



Ethnobotanical study and antioxidant activity of anti-hepatitis plants extracts of the COMOE province, Burkina Faso

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ABSTRACT

Acute hepatitis B and its complications cause 800000 and 3300 deaths each year respectively in the world and in Burkina Faso. In Burkina Faso, the majority of the population uses medicinal plants to treat hepatitis. The present study consisted to identify the medicinal plants used to treat hepatitis in COMOE province of Burkina Faso. Extracts from the most cited species were screened for their antioxidant capacity (using ABTS and FRAP methods) and their content in phenolics. Thirty-two anti-hepatitis species belonging to 29 genera and 20 families were recorded in the COMOE province. Extracts from *Diospyros mespiliformis* and *Terminalia macroptera* showed the best antioxidant activities (1.17 ± 0.00 mM TEAC/g and 70.77 ± 0.4 μ M ET/g ; 1.09 ± 0.03 mM TEAC/g and 81.17 ± 0.5 μ M TE/g extract, respectively). The same extracts exhibited the highest total phenolic contents. Low correlation has been obtained between total phenolic contents and antioxidant capacity (TEAC) of the extracts. This finding suggests that non-phenolic antioxidant compounds would be involved in the bioactivity of these species. This study constitutes a contribution in the safeguarding of traditional hepatoprotective medicinal knowledge of COMOE province of Burkina Faso.

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Keywords: Anti-hepatitis plants, antioxidant activity, COMOE province, Burkina Faso.

INTRODUCTION

Viral hepatitis is a major public health problem (OMS, 2012). Two billion people have been infected worldwide with hepatitis B virus (HBV) and 360 million people are chronic carriers with nearly 800,000 deaths a year (OMS, 2014). Three to four million people contract hepatitis C every year and nearly 150 million people are chronic carriers

with over 500,000 deaths per year (OMS, 2014). In Burkina Faso, acute hepatitis B causes 1,100 deaths; Cirrhosis and primary liver cancer from chronic forms cause respectively 900 and 1,300 deaths per year (WHO, 2004). Modern treatments of viral hepatitis are expensive (Schwierz et al., 2011) and have limited effectiveness by poor tolerance of side effects (Thevenot et al.,

2006). The only vaccine existing, the hepatitis B vaccine remains inaccessible to the poor free of the population in terms of its expensive cost. This situation explains the interest of evaluating the natural substances of plants traditionally used (Mukazayire et al., 2011). The present study consisted in identifying the anti-hepatic medicinal plants used in certain localities of the COMOIE province in Burkina Faso. Viral attack of liver cells results in increased production of free radicals that cause liver damage (Twedt, 2006). Plant antioxidants that have the property of trapping free radicals can be a therapeutic way in viral hepatitis. The species most quoted by the surveyed were therefore evaluated for their antioxidant capacity as well as their content of phenolic compounds: *Cassia sieberiana* DC. (Caesalpinaceae), *Diospyros mespiliformis* Hochst ex.A.DC (Ebenaceae), *Lophira lanceolata* Tiegh.ex Keay (Ochnaceae) *Piliostigma thonningii* (Schum.) Milne-Redh (Caesalpinaceae) *Sarcocephalus latifolius* (Sm.) EABruce (Rubiaceae) And *Terminalia macroptera* Guill. & Perr (Combretaceae). The objective of this study was to elucidate the pharmacological mechanism of natural substances action of these extracts in order to consider the formulation of phytomedicines from the enriched extracts.

MATERIALS AND METHODS

Ethnobotanical survey

Ethnobotanical area of investigation

The survey was carried out in three communes in the COMOIE province, in the cascade region in south-west Burkina Faso: Banfora, Bérégadougou and Moussodougou. The survey area extends between longitude 4° 67 'and 4° 82' W and between latitudes 10° 73 'and 10° 85' N. The area covers an area of 18 424 km² with a population of 713 059 inhabitants in 2014 according to the National Institute of Statistics and Demography (INSD, 2009). Its population is mainly composed of Dioula, Senoufo, Goin, Turka, Fulfuldé, Karaboro, Komono, Mossi and Tousian. The region is characterized by a South-Sudanian climate. The landscape is made up of wooded

and arboreous savannas, clear forests and gallery, grass carpet.

