179FDS/UL	Tchoutchoudè	0.11	R	Pw/dec	Oral	Stomachache, constipation, ulcer, mental illness, female infertility
ARECACEAE							
<i>Borassus aethiopum</i> Mart.	1830*	Kpirou	0.05	R R R	Pw Pw Mac	Nasal Oral Body bath	Headache Abscess, malaria Epilepsy
<i>Elaeis guineensis</i> Jacq.	02485TG Cit/AK	Baou	0.05	R	Pw/Dec/BPw	Oral	Epilepsy
ARISTOLOCHIACEAE							
<i>Aristolochia albida</i> Duch.	02006TG Cit/AK	Acadeyog	0.08	R R L L	Pw Pw Pw Dec	Oral Skin Nasal Oral	Constipation, hypertension Bone fracture Headache Hernia
ASTERACEAE							
<i>Acanthospermum hispidum</i> DC.	00749TG Cit/AK (*)	Kozosogan sowasowa	0.01	L	Dec	Oral	Typhoid fever
<i>Chrysanthellum indicum</i> DC.		Tchogbalayo	0.01	L	Pw	Oral	Hemorrhoids
BIGNONIACEAE							
<i>Kigelia africana</i> (Lam.) Benth.	1816*	Abliou	0.12	Sb L R	Pw/Dec Dec Pw	Oral Oral Oral	Male infertility, hemorrhoids, trouble of lactation, witchcraft Hemorrhoids Hemorrhoids, abscess, female infertility
<i>Stereospermum kunthianum</i> Cham.	1817*	Sogbeliya	0.08	R Sb	Dec/Pw Dec	Oral Oral	Stomachache, mental illness, abscess, male infertility, female infertility Female infertility
FABACEAE— CAESALPINIOIDEAE							
<i>Burkea africana</i> Hook.	1818*	Digbagbati	0.07	R R Sb L	Pw Pw Dec BPw	Skin Oral Oral Oral	Abscess, bone fracture Sickle cell Syphilis Epilepsy
<i>Cassia occidentalis</i> L.	1819*	Kitchemtchem	0.05	L L R	Pw BPw Dec/Pw	Oral Oral Oral	Constipation Malaria Epilepsy, abscess
<i>Erythrophleum africanum</i> (Welw. ex Benth.) Harms	1820*	Kékéou	0.03	L R	Pw Pw	Skin Oral	Snakebite Hemorrhoids
<i>Piliostigma thonningii</i> (Schumach.) Milne-Redh.	0469 FDS/UL	Baco	0.14	R R Sb	Pw Pw/Dec Dec/Pw	Anal Oral Oral	Hemorrhoids Mental illness sinusitis, fibroids, intestinal parasites, witchcraft Malaria, epilepsy
CARICACEAE							
<i>Carica papaya</i> L.	00340TG Cit/AK	Borofoudé	0.11	R Fr Sd Sd L L	Pw/Dec BPw Dec BPw Dec Dec	Oral Oral Oral Oral Body bath Anal	Constipation, witchcraft Vaginal discharge Intestinal parasites Witchcraft Malaria Trouble of delivery

Table 3 contd...

