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An ethnobotanical study of plants used to treat liver diseases in the Maritime region of Togo

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ABSTRACT

Ethnopharmacological relevance: In Togo, many persons still rely on plants for healing, however very little is known about the medicinal practices of the indigenous people. The present study aimed to document the medicinal plant utilization for the management of liver diseases in the Maritime region of the country.

Methodology: This was an ethnobotanical survey conducted in the Maritime region of Togo from June to August 2015. The data were gathered from 104 traditional healers (TH) by direct interviews using a semi-structured questionnaire. The calculated use values (UV) were used to analyze the importance of the cited plants.

Results: A total of 99 plant species belonging to 88 genera and 49 families were cited by the TH as curing the hepatic diseases. The most represented families were Caesalpiniaceae with 8 species, followed by Euphorbiaceae with 7 species, Apocynaceae and Asteraceae with 6 species each. The highest UV were recorded with *Gomphrena celosioides* (0.13), *Xylopia ethiopica* (0.12), *Senna occidentalis* (0.12), *Bridelia ferruginea* (0.12), *Cymbopogon citratus* (0.12), *Kigellia Africana* (0.09), *Cassia sieberiana* (0.08) and *Sanseviera liberica* (0.08), showing their importance in the management of liver dysfunction in the surveyed region. The main used parts were the leaves, followed by the roots, the whole plant, the rhizome and the bark, accounting for more than 10% each. The herbal medicines were mostly prepared in the form of decoction and administrated by oral route.

Conclusion: This study showed that Maritime region of Togo has an important plant biodiversity that is exploited by the indigenous TH. However, some plants cited by the TH have not been studied for their possible hepatoprotective effects. These plants are therefore a starting point for biological screenings.

1. Introduction

Nowadays, there is a renewed interest in the medicinal plants research because of the health problems that remained unsolved (Briskin, 2000; Rafieian-Kopaei, 2011; Atanasov et al., 2015). The humanity is confronted with infectious diseases such as malaria for decades without really finding a definitive solution. Indeed, there is no effective vaccine against the disease, while the *Plasmodium* increasingly resists to currently available drugs (Larremore et al., 2015; Rosa et al., 2015). Concerning the bacterial infections, new antibiotics are continuously introduced on the market but each antibiotic has a limited effective lifetime after which, the majority of bacteria develop a resistance (Cohen et al., 2015; Le Doare et al., 2015; Oneko et al., 2015). There are in addition, cancers and metabolic diseases such as diabetes and arterial hypertension whose incidence is increasing. Many efforts are being made in synthetic chemistry to bring to market new drugs against these diseases, but the need for new molecules arises today with acuity. This current situation justifies the new resurgence of interest in medicinal plants, given their potential in this topic (Gali-Muhtasib et al., 2015; Lakshmi et al., 2015). A plant can synthesize thousands of secondary metabolites with pharmacological properties. Thus, the plant-derived molecules have largely contributed to the fight against various diseases (Patridge et al., 2015; Prasad and Tyagi, 2015).

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The investigation of medicinal plants has often followed a classic pattern. Firstly, the ethnobotanical surveys are conducted to gather the knowledge acquired by man and handed on from generation to generation through the oral tradition, secondly the laboratory studies are performed following these traditional usage to identify the active principles. Interestingly, the African continent has an important floristic biodiversity and a secular knowledge about the use of plants for healing (Homsy et al., 2015). In fact, in Africa it is a question of culture and tradition and it is estimated that over 80% of the population in rural areas have an exclusive use of plants for their primary health care needs (Egharevba et al., 2015). The studies related to medicinal plants are continuously conducted on the continent and some lead to the identification of active principles (Tchacondo et al., 2012; Ilboudo et al., 2013). However, considering the problem of climate change, exacerbated by the rapid degradation of the environment with the extinction of many plant species; it becomes urgent to accelerate ethnobotanical studies to establish an exhaustive list of species and their use. To date, it is estimated that less than 10% of the plants have been systematically studied for their biochemical composition (Atanasov et al., 2015).

In Togo, the medicinal plants are used by most of the people to heal various diseases. Thus ethnobotanical studies are being conducted to document the Togolese herbal medicine. Until now, the targeted diseases included malaria, diabetes and arterial hypertension (Karou et al., 2011a; Koudouvo et al., 2011; Holaly et al., 2015; Kpodar et al. 2015). The ethnobotanical data on plants used in liver diseases management are almost nonexistent. This study was therefore undertaken to document the medicinal plants used in the Maritime region to treat liver diseases.

2. Materials and methods

2.1. Study area

Togo is a western African country lying between Burkina Faso in the North, Benin in the East, Ghana in the West and the Atlantic Ocean in the South. The country is divided into five economic regions namely Savannah Region, Kara Region, Central Region, Plateaux Region, and Maritime Region. This study was conducted in Maritime Region. The study area was previously described (Kpodar et al., 2015). In brief, the Maritime Region stands between 1°20′–1°50′ east and 6°10′–6°60′ north of the equator. The region is bordered respectively to the north, West, East and the South by Plateaux Region, Republic of Ghana, Republic of Benin and the Atlantic Ocean. It surface consists of a total area of 6100 km^2, approximately 10.78% of the total land area of the country. The climate is sub-equatorial. The region is inhabited by 1.828.000 people, a density of 50–200 persons/km^2.

2.2. Data collection

Direct interviews with traditional healers (TH) were conducted between June and August 2015 using a semi-structured questionnaire, after their informed consent. Each TH gave a verbal consent certifying his/her agreement. Questions asked were about (i) the TH identity, i.e. name and surname, sex, age, level of education; (ii) the origin of their knowledge; (iii) the status of the TH, i.e. full-time professional TH or partial-time professional TH; (iv) the disease, i.e. name of the disease in the local language; (v) the causes of the disease; (vi) the diagnosis, i.e. main symptoms; (vii) the possible collaboration with the modern medicine; and (viii) the remedies, i.e. the number of plants in the remedy, the local names of the plants, the used parts, the remedy formulation, and the administration route.

2.3. Plant identification

After the interviews, a preliminary identification of the plants was done in the field by a botanist. Subsequently, herbarium specimens were prepared and photographs were taken to aid in the botanical authentication of the plants. Plant identities were confirmed by comparison with available voucher specimens in the Herbarium of the Botany Department, University of Lomé, using the taxonomic keys of the online databases of West African Plants – a photo Guide on the website: http://www.westafricanplants.senckenberg.de/root/index.php. The nomenclature of species was done using the online data base of IPNI website: http://www.ipni.org/ipni/plantnamesearchpage.do.