Data gathering

The ethnomedical survey consisted of an open, semi-structured interview in which the interviewee was asked to answer exhaustively the questions asked by the interviewer. The questions were asked in the Dioula, Turka or French languages. The themes dealt with mainly relate to the local and scientific names of the plant, its part used, its preparation, its administration, the pathologies treated, the type (s) and the duration of the treatment. The interviewee concerned was mostly traditional healers or herbalists. The diagnosis made by the interviewee was mainly based on jaundice and other clinical factors such as asthenia, fever, headache, insomnia. Field trips were made in the presence of the interviewee, to see the species mentioned, to take their GPS coordinates, to photograph them and to collect specimens. Specimens of the indicated plant species were harvested from the site and subsequently identify at the UFR/SVT Ecology Laboratory at Ouaga University Professor Joseph Ki Zerbo. Six species were selected according to the citation index and according to a bibliographic review for the study of biological activities.

Determination of antioxidant activities and levels of phenolic compounds

Plant material

The roots and leaves of *Cassia sieberiana* DC., *Piliostigma thonningii* (Schum.) Milne-Redh, *Sarcocephalus latifolius* (Sm.) EABruce, leaves of *Diospyros mespiliformis* Hochst ex.A.DC, root bark of *Lophira lanceolata* Tiegh.ex Keay and *Terminalia macroptera* Guill. And Perr, were harvested in November 2012 in the COMOIE province of Burkina Faso, then dried out of the sun and pulverized into fine powder by a blade mill (Gladiator East, 1931 Type BN 1 Mach 40461 1083).

Extraction

The extraction modes are the aqueous infusion for the leaves of *Diospyros*

mespiliformis and aqueous decoctions for the eight other plant samples.

Methods for determining antioxidant activities

ABTS (2',2'-azino-bis-(3-ethylbenzothiazoline)-6-sulfonic acid) method

The TEAC test (Trolox Equivalent Antioxidant Capacity) was determined by the ABTS test (Re et al., 1999). ABTS is dissolved in water at a concentration of 7 mM. The ABTS (ABTS⁺) cation radical is produced by reacting the stock solution of ABTS with 2.45 mM of potassium persulfate and the mixture placed in the dark at room temperature for 12-16 h prior to use. The reaction mixture consisted of 1.0 mL of diluted ABTS⁺ solution and 10 µL of extract or Trolox (1 mM concentration standard in ethanol). We incubated it for 30 minutes at room temperature and the absorbance read at 734 nm. Negative control was consisted of distilled water. All measurements were carried out in three independent tests. The inhibition percentage was calculated according to the following formula:

$$\% \text{ Inhibition} = [(A_0 - A_1)/A_0] \times 100$$

The 50% inhibitory concentration (IC₅₀) was determined and the anti-radical power (ARP) was given by the following formula: ARP = [1/IC₅₀] × 100.

The antioxidant power (TEAC) was calculated according to the formula: TEAC = (ARP product)/(ARP trolox)

Ferric Reducing Antioxidant Power (FRAP) method

The method described by Hinneburg et al. (2006) was used. 1.25 mL of phosphate buffer (0.2 M, pH 6.6) are added to a test tube containing 0.5 mL of extract (0.1 mg/mL) and then 1.25 mL of potassium hexacyanoferrate [K₃Fe(CN)₆] 1% in water. The whole is heated at 50 °C in a water bath for 30 minutes. Then, 1.25 mL of trichloroacetic acid (10%) was added and the mixture was centrifuged at 2000 rpm for 10 minutes. Three 0.625 mL aliquots were taken from the supernatant and placed in 3 eppendorf tubes to which was added 0.625 mL of distilled water and then 0.125 mL of freshly prepared 0.1% FeCl₃ in

distilled water. A blank without a sample was prepared under the same conditions. The reading was carried out at 700 nm against a standard trolox curve ($y = 0.6237x + 0.0387$, $R^2 = 0.9926$) and the reducing powers were expressed in µmol ET/g dry extract.

Determination of phenolic compounds

Determination of total phenolics

The total phenolic compounds were assayed according to the method of Singleton et al. (1999). The phenolic compounds react with the Folin Ciocalteu reagent (FCR) in an alkaline medium, forming a blue colored complex whose maximum absorption is at 760 nm. The reaction mixture consists of 1 mL of extract, 1 mL of 2N FCR and 3 mL of a 20% sodium carbonate solution. It was allowed to stand at room temperature for 40 minutes and then the absorbance was measured at 760 nm on the spectrophotometer (Agilent 8453) against a tannic acid standard curve (1-5 µg/mL). Three independent tests were conducted.