Scientific name	Voucher specimen number	Local name	UV	Organs	Mode of preparation	Route	Indications
CELASTRACEAE							
<i>Gymnosporia senegalensis</i> (Lam.) Loes.	3738 FDS/UL	Tchintchingan	0.14	R	Dec/Pw	Oral	Epilepsy, sickle cell, abscess, stomachache, sexual weakness
				R	BPw	Oral	Malaria
				L	Pw/Dec	Oral	Typhoid fever, hernia
				Sb	Dec	Oral	Male infertility, hemorrhoids
CHRYSOBALANACEAE							
<i>Parinari curatellifolia</i> Planch. ex Benth.	1821*	Millimilou	0.05	R	Pw	Oral	Mental illness
				Sb	Dec	Oral	Witchcraft
<i>Parinari senegalensis</i> Perr. ex DC.	1822*		0.03	Sb	Dec	Oral	Syphilis
				R	Pw	Oral	Hemorrhoids
COMBRETACEAE							
<i>Pteleopsis suberosa</i> Engl. and Diels	8078 FDS/UL	Sisinon	0.05	R	Dec/Pw	Oral	Sickle cell, hemorrhoids
				Sb	Pw	Oral	Hypertension
				L	Dec	Oral	Stomachache
<i>Terminalia avicennioides</i> Guill. and Perr.	1823*	Souwo	0.04	R	Dec/Pw	Oral	Witchcraft, trouble of lactation
CUCURBITACEAE							
<i>Momordica charantia</i> L.	6182 FDS/UL	Katchalayo	0.04	L	Pw	Oral	Hemorrhoids
				L	Dec	Anal	Trouble of delivery
				R	Pw	Oral	Hemorrhoids
EUPHORBIACEAE							
<i>Bridelia ferruginea</i> Benth.	7382 FDS/UL	Kolou	0.07	R	Pw/Dec	Oral	Malaria, sickle cell, typhoid fever
				Sb	Pw	Oral	Stomachache
<i>Euphorbia hirta</i> L.	1824*	Kovoyoyilim	0.04	R	Dec	Oral	Female infertility, intestinal parasites
				L	Pw	Oral	Malaria
<i>Jatropha curcas</i> L.	1825*	Sawou kifouloumou	0.05	R	Dec/Pw	Anal	Hemorrhoids, stomachache
				L	Mac	Anal	Female infertility
<i>Jatropha gossypifolia</i> L.	CNE	Sawou kissè mou	0.04	R	Pw	Anal	Hemorrhoids, stomachache
				L	Dec	Oral	Malaria
<i>Phyllanthus amarus</i> Schumach. and Thonn.	571 FDS/UL	Sénisèniyo	0.04	R	Dec/Pw	Oral	Stomachache, abscess, malaria, hemorrhoids
				R	BPw	Oral	Witchcraft
				L	Pw	Oral	Hemorrhoids
<i>Phyllanthus muellerianus</i> (Kuntze) Exell	1826*	Librélibré	0.07	R	Pw	Oral	Epilepsy, stomachache, headache
<i>Excoecaria grahamii</i> Stapf	1827*	Katchikadou	0.11	R	Dec/Pw	Oral	Mental illness, female infertility, stomachache, trouble of lactation, yellow fever, snakebite
				Sb	Dec	Oral	malaria
<i>Flueggea virosa</i> (Roxb. ex Willd.) Voigt	008 FDS/UL	Tchacatchaca	0.11	R	Pw/Dec	Oral	Hemorrhoids, stomachache, sickle cell, epilepsy, diabetes, snakebite
				Sb	Dec	Oral	Diabetes
FABACEAE—FABOIDEAE							
<i>Phenoptera cyanescens</i> (Schumach. and Thonn.) Roberty	4409 FDS/UL	Tchèlè	0.05	Sb	Dec	Oral	Female infertility, hypertension
			0.01	L	Dec	Body bath	Malaria
				R	Pw	Oral	Epilepsy
<i>Millettia thonningii</i> (Schumach. and Thonn.) Baker	10822	Kodoliya	0.19	R	Pw/Dec	Oral	Ulcer, epilepsy, stomachache, intestinal parasites, hemorrhoids, diabetes
				R	Pw	Nasal	Headache
				R	Pw	Skin	Abscess
				Sb	Dec/Pw	Oral	Epilepsy, male infertility
<i>Pterocarpus erinaceus</i> Poir.	15 FDS/UL	Tem	0.03	R	Pw	Oral	Typhoid fever
				Sb	Dec	Oral	Hemorrhoids
<i>Xeroderris stuhlmannii</i> (Taub.) Mendonça and E.P. Sousa	10571 FDS/UL	Tchalawari	0.05	Sb	Dec /Pw	Oral	Witchcraft, fibroids
				R	Pw	Oral	Typhoid fever
				R	Pw	Oral	Epilepsy
LAMIACEAE							
<i>Hyptis suaveolens</i> Poit.	04184TG Clt/AK	Botifadini	0.05	R	Dec	Oral	Abscess
				L	Dec	Oral/body bath	Malaria

Table 3 contd...