2.4. Data analysis

Excel spread sheet was used to make simple calculations and determine plant frequencies. Histograms were drawn with the GraphPad Prism 5 software. The use value (UV), a quantitative method indicating the relative importance of species, was calculated as follows:

$$UV=\Sigma U/n$$

where, UV is the use value of a species; ΣU the total number of citations per species; n the number of informants (Aburjai et al., 2007; Hudaib et al., 2008).

3. Results

3.1. Socio demographic profiles of the traditional healers

The socio demographic profiles of the traditional healers are displayed in the Table 1. A total of 104 TH were interviewed including 51 males and 53 females. Their age varied between 30 and 82 years, mean age of 52.55 ± 13.31. Most of them were ranged in the age groups of 50–70 years and 30–50 years, corresponding to 43.27 and 42.31% respectively. Concerning the educational level, 55.77% were illiterates; the others were at least of primary educational level. Thus, 29.81% of the TH attended the primary school and 12.50% the secondary school. Only 2 TH reached the university. Different origins of the medicinal practice or knowledge were recorded, notably the familial inheritance, the initiation from a TH and the divine revelation. Some TH mentioned several origins of their knowledge; for example, a TH could have inherited the knowledge through the oral tradition in his family in addition to the divine revelation. According to Table 1, the main origins of medicinal knowledge were the familial inheritance (95.19%), the divine revelation (27.88%) and the initiation from a senior TH (26.92%). In addition, the majority of the TH (82.69%) exerts the medicinal practice as their main activity. The others were either farmers or teachers or merchants exerting the traditional medicine as a secondary activity. Few of them (17.31%) claimed to collaborate with the modern medicine, by referring the serious cases they could not support to the hospital.

3.2. Symptoms and probable causes of liver dysfunction

Two names were recorded for the liver dysfunction in the Maritime region, "*Vevedzadaazodzi*" in *Mina* language that literally means the bile pours on the liver and "*Akla-do*" in *Ewe* language, that literally means the liver disease. Table 2 summarized the symptoms used by the TH to diagnose the hepatic damage. A total of 29 symptoms were cited. Of them, yellow urine, hard stools, asthenia, eyes yellowing, constipation, spots on the skin and

Table 1
Socio demographic data of the interviewed traditional healers.

Parameter	Respondents *N*(%)
Gender	
Male	51(49.04)
Female	53(50.96)
Age	
[30–50]	44(42.31)
[50–70]	45(43.27)
[70–80]	15(14.42)
Educational level	
Illiterates	58(55.77)
Primary school	31 (29.81)
Secondary school	13(12.50)
University	2(1.92)
Origin of the knowledge	
Familial heritance	99(95.19)
Initiation from a TH	28(26.92)
Divine revelation	29(27.88)
Collaboration with modern medicine	
Collaborative	18(17.31)
Non collaborative	86(82.69)
Status of the TH	
Full time profession	86(82.69)
Partial time profession	18(17.31)

Table 2
Clinical symptoms cited by the interviewed traditional healers.

Symptoms	Respondents *N*(%)
Yellow urine	89(85.58)
Hard stools	77(74.04)
Asthenia	71(68.27)
Eyes yellowing	68(65.38)
Constipation	47(45.19)
Spots on the skin	23(22.12)
Bloated stomach	23(22.12)
Itching	19(18.27)
Insomnia	18(17.31)
Anorexia	16(15.38)
Emaciation	16(15.38)
Anemia	13(12.50)
Pale appearance	12(11.54)
Foul mouth feel	10(9.62)
Swollen feet	10(9.62)
Nausea	9(8.65)
Smelling stools	9(8.65)
Fever	8(7.69)
Headache	8(7.69)
Shortness of breath	7(6.73)
Abdominal pains	6(5.77)
Dizziness	6(5.77)
Swollen eyelids	6(5.77)
Bloody stools	4(3.85)
Pimples	3(2.88)
Burp	3(2.88)
Edema	3(2.88)
Chest pain	3(2.88)
Skin yellowing	2(1.92)

bloated stomach were cited by more than 20% of the respondents. Less than 5% of the TH cited clinical signs like bloody stools, pimples, burp, edema, chest pain and skin yellowing. Concerning the causes of liver dysfunction, the TH cited the 9 causes presented in Table 3. The first cause of the liver disease, according to the TH was the poisoning, cited by more than 86% of the respondents. Alcoholism was the second cause, cited by 61.54% of the TH. However, for more than 50% of the TH, the liver dysfunction may be related to the diet. In this particular case, they cited the example of the abuse of the oil consumption, while 3.85% of the TH pointed the modern drugs as a probable cause of the liver disease.

Table 3
Probable causes of liver dysfunction.

Causes	Respondents *N*(%)
Poisoning	90(86.54)
Alcohol	64(61.54)
Diet	56(53.84)
Witch assaults	35(33.65)
Tobacco	11(10.58)
Modern drugs	4(3.85)
Microbe	2(1.92)
Dirty blood	2(1.92)
Malaria	1(0.96)

According to them, it is better to use plants than the modern pharmaceuticals. Only 2 TH cited microbes as a possible cause of the liver disease.

3.3. Diversity of medicinal plants and their uses

A total of 99 plant species belonging to 88 genera and 49 families were identified in the present study (Table 3). The species comprised the shrubs, trees, herbs and liana. The main growth habit of the species was the shrubs, accounting for more than 50% (Fig. 1). It was followed by the trees and herbs.

The Caesalpiniaceae family recorded the highest number of species namely *Senna occidentalis*, *Senna rotundifolia*, *Senna siamea*, *Senna Alata*, *Senna tora, Cassia sieberiana*, Cassia *angustifolia* and *Caesalpinia pulcherrima.* It was followed by Euphorbiaceae with 7 species namely *Phyllanthus amarus, Alchornea cordifolia, Euphorbia hirta, Jatropha gossypiifolia, Jatropha curcas, Bridelia ferruginea* and *Flueggea virosa.* Apocynaceae and Asteraceae were represented with 6 species each. Twenty-eight families contributed with one species each.

The calculated use values ranged between 0.13 and 0.01. The highest use values were recorded with selected species such as *Gomphrena celosioides* (0.13), *Xylopia aethiopica* (0.12), *Senna occidentalis* (0.12), *Bridelia ferruginea* (0.12), *Cymbopogon citratus* (0.12), *Lippia multiflora* (0.12), *Kigelia africana* (0.9), *Cassia sieberiana* (0.8) and *Sansevieria liberica* (0.8), showing the importance of these plants in the management of liver dysfunction in the Maritime region of Togo. A total of 17 species recorded a use value of 0.02 while 40 species recorded the lowest use value (0.01).