Determination of tannins

The method described by Tibiri et al. (2007) was used. The tannins were precipitated by formation of complex with the polyvinyl polypyrrolidone (PVPP). 100 mg of PVPP were sufficient to complex 2 mg of total phenolics. The quantity of PVPP necessary to complex the total phenols determined as described above was added to 1 mL of extract of concentration 0.5 mg/mL. The mixture was vortexed, kept at 4 °C for 15 min and then centrifuged at 3000 g for 10 min. The supernatant contains the phenolic compounds other than the tannins, these having been precipitated by the PVPP. A metering tube was made as for total phenolics. After 40 minutes, it was centrifuged and the absorbance of the supernatant was measured at 760 nm. The tannin content was determined by differentiating between the first value of the total phenolic compounds (which contained the tannins) and the second value of the total phenolic compounds (in the absence of tannins).

Dosage of total flavonoids

The flavonoid assay was carried out according to the method described by Abdel-Hameed (2009). 100 μ L of extract (10 mg/mL) in methanol were mixed with 100 μ L of 2% aluminum trichloride in methanol and a drop of acetic acid and the volume was then brought to 5 mL with methanol. After 40 min, the absorbance was read at 415 nm. Positive control was performed with quercetin. The absorbance was read against a quercetin standard curve. The amount of flavonoids in the plant extract was expressed in gram quercetin equivalent (QE) per 100 g of plant powder.

Statistical analysis of data

The survey results were recorded and processed with the Sphinx V5 software. All the experiments were performed in triplicate ($n = 3$) and the results were expressed as mean \pm SD. The statistical study was carried out by the statistical software XLSTAT V.7.1. Using ANOVA followed by the Fisher LSD test for multiple comparisons. The differences were considered significant at the probability threshold of 5% if $p < 0.05$.

RESULTS

Ethnobotanical survey

Twenty-six (26) people, including 22 men, agreed to submit to the questionnaire. The interviewee age ranged between 25 and 75 years. More than 60% of respondents were old of 50 years with at least 10 years of experience in traditional medicine. Thirty-two species (Table 1), belonging to 29 genera and 20 families, were recorded. The most representative families were Caesalpiniaceae, Combretaceae, Meliaceae, Asteraceae and Mimosaceae (Table 2). The listed hepatotropic plants are predominantly trees and shrubs. Citation index vary between 1 and 13. *Cochlospermum tinctorium* is the most commonly used species, followed by *C. sieberiana* and *S. latifolius* (Table 1).

Different organs were used by traditional healers or herborists to treat liver disease. Leaves were the most used organs, 46%, followed by roots 34% (Figure 2). Fruits

and stem bark were little used. The decoction (74%) was the most used method of preparation (Figure 3). Infusion (14%) and maceration (10%) were little used, while other forms of preparation (2%) were also little used (Figure 3).

Antioxidant activities and levels of phenolic compounds

The tests carried out reveal that the various extracts possess antioxidant powers and that they contain phenolic compounds (Table 3).

The antioxidant activities of the extracts varies between 1.17 ± 0.00 and 0.05 ± 0.01 mM for the ABTS method and between 83 ± 0.6 and 46.88 ± 3.3 μ M TE/g extract for the FRAP method. The extract of the root bark of *P. thonningii* revealed the strongest reducing power (FRAP) while the extract of the roots of *S. latifolius* showed the lowest reducing power. The *D. mespiliformis* leaves and the roots of *S. latifolius* extracts gave the strongest and the lowest antioxidant capacity (TEAC) respectively. Extracts of *D. mespiliformis* and *T. macroptera* showed high significant antioxidant capacities (TEAC) ($P < 0.05$) compared with the trolox (1mM) used as reference compound. The other extracts showed a significantly lower antioxidant capacity ($P < 0.05$) than that of the trolox. Extracts of *S. latifolius* showed the weakest antioxidant activities (ABTS, FRAP).