Scientific name	Voucher specimen number	Local name	UV	Organs	Mode of preparation	Route	Indications
<i>Ocimum americanum</i> L.	04199TG Cit/AK	Kozosogan	0.01	L	Pw	Oral	Hemorrhoids
<i>Ocimum gratissimum</i> L.	3892 FDS/ UL	Kounozorou	0.08	L	BPw	Oral	Malaria
				L	Mac	Anal	Female infertility
				L	Pw	Nasal	Headache
				L	BPw	Oral	malaria
				R	Pw	Oral	Trouble of lactation, constipation
LILLIACEAE							
<i>Aloe vera</i> (L.) Burm.f.	10857	Faradjo	0.01	R	Dec	Oral	Diabetes
<i>Allium sativum</i> L.	10856	Ayo	0.03	R	Dec	Oral	Hemorrhoids
GENTIANACEAE							
<i>Anthocleista djalonensis</i> A. Chev.	2326 FDS/ UL	Assoubobiss- aou	0.27	Sb	Pw/Dec	Oral	Hypertension, hemorrhoids, syphilis, female infertility, diabetes
				L	Dec	Oral	Hemorrhoids, malaria, hernia, stomachache
				L	Mac	Anal/body bath	Female infertility, epilepsy
				R	Dec/Pw	Oral	Hemorrhoids, hypertension, diabetes, male infertility, female infertility
				R	BPw	Oral	Epilepsy
STRYCHNACEAE							
<i>Strychnos spinosa</i> Lam.	10779 FDS/ UL	Kpogbovouro	0.07	R	Pw	Oral	Witchcraft, stomachache, headache, mental illness
MELIACEAE							
<i>Azadirachta indica</i> A. Juss.	04647Tg Cit/AK	Tiyo	0.07	R	Pw	Oral	Malaria, hemorrhoids, constipation
<i>Khaya senegalensis</i> (Desr.) A.Juss.	10641 FDS/ UL bis	Frimou	0.36	L	Dec	Oral	Malaria
				R	Pw	Anal	Hemorrhoids
				R	Pw/Dec	Oral	Hemorrhoids, malaria, sickle cell, stomachache, hypertension, fainting
				Sb	Pw/Dec	Oral	Hemorrhoids, stomachache, epilepsy, female infertility, diabetes
<i>Pseudocedrela kotschyi</i> (Schweinf.) Harms	7719 FDS/ UL	Ditotorè	0.12	L	Pw	Oral	Fainting
				R	Pw/Dec	Oral	Epilepsy, mental illness, abscess, malaria, hemorrhoids
<i>Trichilia emetica</i> Vahl	308 FDS/ UL	Adjindjinkpi- zou	0.25	L	BPw	Oral	Epilepsy
				L	Dec	Oral	Stomachache
				R	Pw/Dec	Oral	Hemorrhoids, mental illness, epilepsy, abscess, typhoid fever, malaria, hypertension
				R	BPw	Oral	Witchcraft, epilepsy
				R/L	Pw	Skin	Abscess
				L	Mac	Body bath	Trouble of sight
FABACEAE— MIMOSOIDEAE							
<i>Dichrostachys cinerea</i> (L.) Wight and Arn.	299 FDS/ UL	Bouvoun	0.03	Th	Burnt Pw	Oral	Witchcraft
<i>Entada africana</i> Guill. and Perr.	1828*	N'doulou	0.05	R	Pw	Oral	Constipation, female infertility
				L	Pw	Oral	Constipation
				Sb	Pw	Oral	Sickle cell, trouble of lactation
<i>Parkia biglobosa</i> (Jacq.) R. Br. ex G. Don	9468 FDS/ UL	Soulou	0.10	R	Pw	Skin	Abscess
				R	Pw/Dec	Oral	Stomachache, epilepsy
				Sb	Dec	Oral	Epilepsy
				L	Pw	Oral	Ulcer, headache
<i>Pericopsis laxiflora</i> (Benth.) Meeuwen	2324 FDS/ UL	Tchèmany	0.12	R	Pw/Dec	Oral	Stomachache, headache, yellow fever, intestinal parasites, Sickle cell, hemorrhoids, abscess
				R	Mac	Body bath	Epilepsy
				Sb	Dec	Oral	Malaria

Table 3 contd...