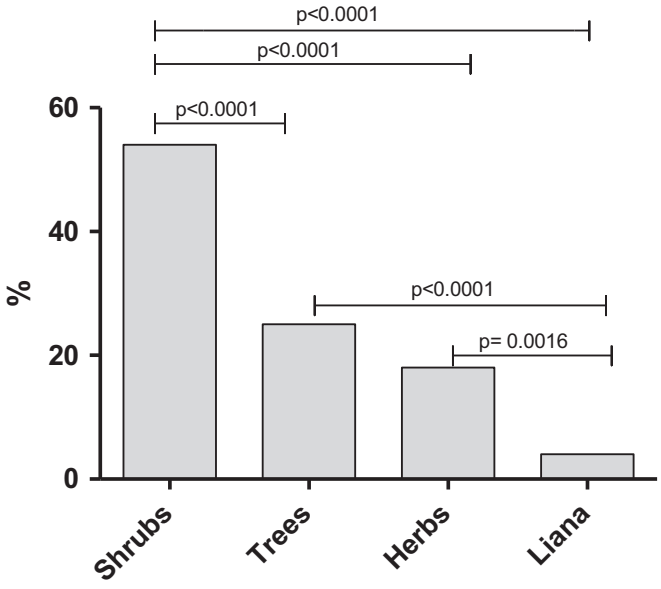

Fig. 1. Growth habits of the medicinal plants species used in the treatment of liver diseases.

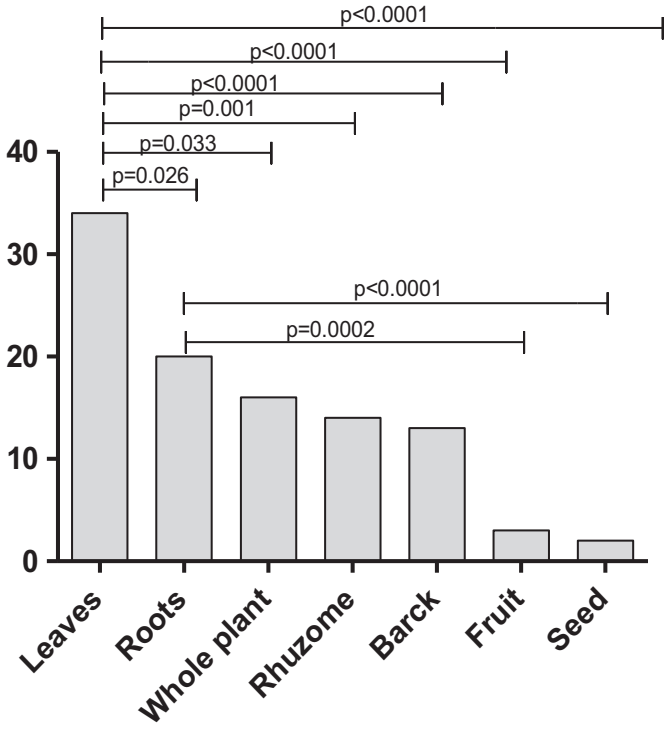

Fig. 2. Plants part used in the management of the liver diseases.

3.4. Plant parts used, modes of preparation and administration routes

The TH in the Maritime region were found to use different parts of the plants for the medicinal purposes. For the treatment of the liver diseases, the main used parts were the leaves, followed by the roots, the whole plant, the rhizome and the bark, accounting for more than 10% each. The fruits and the seeds were less used (Fig. 2). The herbal medicines were mostly prepared in the form of decoction (Fig. 3). The other forms were the infusion, powder and crushing. All the herbal medicines were administrated by oral route.

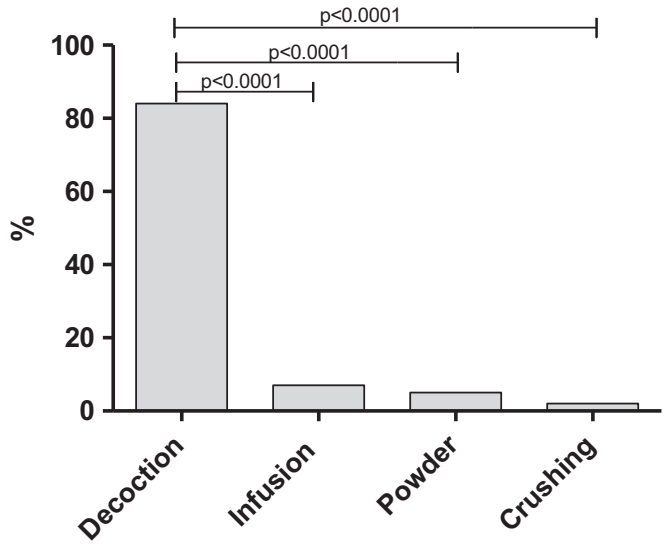

Fig. 3. Mode of preparation of medicinal recipes used in the management of the liver diseases.

4. Discussion

This study aimed to identify the plants used in the treatment of liver diseases by the traditional healers in the Maritime region of Togo. The survey of the traditional healers in the region showed that the medicinal practice was dedicated to senior adults. These results are in accordance with previous studies. Thus, in the Central Region, the results showed the predominance seniors. This is because the knowledge is often transmitted through oral tradition or initiation from an older healer, requiring a minimum of trust, though some healers often claim to have their knowledge from a divine revelation. The results of this study corroborate this observation, because about 95% of the respondents have acquired at least one medicinal practice within the family and over 25% were initiated with an old healer.