The total phenolics, tannins and flavonoids contents respectively ranged from 32.44 ± 0.10 to 1.86 ± 0.11 g EAT/100 g dry matter, from 20.35 ± 0.61 to 1.36 ± 0.14 g EAT/100 g dry matter and 5.22 ± 0.41 to 0.11 ± 0.004 g EQ/100 g dry matter. The extract of *T. macroptera* showed the highest total phenolics, tannins and flavonoids. The lowest levels of total phenolics and tannins were obtained with the roots of *S. latifolius*. The lowest content of flavonoids was obtained with the roots of *P. thonningii*. Extracts of *D. mespiliformis* and *T. macroptera* showed interesting antioxidant activities with the ABTS and FRAP method. The same extracts also gave the highest total phenolic.

Table 1: Anti-hepatic medicinal plants identified during the ethnomedical survey.

Plant Species	Local Name	Type of plant	Organ used/ preparation/mode used	Citation index
<i>Anogeissus leiocarpus</i> (DC.) G.Perr. (Combretaceae)	Gombliri (Turka)	Tree	Leaves/Decoction/Drink	1
<i>Argemone mexicana</i> L. (Papaveraceae)		Grass	Leaves/Decoction/Drink	1
<i>Azadirachta indica</i> .Juss (Meliaceae)	Neem (Français)	Tree	Leaves/Decoction/Drink	1
<i>Carica papaya</i> L. (Caricaceae)	Papayer (Français)	Tree	Yellow leaves/Decoction/Drink	2
			Fruits/Boil/Eating	2
<i>Cassia occidentalis</i> L. (Caesalpiniaceae)	Kinkéliba(Français)	Shrub	Leaves/Decoction/Drink	1
<i>Cassia siamea</i> .Lam (Caesalpiniaceae)	Cassia (Français)	Tree	Leaves/Decoction/Drink	1
<i>Cassia sieberiana</i> DC. (Caesalpiniaceae)	Sindian yiri (Dioula)	Tree	Leaves/Decoction/Drink	4
			Root/Decoction/Drink	1
<i>Cassytha filiformis</i> L. (Lauraceae)		Shrub	Aerial part/Maceration /Drink	1
<i>Chrysantellum americanum</i> L. (Asteraceae)		Shrub	Aerial part/ Infusion of powder/Drink	1
<i>Citrus aurantifolia</i> (Christm) Swingle (Rutaceae)	Citronnier (Français)	Tree	Fruit + leaves of kinkeliba/ Decoction/Drink	1
<i>Cochlospermum planchonii</i> MS. (Cochlospermaceae)	N'Dribala (Dioula)	Shrub	Roots/Decoction/Drink	1
<i>Cochlospermum tinctorium</i> A.Rich. (Cochlospermaceae)	Faux cotonnier (Français)	Shrub	Roots/Decoction/Drink	8
			Root/Infusion/Drink	3
			Roots/Maceration/Drink	2
<i>Combretum fragrans</i> F.Hoffm. (Combretaceae)	Vapélosié (Dagara)	Tree	Leaves/Decoction/Drink	1
<i>Commelina benghalensis</i> L. (Commelinaceae)	Barbar (Turka)	Grass	Aerial part/Decoction/Drink	1
<i>Detarium microcarpum</i> Guill. & Perr. (Caesalpiniaceae)		Tree	Roots/Maceration/Drink	1