Scientific name	Voucher specimen number	Local name	UV	Organs	Mode of preparation	Route	Indications
<i>Prosopis africana</i> (Guill. and Perr.) Taub.	848 FDS/UL	Kpalou	0.15	R	Pw/Dec	Oral	Epilepsy, sickle cell, abscess, stomachache, diabetes
				L	Dec	Oral	Stomachache
				Sb	Dec	Oral	Sinusitis, diabetes
MORACEAE							
<i>Ficus sur</i> Forssk.	1952*	Kilimaou	0.04	R	Pw	Oral	Hypertension, stomachache
				Sb	Pw	Oral	Sickle cell
MORINGACEAE							
<i>Moringa oleifera</i> L.	05250TG Clt/AK	Sogorogodi	0.01	R	Pw	Nasal	Headache
OCHNACEAE							
<i>Lophira lanceolata</i> Tiegh. ex Keay	1829*	Kparakpara	0.15	L	Dec	Oral	Hemorrhoids, malaria
				L	Mac	Body bath	Epilepsy
				R	Dec/Pw	Oral	Witchcraft, sexual weakness, hemorrhoids, stomachache, hypertension
POACEAE							
<i>Cymbopogon citratus</i> (DC.) Stapf	10749TG Clt/AK	Tigbé	0.01	L	Dec	Oral	malaria
<i>Imperata cylindrica</i> (L.) Raeusch.	1831*	Falalaou	0.01	R	BPw	Oral	Strengthen memory, witchcraft
POLYGOLACEAE							
<i>Securidaca longepedunculata</i> Fresen	9491 FDS/UL	Fozi	0.08	R	Pw	Nasal	Headache
				R	Pw/Dec	Oral	Abscess, malaria, hypertension, hemorrhoids
				Sb	Dec	Oral	Yellow fever
PROTEACEAE							
<i>Protea madiensis</i> Oliv.	1832*	Doudouridè	0.03	L	Dec	Oral	Stomachache
				R + Sb	Pw	Oral	Abscess
RUBIACEAE							
<i>Gardenia ternifolia</i> Schumach. and Thonn.	07354TG Clt/AK	Kaou	0.07	R	Pw	Oral	Stomachache, constipation
				R	Pw	Skin	Abscess
<i>Sarcocephalus latifolius</i> (Sm.) E.A.Bruce	07535TG Clt/AK	Kidjitchilou	0.21	R	Pw/Dec	Oral	Epilepsy, hemorrhoids, sinusitis, sickle cell, witchcraft, stomachache, female infertility
				R	Pw	Skin	Abscess
				Fr	Pw	Oral	Constipation
				L	Dec	Oral/body bath	malaria, stomachache
RUTACEAE							
<i>Citrus aurantiifolia</i> (Christm.) Swingle	02480TG Clt/AK	Akanka	0.05	Fr	Pw/Dec	Oral	Hernia, malaria, ulcer
				R	Dec	Oral	Sickle cell
<i>Zanthoxylum zanthoxyloides</i> (Lam.) Zepern. and Timler	08061TG Clt/AK	Frou	0.11	R	Dec/Pw	Oral	Epilepsy, mental illness, ulcer, abscess, witchcraft, constipation, hemorrhoids
SAPINDACEAE							
<i>Blighia sapida</i> K.D. Koenig	1833*	Kpizou	0.03	R	Pw/Dec	Oral	Sickle cell, malaria
<i>Paullinia pinnata</i> L.	08181TG Clt/AK	Fatimagoro	0.04	R	Pw/Dec	Anal	Constipation, stomachache, sickle cell
SAPOTACEAE							
<i>Vitellaria paradoxa</i> C.F. Gaertn.	9443 FDS/UL	Somou	0.14	R	Dec/Pw	Oral	Hemorrhoids, stomachache, constipation, mental illness, syphilis, abscess
				Sb	Dec/Pw	Oral	Female infertility, hypertension, hemorrhoids
				L	Pw	Oral	Ulcer
SCROPHULARIACEAE							
<i>Scoparia dulcis</i> L.	1834*	Alaphakikpadou	0.01	R	Pw	Oral	Stomachache
SOLANACEAE							
<i>Capsicum frutescens</i> L.	1835*	Tchanganyi	0.03	Fr/R	Dec	Anal	Hemorrhoids
STERCULIACEAE							
<i>Cola nitida</i> A. Chev.	0376 FDS/UL	Goro	0.04	Sb	Pw	Nasal	Headache
				Fr	Pw	Oral	Constipation, witchcraft

Table 3 contd...