The proportion of TH that were literate remains low. The level of education does not often involved in the acquisition of medicinal practices but, nowadays it is important for the TH to archive their data. For research teams that go on the field, the educational level is the parameter that allows us to understand their ability to cooperate with modern medicine. Indeed, we found that non-literates were very reluctant to answer our questions and therefore to cooperate with the modern medicine. In addition, they have more difficulties in implementing the suggestions we make them regarding the hygiene. Consequently, less than 20% of TH argue to cooperate with the modern medicine, against over 60% in the central region of the country (Karou et al., 2011a). In this regard, we suggest that much effort must be made by authorities to reconcile the actors of traditional medicine and those of modern medicine, often plagued by rivalries of all kinds. In terms of diagnosis it should be noted that the healers rely solely on the clinical symptoms. Obviously, they cited the major symptoms that could accompany the liver dysfunction, but the risk of misdiagnosis remains, given that over 80% do not cooperate with modern medicine. This constituted a limitation of the study. Indeed, when asked about the major causes of the liver dysfunction, the TH cited alcoholism, smoking and poisoning. Only two TH have mentioned microbes that may imply viral hepatitis, without going into details about viruses and their transmission. However, the viral hepatitis are a real public health problem in the country. An epidemiological survey conducted at the University Hospital of Lomé showed that the prevalence of HCV was 3.3% among the blood donors, 1.3% among the patients consulting for sexually transmitted diseases and 6.1% among the hospitalized patients (Agbodjan et al., 1995).

Earlier ethnobotanical studies have been undertaken in the country on the plants used against malaria, diabetes and hypertension, the present study gives new insight in the treatment of liver diseases. Regarding the diversity of plants, the study identified 99 species belonging to 88 genera and 49 families. This biodiversity is higher than that recorded by Koudouvo et al. (2011), 52 species belonging to 49 genera and 27 families for the treatment of malaria; and Karou et al. (2011a), 49 species belonging to 31 families for the treatment of diabetes and hypertension. A great biodiversity was recorded by Holaly et al. (2015), who identified 112 plant species belonging to 51 families. The most represented families in this study were Caesalpiniaceae, Euphorbiaceae, Apocynaceae and Asteraceae with at least 6 species each. These families have been identified as the most used in the treatment of diabetes (Holaly et al., 2015; Kpodar et al., 2015). However, Koudouvo et al. (2011) showed in the same region that Rubiaceae and Rutaceae were the most common families used in the treatment of malaria. There is no doubt that some plant families are particularly recognized for their effectiveness against specific diseases. This is the case of Rubiaceae because of their alkaloids well known for their action against the *Plasmodium* (Karou et al., 2011b) or the

Table 4
Diversity of medicinal plants and their uses for the treatment of the liver diseases in the Maritime Region.

Species	Local name	Voucher No	Use values	Used parts	Habits	Mode of preparation
Amarantaceae						
Gomphrena celosioides Mart.	Amegantaxe	TG20151	0.13	WP	Herb	Dec, Inf
Pupalia lappacea (L.) Moq.	Tetemalima	TG20152	0.02	Fl	Herb	Dec, Cru
Anacardiaceae						
Spondias mombin L.	Akliko	01851TGClt/AK	0.02	L	Tree	Dec
Mangifera indica L.	Amangoti	01797TGClt/AK	0.04	L	Tree	Dec
Lannea kerstingii Engl. &K.Krause	Melonkou	TG20153	0.02	Bk	Tree	Dec
Annonaceae						
Annona senegalensis Pers.	Zogbegnigli	2179FDS/UL	0.04	L	Shrub	Dec
Annona muricata L.	Agnigli	02267Tg Clt/AK	0.01	L	Shrub	Dec
Xylopia aethiopica (Dunal) A.Rich.	Esso	01984TG Clt/AK	0.12	Fr	Tree	Dec
*Uvaria chamae*P. Beauv.	Agbana	01941TGClt/AK	0.04	R	Shrub	Dec
Monodora myristica (Gaertn.) Dunal.	Ayikou	TG20154	0.01	Sd	Tree	Dec
Apocynaceae						
Rauvolfia vomitoria Afzl.	Dodemakpowoe	TG12750	0.03	Bk	Shrub	Dec, Pow
Catharanthu sroseus (L.) G.Don	Flawavigbe	TG10800	0.01	L	Herb	Dec, Inf
Strophanthus hispidus DC.	Tsakpati	TG20155	0.04	Rh	Shrub	Dec
Carissa edulis Vahl.	Boetso	TG20156	0.01	R, L	Shrub	Dec
Picralima nitida (Stapf) Th.etH.Dur.	Ayokpe	220FDS/UL	0.01	Sd	Shrub	Dec
Alstonia boonei De Willd.	Gnamidua, Tom-Tom	02006TGClt/AK	0.02	Bk	Tree	Dec
Arecaceae						
Cocos nucifera L.	Neti	02481TG Clt/AK	0.06	R	Tree	Dec
Asteraceae						
Acanthospermum hispidum DC.	Apegbin, Ahlangovi	00749TGClt/AK (*)	0.05	WP	Herb	Dec
Tridax procumbens L.	Azuigbe	TG20157	0.03	WP	Herb	Dec
Conyza aegyptiaca (L.) Aiton.var. lineariloba (DC.) O.Hoffm	Dagnigbe	TG20158	0.01	WP	Herb	Dec, Inf
Lactuca taraxacifolia (Willd.) Schum.	Anonto	TG12752	0.04	L	Herb	Dec
Vernonia cinerea (L.) Less.	Hunssikonou	TG20159	0.01	L	Herb	Dec
Vernonia amygdalina Delile	Aloma	10700FDS/UL	0.02	L	Shrub	Dec, Pow
Balanophoracea						
Thonningia sanguine Vahl	Epidé	TG201510	0.01	Rh	Shrub	Dec
Bignoniaceae						
Kigelia Africana (Lam.) Benth.	Gnakpekpe	TG201511	0.09	Bk	Tree	Dec
Spathodea campanulata P. Beauv.	Adatsigolo	TG201512	0.02	Bk	Tree	Dec
Newbouldia laevis (P.Beau.) Seem.	Kpatima	02453TGClt/AK	0.03	L	Tree	Cru
Bombacaceae						
Adansonia digitata L.	Alangban	02476TGClt/AK	0.01	Fr	Tree	Pow
Boraginaceae						
Heliotropium indicum L.	Agamassike	TG201513	0.01	WP	Herb	Dec
Caesalpiniaceae						
Senna occidentalis (L.) Link	Bessissan, Awakofin	TG201514	0.12	L, Sd, R	Herb	Dec
Senna rotundifolia Pers.	Azigbe	TG201515	0.01	WP	Herb	Dec
Senna siamea (Lam.) H.S.Irwin&Barneby	zangarati	0012TGClt/AK	0.02	L, R	Shrub	Dec
Senna Alata L.	Madonsohome	TG201516	0.05	L	Shrub	Dec
Cassia sieberiana DC.	Gati- gati	TG201517	0.08	R	Tree	Dec
Senna tora(L.) Roxb.	Kpam	TG201518	0.02	L	Shrub	Dec,Inf
Cassia angustifolia Vahl.	Agoegbe	TG201519	0.02	L	Herb	Dec, Inf
Caesalpinia pulcherrima (L.) Sw.	Orgueil de Chine	TG201520	0.01	L	Shrub	Dec
Caparidaceae						
Crateva religiosa G.Forst.	Awatayisan	00326TGClt/AK	0.04	L	Tree	Dec
Caricaceae						
Carica papaya L.	Adibati, aduba	00340TGClt/AK	0.06	L, Fr	Shrub	Dec
Cochlospermaceae						
Cochlospermum planchonii Hook.f.	Zogbedeti	TG201521	0.03	Rh	Shrub	Dec, Pow
Cochlospermum tinctorium Perr.	Soulefadine, Frado	TG201522	0.05	Rh	Shrub	Dec, Pow
Combretaceae						
*Anogeissus leiocarpus*DC.	Heheti	TG201523	0.02	L	Tree	Dec, Inf
Pteleopsis suberosa Engl. &Diels	kotokolika	TG201524	0.01	Bk	Tree	Dec
Convolvulaceae						
Merremia tridentata (L.) Hallier f.	Vouvoudragni	TG201525	0.02	WP	Liana	Dec
Cucurbitacae						
Momordica charantia L.	Agnagran	6182 FDS/UL	0.03	WP	Liana	DecPow
Luffa aegyptiaca Mill.	Yovokoussa	TG201526	0.01	L	Liana	Dec
Clusiaceae						
Garcinia kola Heckel	Ewo, Ahohe	TG201527	0.01	Gr	Tree	Dec
Dichapetalaceae						
Dichapetalum madagascariense Poir.	Gboklin, Atihali	TG201528	0.03	L	Shrub	Dec, Inf
Dracaenaceae						
Sansevieria liberica Hort. ex Gérôme & Labroy	Yodobo	TG201529	0.08	Rh	Shrub	Dec
Euphorbiaceae						
Phyllanthus amarus Schumach. &Thonn.	Hlinvi, Soviwadan	TG201530	0.05	PE	Herb	Dec
Alchorne acordifolia (Schumach. &Thonn.) Müll. Arg.	Avovlo	03023TGClt/AK	0.08	F	Shrub	Dec
Euphorbia hirta L.	Anossika	TG12747	0.05	WB	Herb	Dec
Jatropha gossypiifolia L.	Babatidzin	TG12753	0.03	L	Shrub	Dec
Jatropha curcas L.	Babatihe	TG201531	0.01	L	Shrub	Dec