<i>Diospyros mespiliformis</i> Hochst ex.A.DC. (Ebenaceae)	Sounsou yiri (Dioula)	Tree	Leaves/Infusion of powder/Drink	1
<i>Entada africana</i> Guill et Perr (Mimosaceae)	Sama nèrè (Dioula)	Shrub	Roots/Infusion/Drink	2
<i>Guiera senegalensis</i> J.F.Gmel. (Combretaceae)	Counglè yiri (Dioula)	Shrub	Leaves/Infusion of powder/Enema and drink	1
<i>Khaya senegalensis</i> (Desr) A.Juss. (Meliaceae)	Caicedra (Français)	Tree	Stem bark/Decoction /Drink	1
<i>Lophira lanceolata</i> Tiegh.ex Keay. (Ochnaceae)	Nwali (Turka)	Tree	Roots bark/ Decoction/Drink	1
<i>Mangifera indica</i> L. (Anacardiaceae)	Manguier (Français)	Tree	Leaves/Decoction/Drink	1
<i>Parkia biglobosa</i> (Jacq).R.Br.ex G.Don. (Mimosaceae)	Néré (Français)	Tree	Roots/Infusion/Drink	1
<i>Phyllanthus amarus</i> Schumacher. (Euphorbiaceae)				
<i>Piliostigma thonningii</i> (Schum.) Milne-Redh. (Caesalpiniaceae)		Grass	Leaves/Decoction/Drink	1
<i>Pterocarpus erinaceus</i> Poir. (Fabaceae)	Nyamma yiri (Dioula)	Shrub	Leaves/Decoction/Drink	1
			Roots/Decoction/Drink	1
	Balan yiri (Dioula)	Tree	Leaves/Decoction/Drink	1
<i>Saba senegalensis</i> (A.DC.) Pichon var. (Apocynaceae)	Zaban yiri (Dioula)	Creeper	Roots/Infusion/Drink	1
<i>Sarcocephalus latifolius</i> (Sm.) E.A.Bruce (Rubiaceae)	Bâti yiri (Dioula)	Tree	Roots/Decoction/Drink	1
			Leaves/Decoction/Drink	3
<i>Securidaca logepedunculata</i> Fers (Polygalaceae)	Djoro (Dioula)	Shrub	Roots bark/Decoction/Inhalation and enema	2
<i>Tamarindus indica</i> L. (Caesalpiniaceae)	Tamarinier (Français)	Tree	Fruits/Maceration/Drink	1
			Leaves/Decoction/Drink	1
<i>Terminalia macroptera</i> Guill. & Perr. (Combretaceae)	Kougali (Turka)	Tree	Roots bark/ Decoction/Drink	1
<i>Vernonia colorata</i> (Wild.) Drake (Asteraceae)	Koisafine (Turka)	Shrub	Leaves/Decoction/Drink	1
<i>Zingiber officinale</i> Rosc. (Zingiberaceae)	Gnamakou (Dioula)	Grass	Clove/Maceration/Drink	1

Table 2: Taxonomic diversity of hepatoprotective plants checked off in the COMOE.

Families	Number of genres	Number of species
Caesalpiniaceae	4	6
Combretaceae	4	4
Meliaceae	2	2
Mimosaceae	2	2
Asteraceae	2	2
Cochlospermaceae	1	2
Others families	14	14
Total	29	32

Table 3: Results of the Antioxidant Activities and the Phenolic Compounds of the Extracts.

Species	Organs used	Total phenolic content (g EAT/100g DM)	Total tannin content (g EAT/100g DM)	Total flavonoid content (g EQ/100g DM)	Antioxidant capacities TEAC in mM (ABTS)	Reductive power (FRAP) of the ferric ion in ferrous ion (μ M ET/g of dry extract)
<i>C. sieberiana</i>	Leaves	9,89 \pm 0,005 ^e	7,97 \pm 0,23 ^c	1,72 \pm 0,07 ^c	0,11 \pm 0,00 ^{g,h}	79,85 \pm 1,1 ^b
	Roots	8,36 \pm 0,28 ^f	7,18 \pm 0,03 ^d	0,55 \pm 0,07 ^{d,e}	0,26 \pm 0,03 ^e	59,12 \pm 1,1 ^f
<i>D. mespiliformis</i>	Leaves	16,41 \pm 0,30 ^b	Nd	Nd	1,17 \pm 0,00 ^a	70,77 \pm 0,4 ^d
<i>L. lanceolata</i>	Roots bark	14,16 \pm 0,22 ^d	12,72 \pm 0,007 ^b	0,3 \pm 0,01 ^{e,i}	0,67 \pm 0,03 ^d	64,15 \pm 0,5 ^e
<i>P. thonningii</i>	Leaves	14,98 \pm 1,09 ^c	12,62 \pm 0,02 ^b	2,17 \pm 0,13 ^b	0,18 \pm 0,03 ^{f,g}	79,92 \pm 0,7 ^b
	Roots	5,08 \pm 0,06 ^g	3,98 \pm 0,004 ^e	0,11 \pm 0,004 ^f	0,2 \pm 0,02 ^f	83 \pm 0,6 ^a
<i>S. latifolus</i>	Leaves	5,12 \pm 0,33 ^g	4,33 \pm 0,34 ^e	0,6 \pm 0,09 ^d	0,08 \pm 0,005 ^h	58,62 \pm 0,6 ^f
	Roots	1,86 \pm 0,11 ^h	1,36 \pm 0,14 ^f	0,45 \pm 0,07 ^{d,e}	0,05 \pm 0,01 ^h	46,88 \pm 3,3 ^g
<i>T. macroptera</i>	Roots bark	32,44 \pm 0,10 ^a	20,35 \pm 0,61 ^a	5,22 \pm 0,41 ^a	1,09 \pm 0,03 ^b	81,17 \pm 0,5 ^b
<i>Trolox</i>	-----	-----	-----	-----	1,00 \pm 0,00 ^c	-----