Scientific name	Voucher specimen number	Local name	UV	Organs	Mode of preparation	Route	Indications
STRYCHNACEAE							
<i>Strychnos spinosa</i> Lam.	10779 FDS/UL	Kpogbovouro	0.07	R	Pw	Oral	Witchcraft, stomachache, headache, mental illness
TILIACEAE							
<i>Grewia mollis</i> Juss.	1836*	Bolo	0.03	L Sb	Pw Pw	Oral Skin	Mental illness Abscess
VERBENACEAE							
<i>Premna quadrifolia</i> Schumach. and Thonn.	1837*	Tchakpeya	0.03	R L	Pw BPw	Oral Oral	Female infertility Epilepsy
<i>Stachytarpheta indica</i> (L.) Vahl	820 FDS/UL	Tchouboulou-zou	0.01	R	Mac	Body bath	Trouble of sight
<i>Tectona grandis</i> L.f.	09267TG Cit/AK	Tantouna	0.04	L L	Dec Dec	Oral Oral/body bath	Anemia malaria
VITACEAE							
<i>Cissus aralioides</i> (Baker) Planch.	1838*	Bodi	0.05	R	Pw/Dec	Oral	Intestinal parasites, malaria, stomachache

L: leaves, Fr: fruits, R: roots, Sb: stem bark, S: seeds, Pw: powder, Dec: decoction, Mac: maceration, BPw, burnt powder, Th, thorn

**Table 4: Periodicity of symptoms of several diseases**

Diseases	Peak of symptoms	Number of TH
Epilepsy	Full moon (10 <sup>th</sup> to 15 <sup>th</sup> days of the month)	18/73
Abscess	Night	14/73
Asthma	Early morning	19/73
Sickle cell	Cold time (November to February)	21/73
Arterial hypertension	Early morning	23/73
Mental illness	Midnight	09/73

time of harvest can vary from one organ to another. Generally, the roots and the stem bark are harvested during the dry season and the leaves during the rainy season, most frequently in the morning. In this study, 29 plants (40.28%) must be harvested at specific moment of the day and/or the year to be efficient. These plants are incorporated in the preparation of 19 medical recipes used to cure the following diseases: headache, hemorrhoids, constipation, mental illness, female infertility, epilepsy, stomach pain, sickle cell anemia, malaria, fainting, and hypertension. As an example, the leaves of *Khaya senegalensis* are harvested in the morning in the rainy season. These leaves are pulverized to give a recipe called “Iralèda” taken orally in the case of fainting. *Trichilia emetica* leaves are harvested in the night during the dry season, and they are used in the form of decoction orally against overwork. *Sarcocephalus latifolius* roots are harvested in the dry season in the evening. The powder is incorporated in a recipe, “Gnon” used in the treatment of stomach pains. On the other hand, the leaves are harvested in the morning in the dry season and are used in the form of decoction in association with the roots of *Bridelia ferruginea* and *Cissus aralioides* against malaria. This

recipe is traditionally known as “Lakaza.”

#### The “timing” factor in the administration of herbal medicines

According to the 73 healers interviewed in this survey, the cure or the occurrence of adverse reactions after ingestion of a drug depends on the time of administration. A total of 72 recipes were identified for this purpose. These recipes prepared with 60 plants have their optimal therapeutic effects either in the morning, midday, and/or evening. For example, 11 recipes made from 22 plants were identified as having an optimal activity if administered in the morning. These recipes were mostly composed of roots, and presented in the form of powder and administered orally. “Lizi”, for example, is a concoction made of *Carica papaya* seeds and roots of *Euphorbia hirta*. This decoction is administered orally to treat intestinal parasites. Its activity is optimal if it is taken in the morning. Similarly, maceration of leaves of *Alternanthera pungens*, known as the “Sinama” and used orally to treat malaria, has an optimal activity when taken in the morning. Nineteen recipes made of 37 plants were recorded as having optimal activity at night. These recipes are mostly from roots and used as powder or decoction orally. “Maza”, made of powdered roots of *Khaya senegalensis* and *Piliostigma thonningii*, is presented in the form of capsule. It is administered orally to treat hemorrhoids. Its activity is optimal in the evening. Similarly “Labitala”, a decoction of the roots of *Excoecaria grahamii* and *Euphorbia hirta*, is preferably administered orally at night to treat female infertility.