Table 4 (*continued*)

Species	Local name	Voucher No	Use values	Used parts	Habits	Mode of preparation
Bridelia ferruginea Benth.	Akamati, Hlihon	7382 FDS/UL	0.12	L, R	Shrub	Dec
Flueggea virosa (Roxb. ex Willd.) Voigt	Hesre, tchakatchaka	03763TGClt/AK	0.04	L, R	Shrub	Dec
Fabaceae						
Baphia nitida Lodd.	Eto	TG201532	0.01	Bk	Tree	Dec
Clitoria ternatea L.	Azankpo	TG201533	0.01	L	Liana	Dec
Lonchocarpus sericeus (Poir.) Kunth	Lanba	TG201534	0.01	L	Shrub	Dec
Lamiaceae						
Ocimum canum Sims	Ahame	04199TGClt/AK	0.06	WP	Herb	Dec
Ocimum gratissimum L.	Esrou,Deveti	3892 FDS/UL	0.03	L	Shrub	Dec
Hyptis suaveolens Poit.	Awissakadi	04184TG Clt/AK	0.01	L	Herb	Dec
Hoslundia opposite Vahl	Kotamédevetsui	TG201535	0.01	WP	Shrub	Dec
Liliaceae						
Allium sativum L.	Ayo	TG10856	0.04	Rh	Herb	Dec
Loganiaceae						
Anthocleista nobilis G. Don.	Gboloba	TG201536	0.07	R; Bk	Shrub	Dec
Malvaceae						
Hibiscus sabdariffa L.	Gnanto	TG201537	0.01	L	Shrub	Dec
Hibiscus surattensis L.	Kpondé	TG201538	0.03	L, WP	Liana	Dec
Meliaceae						
Azadirachta indica A. Juss.	Kiniti	04647TgClt/AK	0.05	L	Tree	Dec
Pseudocedrela kotschyi (Schweinf.) Harms	Yotsa, Loboli	7719 FDS/UL	0.01	Bk	Tree	Dec
Khaya senegalensis (Desr.) A.Juss.	Mahogen	10641 FDS/UL bis	0.05	Bk	Tree	Dec
Menispermaceae						
Tiliacora funifera Oliv.	Katokpan	TG201539	0.01	R	Shrub	Dec
Mimosaceae						
Parkia biglobosa (Jacq.) R.Br. ex G.Don	Ewati	9468 FDS/UL	0.05	Bk	Tree	Dec
Acacia nilotica var. adansonii(Guill. et Perr.) O.Ktze.	Gamalwa	TG201540	0.01	Sd	Tree	Dec
Moraceae						
Ficus platyphylla Delile	Vodjin	TG201541	0.02	Bk	Tree	Dec
Moringaceae						
Moringa oleifera L.	Yovoviti	05250TG Clt/AK	0.02	L, R	Shrub	Dec
Myrtaceae						
Eucalyptus camaldulensis Dehnh.	Eucalyptus	TG201542	0.01	L	Tree	Dec
Psidium guajava L.	Agowa,Gbebe	TG10866	0.01	L	Shrub	Dec
Nyctaginaceae						
Boerhavia diffusa L.	Katson –agni	TG201543	0.01	Rh	Shrub	Dec
Papaveraceae						
Argemone mexicana L.	Hoetségnon	TG201544	0.01	WP	Herb	Dec
Passifloraceae						
Passiflora foetida L.	Gbantogbanto	TG201545	0.01	WP	Liana	Dec
Periplocaceae						
Cryptolepsis sanguinolenta (Lindl.)Schltr.	Kadzin	TG201546	0.01	R	Liana	Dec
Poaceae						
Cymbopogon citrates (DC.)Stapf	Tigbé	10749TGClt/AK	0.12	L	Herb	Dec, Inf
Polygalaceae						
Securidaca longepedunculata Fresen.	Tritou	TG201547	0.02	Bk	Shrub	Dec
Portulacaceae						
Portula caoleracea L.	Aflatovi	TG201548	0.01	WP	Herb	Dec
Rubiaceae						
Morinda lucida Benth.	Zaklam, Dadaklan	07498Tg Clt/AK	0.07	L, Bk	Shrub	Dec
Mitragyna inermis (Willd.) Kuntze	Limpkati	07354TGClt/AK	0.01	L, Bk	Shrub	Dec
Sarcocephalu slatifolius (Sm.) E.A.Bruce	Gnimon	07535TG Clt/AK	0.07	R	Shrub	Dec
Chassalia kolly (Schumach.) Hepper	Atihon-edokoe	TG201549	0.01	L	Shrub	Dec
Rutaceae						
Citrus aurantiifolia (Christm.) Swingle	Donti	02480TG Clt/AK	0.02	Fr	Shrub	Dec
Clausena anisata (Willd.) Hook.f. ex Benth.	Eyra	08028TGClt/AK	0.01	L, R	Shrub	Dec
Sapindaceae						
Paullinia pinnata L.	Agbassalika	08181TGClt/AK	0.01	L	Liana	Dec
Sapotaceae						
Butyrospermum parkii (G.Don) Kotschy.	yokuti	TG201550	0.01	Bk	Tree	Dec
Simabouraceae						
Harrisonia abyssinica Oliv.	Hedza	TG201551	0.06	L	Shrub	Dec
Sterculiaceae						
Cola millenii K. Schum.	Kpando	TG201552	0.02	L	Shrub	Dec
Ulmaceae						
Trema guineensis (Schumach. &Thonn.) Ficalho	Waza-Waza	08974TGClt/AK	0.01	WP	Shrub	Dec
Verbenaceae						
Lippia multiflora Moldenke	Avondati	09207TG Clt/AK	0.12	L	Shrub	Dec, Inf
Lantana camara L.	Fonyivi, Adelanmagni	TG201553	0.01	L	Liana	Dec,
Vitaceae						
Ampelocissus leonensis (Hook.f.)Planch.	Adidogo	TG201554	0.02	L	Shrub	Dec
Zingiberaceae						
Zingiber officinale Roscoe	Dotè	TG201555	0.01	Rh	Shrub	Dec