EAT/100g of MS = Equivalent Tannic Acid per 100 grams of Dry Matter; EQ/100g of MS = Equivalent Quercetin per hundred gram of Dry Matter; TEAC = Trolox Equivalent Antioxidant Capacity; ET/g = Trolox equivalent per gram of dry extract; Nd: Not determined.

The letters a, b, c, d e, f, g, h indicate the significant differences between the extracts for each test at the probability threshold of 5% if p <0.05.

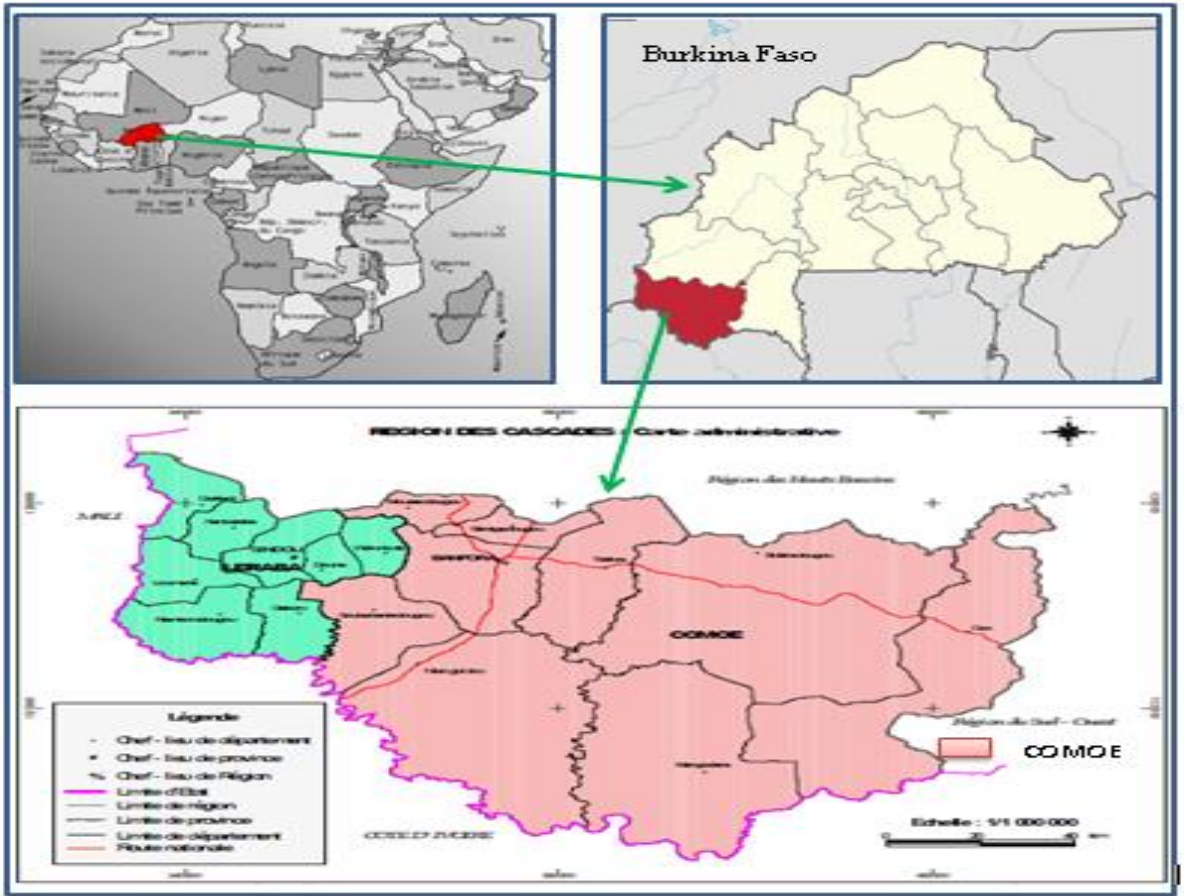


Figure 1: Survey area, Comoe province in the Cascades region: communes of Banfora, Bérégadougou, Moussodougou.