#### The time of administration and the occurrence of adverse events

The survey showed that 44 recipes from 56 plants could be a source of toxic or undesirable effects if the time of

administration is not respected. Thus, we identified eight recipes from 16 plants that have acute toxicities sometimes if taken in the morning. For example, the bark *Lophira lanceolata* is used in the form of a powder called “Essovalè” administered orally in the case of female infertility. Administered in the morning, the recipe may cause abdominal pain or itching. Similarly, the roots of *Aristolochia albidia* are used in the form of powder against cough. Oral administration in the morning can cause diarrhea and abdominal pain. Four recipes based on 11 plants have their peak of toxicity in the evening. “N’Ketekina” is a powder made of the fruits of *Sarcocephalus latifolius* and the roots of *Entada africana*. This recipe is used orally against constipation, but administered in the evening it can cause diarrhea, vomiting, and general weakness.

## DISCUSSION

The main objective of this study was to investigate the use of the plants in the TM. Our results revealed that the interviewed TH were mostly senior male citizens entirely dedicated to the exercise of TM. The low number of illiterates is due to the fact that these TH are members of the CERMETRA. In fact the institution requires a minimum educational level. By adhering to CERMETRA, the TH who are illiterate receive courses to learn speaking and reading French and the local language.<sup>[13]</sup>

There seems to be a tendency for a few plant families to stand out in any pharmacopoeia. In a survey on antimalarial plants conducted in the Maritime Region of Togo, Koudouvo *et al.*<sup>[29]</sup> identified 52 plants species belonging to 29 families, the most represented being the Rubiaceae and Rutaceae. In the study conducted in the Central Plate of Burkina Faso by Nadembega *et al.*,<sup>[30]</sup> the families Caesalpiniaceae, Poaceae, Mimosaceae and Fabaceae were classified as the richest in species citations. Maroyi *et al.*<sup>[31]</sup> recorded 61 plant species as useful in traditionally curing of various human diseases in the Nhema communal area in Zimbabwe. These medicinal plants were distributed among 28 families, the largest proportion belonging to Fabaceae and Anacardiaceae families. Telefo *et al.*<sup>[32]</sup> also identified 46 plant species belonging to 26 families, the largest number of species being recorded in the Asteraceae and Acanthaceae. In this study, the largest number of species belonged to the Euphorbiaceae family. Preference for their use may be related as much to their ready availability, for they are common in this area, as to factors related to their biological activity.

*Khaya senegalensis* was the plant with highest UV. The main therapeutic indications of this plant were: hemorrhoids, malaria, sickle cell, stomachache, hypertension,

female infertility, and diabetes. In fact this plant is well known by TH native from western Africa, and it assumed to cure several diseases. In Burkina Faso, the plant is used in the treatment of malaria and stomachache.<sup>[33]</sup> In Ivory Coast, the bark of the plant is used in the management of external and internal wounds, diarrhea, and dysentery.<sup>[34]</sup> In Mali, in addition to the treatment of wounds, the plant is also used in the management of snake or insect bites.<sup>[35]</sup> In Guinea, the plant is used to treat infectious diseases including sexually transmitted ones.<sup>[36]</sup> Indeed, there are some similarities in the use of *Khaya senegalensis* in Western Africa, the main indication being the treatment of microbial infections. Following these indications, laboratory screenings were conducted on the plant. Karou *et al.*<sup>[37,38]</sup> found weak antiplasmodial and antibacterial activities of the crude extracts of leaves and bark of the plant. The phytochemical studies on the plant resulted in the isolation of several compounds, the most commons being the limonoids with antimicrobial activity.<sup>[39]</sup> *Anthocleista djalonenensis* is used in the management of hypertension, hemorrhoids, syphilis, female infertility, diabetes, malaria, hernia, and stomachache. Gbolade<sup>[40]</sup> also found similar usage of the plant in Nigeria. The *in vitro* screening of the plant revealed an interesting antimicrobial activity of the crude extract.<sup>[41,42]</sup> There is a grate similarity in the use of *Sarcocephalus latifolius* and *Trichilia emetica* in TM in West Africa.<sup>[37,43]</sup> Of the two plants, *Sarcocephalus latifolius* previously known as *Nauclea latifolia* is well investigated for several biological activities including antimalarial, antidiabetic, and antimicrobial properties.<sup>[44]</sup>