Used parts (Bk: bark, Fl: Flower, Fr: fruit, L: leave, R: root, Rh: rhizome, Sd: seed, WP, whole plant).
Mode of preparation (Cru: crushing, Dec: decoction, Inf: infusion, Pow: powder).

Table 5
Literature reporting on relevant ethnomedicinal uses, toxicity and hepatoprotective studies on the most important plants used to treat liver the diseases in Maritime region of Togo.

Species	Relevant ethnobotanical citations	Relevant pharmacological reference to toxic effects	Relevant pharmacological reference to liver damage
Gomphrena celosioides Mart.	Viral hepatitis A and C (Guinnin et al., 2015); liver damage (Sangare et al., 2012a); urinary tract and kidney stones (Prachi et al., 2009).	Oral administration of extract yielded $LD_{50} \geq 5000$ mg/kg body weight a significant increase in transaminases at this dose (Abou et al., 2015)	Effects of aqueous extract on liver enzymes (Sangare et al., 2012b).
Xylopia aethiopica (Dunal) A.Rich.	Excipient (Freiesleben et al., 2015); postpartum care (Malan et al., 2015); Buruli ulcer (Tsouh Fokou et al., 2015).	Cytotoxicity on human breast cancer (MCF-7): $IC_{50}=0.325$ μL/mL and on normal epithelial (ARPE-19): $IC_{50}=1.233$ μL/mL (Bakarnga-Via et al., 2014).	–
Cocos nucifera L.	Viral hepatitis A and C (Guinnin et al., 2015); liver damage (Sangare et al., 2012a); diarrhea (Rakotoarivelo et al., 2015); skin diseases (Khan et al., 2015); toothache (Malan et al., 2015).	LD_{50} of 2.30 g/kg in acute toxicity tests in rabbits with aqueous extract of husk fiber (Alviano et al., 2004); no acute lethal effects in mice (Costa et al., 2011).	Hepatoprotective activity of the nut water on carbon tetrachloride induced liver injury in rats (Loki and Rajamohan, 2003).
Acanthospermum hispidum DC.	Viral hepatitis A and C (Guinnin et al., 2015); liver damage (Sangare et al., 2012a); cancer (Ashidi et al., 2010); malaria (Sanon et al., 2003a).	Weak cytotoxicity of alkaloid extracts against three human cell lines (THP1, normal melanocytes, HTB-66) (Sanon et al., 2003b); low toxicity on J774 macrophage-like murine cells and WI38 human normal fibroblasts (Bero et al., 2009).	–
Kigelia africana (Lam.) Benth.	Viral hepatitis A and C (Guinnin et al., 2015); liver damage (Sangare et al., 2012a); swollen breasts (Malan et al., 2015); sexually transmitted infections (Naidoo et al., 2013).	Cytotoxic effect at high concentrations of hexane extract (CC50=9.37 μg/mL) on LLC/MK2 monkey kidney cells (Zofou et al., 2011); no specific toxicity in rats of the mixture of the plant (Martey et al., 2010; Nyarko et al., 2005)	Hepatoprotective activity on acetaminophen-induced liver damage in mice (Olaleye and Rocha, 2008).
Senna occidentalis (L.) Link	Viral hepatitis A and C (Guinnin et al., 2015); liver damage (Sangare et al., 2012a)	Cytotoxicity of the hydroalcoholic extract of aerial parts found in mouse fibroblasts. (Lombardo et al., 2015); Sub acute toxicity of seeds in rats (Barbosa-Ferreira et al., 2005); acute and subacute toxicities of ethanolic extract of leaves (Pieme et al., 2006).	–
Senna Alata L.	cooling/cleanser (Clement et al., 2015); liver damage (Sangare et al., 2012a); white spot and boils (Ong and Kim, 2014); skin disease, and scabies (Khan et al., 2015)	Increasing levels of creatinine in pregnant rats by the alkaloids of the leaves (Yakubu and Musa, 2012); genotoxicity (Hong and Lyu, 2011); acute and subacute toxicities of ethanolic extract of leaves (Silva et al., 2011);	–
Cassia sieberiana DC.	Diabetes (Salihu Shinkafi et al., 2015); malaria (Diarra et al., 2015; Asase et al., 2005)	Oral administration of Aqueous extract stem bark to rats resulted in hepatotoxicity even at lower dose levels of 20–60 mg/kg and nephrotoxicity at higher doses of180mg/kg (Obidah et al., 2009); low oral acute toxicity ($LD_{50}=1950$ mg/kg) of the extract in rats (Toma et al., 2009.); no signs of acute toxicity of root bark aqueous extract aqueous in rats up to 2000 mg/kg body weight (Nartey et al., 2012)	–
Carica papaya L.	Buruli ulcer (Tsouh Fokou et al., 2015); viral hepatitis A and C (Guinnin et al., 2015); liver damage (Sangare et al., 2012a); dysentery, diabetes, constipation and chronic indigestion (Khan et al., 2015).	Not toxicity effect (Adlin Afzan et al., 2012); no significant toxic effect of the oral administration of the aqueous extract of leaves (Ismail et al., 2014)	–
Cochlospermum tinctorium Perr.	Malaria (Diarra et al., 2015); viral hepatitis A and C (Guinnin et al., 2015); liver damage (Sangare et al., 2012a)	LC_{50} value of 240 ± 3 μg/ mL of acetone extract and 437 ± 8 μg/ mL for butanol extract using the brine shrimp lethality bioassay method (Musa, 2012)	Antihepatotoxic activity of the rhizomes using carbon tetrachloride- induced cytotoxicity in primary cultured rat hepatocytes (Diallo et al., 1987).
Sansevieria liberica hort. ex Gérôme &Labroy	Liver damage (Sangare et al., 2012a)	–	Protective activity of aqueous extract on carbon tetrachloride induced hepatotoxicity in rats (Ikewuchi et al., 2011).
Phyllanthus amarus Schumach. & Thonn.	Viral hepatitis A and C (Guinnin et al., 2015); liver damage (Sangare et al., 2012a); Buruli ulcer (Tsouh Fokou et al., 2015)	Cytotoxic activity of the lignan from the root against HeLa cell line (Sparzak et al., 2015); acute toxicity in rats (Adedapo and Ofuegbe, 2015)	Protective mechanism of lignans against galactosamine/ lipopolysaccharide-induced hepatitis in rats (Bawankule et al., 2014)
Alchornea cordifolia (Schumach. & Thonn.) Müll.Arg.	Buruli ulcer (Tsouh Fokou et al., 2015)	Toxic effects of methanol extract of leaf in male rats (Ajibade and Olayemi, 2015); genotoxicity (Hong and Lyu, 2011)	Hepatoprotective activity of methanol leaf extract on carbon tetrachloride-induced hepatic damage in rats (Osadebe et al., 2012)
Euphorbia hirta L.	Dysentery and diarrhea (Gairola et al., 2013); Viral hepatitis A and C (Guinnin et al., 2015)	Effects of extracts on the ultrastructure of the murine liver (Wong et al., 2013); acute and subchronic toxicity of methanol extract in rats (Yuet Ping et al., 2013a); Cytotoxicity (Kwan et al., 2015)	–
Bridelia ferruginea Benth.	Diabetes (Karou et al., 2011; Kpodar et al., 2015); Viral hepatitis A and C (Guinnin	Hemolytic activity (Karou et al., 2012); Acute and sub-chronic toxicity hydroethanolic	Hepatoprotective activity against 2-acetylaminoflourene-induced damage in rat (Adetutu

Table 5 (*continued*)

Species	Relevant ethnobotanical citations	Relevant pharmacological reference to toxic effects	Relevant pharmacological reference to liver damage
	et al., 2015)	extract in rats (Bakoma et al., 2013); cytotoxycity (Traore et al., 2014)	and Olorunnisola, 2013)
Ocimum canum Sims	Mosquito repellent (Kweka et al., 2008); Buruli ulcer (Tsouh Fokou et al., 2015)	–	Hepatoprotective abilities of the extracts against alcohol-induced oxidative stress in rats (George and Chaturvedi, 2008)
Anthocleista nobilis G. Don.	Malaria, rheumatism (Malan et al., 2015)	–	–
Azadirachta indica A. Juss.	Diabetes (Goyal, 2015); malaria (Iyamah and Idu, 2015); viral hepatitis A and C (Guinnin et al., 2015); liver damage (Sangare et al., 2012a); Buruli ulcer (Tsouh Fokou et al., 2015)	Subchronic toxicity of the oil in mice (Wand et al., 2013, Deng et al., 2013), acute toxicity of a constituent (nimbolide) (Baligar et al., 2014b), toxicity of the seeds (Badshah et al., 2015)	Protective effects of methanolic extract of leaves on cisplatin-induced hepatotoxicity and oxidative stress in female rats (Dkhil et al., 2013); hepatoprotective activity of a constituent (azadirachtin-A) in carbon tetrachloride intoxicated Wistar rats (Baligar et al., 2014a, 2014b)
Parkia biglobosa (Jacq.) R. Br. ex G.Don	Viral hepatitis A and C (Guinnin et al., 2015); liver damage (Sangare et al., 2012a)	Acute toxicity and vascular properties of the seed on rat aorta (Ouédraogo et al., 2012)	–
Cymbopogon citratus (DC.)Stapf	Fever (Clement et al., 2015)	Protective effect of the oil on DNA damage and carcinogenesis in female Balb/C mice (Bidinotto et al., 2011); Cardioprotective effect by biochemical and histopathological changes in experimentally induced cardiotoxicity (Gayathri et al., 2011)	Hepatoprotective effect of the aqueous extract against hydrogen peroxide-induced liver injury in male rats (Rahim et al., 2014); alleviation of carbon tetrachloride-induced hepatic oxidative stress and toxicity (Koh et al., 2012)
Morinda lucida Benth.	Diabetes (Gbolade, 2009); cancer (Ashidi et al., 2010)	Cytotoxicity on brine shrime yielded LC_{50} values of 2.6 μg/ml with methanol extract (Ajaiyeoba et al., 2006); hepatotoxicity and nephrotoxicity in Wistar albino rats exposed of the leaf extract showed non-lethal effect at 6400 mg/kg (Oduola et al., 2010)	–
Sarcocephalus latifolius (Sm.) E.A.Bruce	Malaria (Ranasinghe et al., 2015); viral hepatitis A and C (Guinnin et al., 2015); liver damage (Sangare et al., 2012a)	Cytotoxicity on K562S human monocyte cell lines (Gansané et al., 2010)	Hepatoprotective activity of the aqueous extract in rats treated with carbon tetrachloride (Yesufu et al., 2010)
Harrisonia abyssinica Oliv.	Infectious diseases (Magassouba et al., 2007)	Cytotoxicity on brine shrime (Cyrus et al., 2008)	–
Lippia multiflora Moldenke	No reference	Cytotoxicity on brine shrime yielded LC_{50} =1.1 μg/mLwith methanol extracts (Ajaiyeoba et al., 2006)	–

–: No reference at this moment.

plants with tannins for their effectiveness against bacterial infections (Kırmızıbekmez et al., 2015). Beyond these examples, it is clear that the TH rely primarily on the endogenous flora, thus the dominance of a family or another inevitably influences the choices and the medicinal use of plants.