Overall our results indicated that the TM in Togo shares similarities with the TM of the subregion in the use of plants. We also investigated the importance of timing in the Togolese folk medicine. In this study, the 73 respondents claimed they rely on time in their daily practice. We first checked the knowledge of TH on the periodicity of some clinical symptoms of several diseases. The surveyed TH indicated that the periodicity of the clinical symptoms was circamensual for epilepsy, circadian for the skin abscesses, certain mental disorders, hypertension and asthma, and seasonal for the sickle cell anemia. These data are consistent with the literature. Indeed, the peak of the abnormal electrical discharge in the brain that is the cause of epilepsy appears at the full moon. The pain of skin abscesses can be seen at night. The peak of pain due to sickle cell disease is achieved by cold period, that of asthma, in the final phase of nocturnal rest and that of hypertension reaches its maximum at the end of the night resting phase.<sup>[45,46]</sup>

Of the 72 plants identified, 29 must be harvested at a time and/or a specific season in order to have the expected optimal therapeutic activity. Indeed a number of biological activities in the plants including the flowering and the

synthesis of many secondary metabolites have a moment of peak. In fact, the concentration of active principles in the plant organs evolves following a circannual, circadian even ultradian rhythm. Black *et al.*<sup>[15]</sup> found that the phenol content depends on the moment of organ harvest.

The time is important not only in the concentration of active principles in the plant, but also in the susceptibility of the targeted organs during the treatment.<sup>[22,47]</sup> The 72 plants are used for the preparation of 144 medicinal recipes, 11 of them are active only when administered in the morning, and 19 are active at night. These data are consistent with the requirements of modern drugs, but also with those findings of several authors who highlighted the importance of the timing in the activity of herbal medicines.<sup>[22]</sup> Thus, for the TH interviewed, the timing is important. Disregard this factor could turn some herbal substances toxic or inactive at best. It should be emphasized that the time of plant collection and administration of drugs can vary from a TH to another.<sup>[48]</sup>

Since the practice of TM is still empirical in Africa, the concept of dose of active ingredients and the mechanism of action are intuitive. This is the main problem with the traditional concoctions in Africa. In fact, the TH only rely on their own experience to prepare their recipes. Raw materials or powders are not weighed nor the volume of water measured, so there is a problem for standardization of the preparations. For the same product, the prescribed dose may vary from one TH to another or even from one patient to another with the same TH. It is about one to two teaspoons, two to three times daily for the powders and ½ to 1 cup, two to three times daily for a decoction or a maceration. A pinch is used for the powder administered by inhalation. Sour products are taken together with food or just meal. The baths are often two times daily, usually morning and evening.

Another problem is the diagnosis of the diseases. In this topic, many TH also rely on empirical observation to diagnose, thus the risk of misdiagnosis remains in some cases. These are the main goals of CERMETRA, by encouraging TH for more collaboration with modern medicine. In a recent study, we found that about 75% of TH confirm their diagnosis with laboratory results but this value is overestimated since these TH are adherents of CERMETRA.<sup>[24]</sup> This limit could also be due to the patients, since the majority of people treated by TM are poor and thus not able to pay for a laboratory analysis.

## CONCLUSION

This study demonstrated that local specialists in the central

region of Togo tend to agree with each other in terms of the plants used to treat diabetes, infertility, and abdominal pains, but cite a much more diverse group of plants to treat problems related to hypertension, sickle cell, and abscess. They also rely on the timing in the plant processing and the administration of herbal remedies. All these findings are based on empirical observation, and laboratory screenings are needed to check the effectiveness of these plants.

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