Based on the calculated UV, 24 plant species recorded use values equal to or above 0.05, indicating their importance in the treatment of the liver diseases in the surveyed region. Thus, a literature review was done on these species to record the previous citations in the ethnobotanical and toxicological studies. In addition, the studies concerning the hepatoprotective effects of these species were also reviewed (Table 4). Of the 24 identified species, 23 species were cited at least once in a relevant ethnobotanical study. *Lippia multiflora* is the species that did not recorded a relevant ethnobotanical report on the Medline. This finding is unexpected, as *Lippia multiflora* had a use value of 0.12, thus showing the importance of this plant in the Maritime Region of Togo and certainly in neighboring regions. Some plants have been cited in previous ethnobotanical studies, but the diseases do not relate to the hepatic gland. These are *Harrisonia abyssinica, Morinda lucida, Cymbopogon citratus, Anthocleista nobilis, Ocimum canum, Cassia sieberiana* and *Xylopia aethiopica*. Similar observations were made, indeed *Cymbopogon citratus* and *Xylopia aethiopica* who also recorded use values of 0.12 were cited respectively for fever (Clement et al., 2015) and the postpartum care (Malan et al., 2015) without any link with the hepatic dysfunction (Table 5).

Regarding the other plants, the results of this study are in accordance with previous reports. The diseases mentioned for these plants comprise both the liver diseases, infectious diseases, urinary stones, rheumatism and diabetes. For example, *Gomphrena celosioides* has been cited in at least three ethnobotanical studies. According to Sangare et al. (2012b), the plant is traditionally used for the treatment of hepatic diseases in a broad sense, while Guinnin et al. (2015) quote for viral hepatitis A and C. Other studies mentioned the use of the plant against urinary and kidney stones (Prachi et al., 2009). The report available on *Sansevieria liberica* addressed the liver diseases (Sangare et al., 2012a).

Twelve species on the 24 were the subjected of a biological screening for the beneficial effects on the liver. These studies consisted of inducing liver damages and monitoring hepatic enzymes after administration of the plant extract. The agents used to induce the damages are often carbon tetrachloride (Diallo et al., 1987; Loki and Rajamohan, 2003; Ikewuchi et al., 2011; Osadebe et al., 2012; Sangare et al., 2012b; Baligar et al. 2014a, 2014b), acetaminophen (Olaleye and Rocha, 2008), hydrogen peroxide (Rahim et al., 2014), cisplatin (Dkhil et al., 2013), the acetylaminoflouren (Adetutu and Olorunnisola, 2013) and the galactosamine or lipopolysaccharides (Bawankule et al., 2014). In the particular case of *Ocimum canum*, George and Chaturvedi (2008) used alcohol to induce oxidative stress in rats and followed the effect of the plant on the liver. The monitored enzymes are often transaminases, alkaline phosphatase and bilirubin (Sangare et al., 2012a). When the oxidative stress is induced, the targeted enzymes include glutathione-S-transferase, glutathione peroxidase, catalase and superoxide dismutase (Dkhil et al., 2013).

Some of these plants tested showed a relevant activity on the liver. Sangare et al. (2012b) studied the effect of the aqueous extract of *Gomphena celosoides* in comparison with the known hepatoprotective silymarin. The results of this study showed that the preventive treatment of the animals with the aqueous extract of *Gomphena celosoides* decreased the serum transaminases, alkaline phosphatase and bilirubin levels. The outcome of the study showed that *G. celosoides* acts like silymarin and is more preventive than curative. Similar results have been recorded with other plants such as Kigelia africana (Olaleye and Rocha, 2008), *Sansevieria liberica* (Ikewuchi et al., 2011), *Phyllanthus amarus* (Bawankule et al., 2014), *Alchornea cordifolia* (Osadebe et al., 2012), *Bridelia ferruginea* (Adetutu and Olorunnisola, 2013), demonstrating the beneficial effects of the extracts of these plants on the liver. The work was more extensive with *Azadirachta indica* with identification and isolation of azadirachtin-A as the molecule responsible for this activity (Baligar et al., 2014a).

In terms of toxicity of the 24 plants identified as having a high use value, published data concerning 3 species were not available. These are *Sansevieria liberica*, *Ocimum canum* and *Anthocleista nobilis*. The toxicity studies have mostly been performed in rats or on cell lines. For some plants, the results showed that they had no adverse effects. This is especially the case of *Bridelia ferruginea* (Olajide et al., 1999; Bakoma et al., 2013), *Carica papaya* (Afzan et al., 2012.), *Cymbopogon citratus* (Costa et al., 2011) *Euphorbia hirta* (Yuet Ping et al., 2012, 2013) and *Phyllanthus amarus* (Appiah-Opong et al. 2011). Significant toxic effects were detected for *Senna occidentalis*. It has been shown that the hydroalcoholic extract of the aerial part of the plant was very toxic to mouse fibroblasts (Lombardo et al., 2015). Similarly, the seeds have shown subacute toxicity (Barbosa-Ferreira et al., 2005). Another plant of the same genus, *Senna alata* has also generated some genotoxic effects (Hong and Lyu, 2011) and elevated the creatinine level in rats. The offending compounds were alkaloids (Musa, 2012). For *Cassia sieberiana*, controversial results were recorded. For Obidah et al. (2009), the oral administration of the aqueous extract of the bark engendered a hepatotoxicity at doses greater than 20 mg/kg and a nephrotoxicity at doses greater than 180 mg/kg. More recently, other authors have shown that the oral administration of the same extract was not followed by significant toxicity at doses up to 1950 mg/kg (Toma et al., 2009; Nartey et al., 2012). The rest of the plants showed low to moderate toxicity and yet should be used with care.

5. Conclusion

This study showed that the Maritime region of Togo has an important plant biodiversity that is exploited by the indigenous TH. These TH have knowledge that share certain similarities with the TH in other parts of the world, according to previous reports. However, some plants cited by the TH have not yet been studied for their probable hepatoprotective effects. These plants are therefore a starting point for biological screening in the laboratory.

Competing interest

None.

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