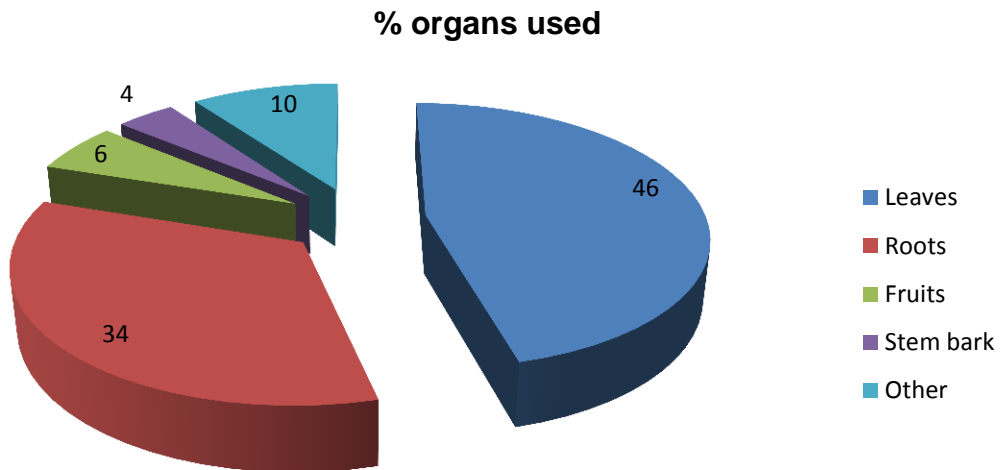


Figure 2: Percentages of the different organs used by the respondents.

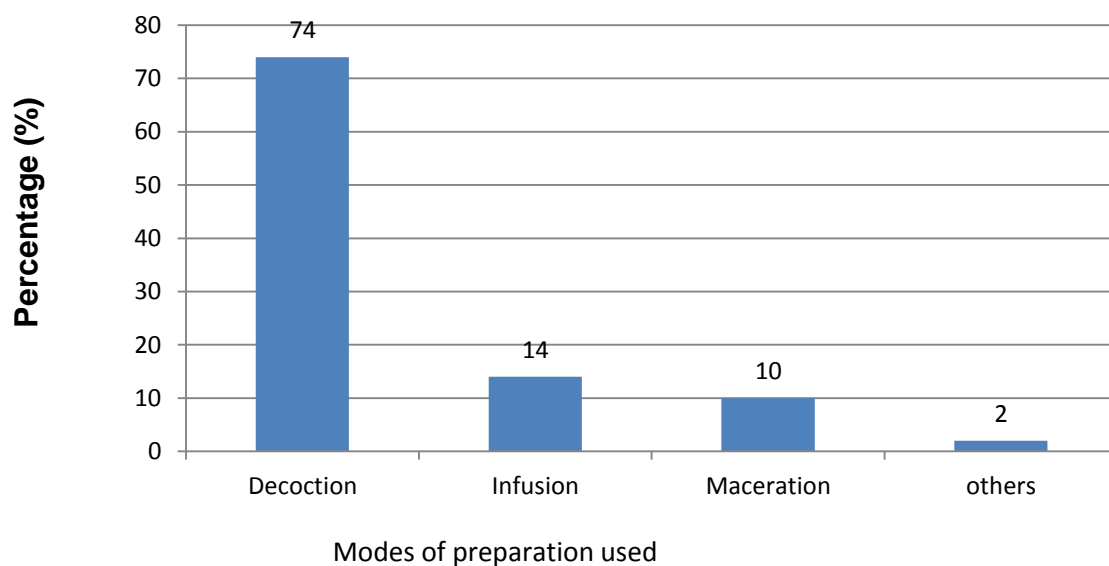


Figure 3: Proportions of the different modes of preparation used by the respondent.

DISCUSSION

Ethnomedical knowledge of hepatoprotective plants

The majority of interviewees in these surveys were men. This may be justified not only by the fact that the transmission of knowledge to most indigenous people in the locality (Turka, Goins, Karaboro) takes place from father to son, but also because hepatitis is not a specific disease to children for whom women have many interests. The survey data have shown that species, *C. tinctorium*, *C. sieberiana* and *S. latifolius* are the best known species in these localities in the treatment of liver diseases with respectively citation index of 13, 5 and 4. Several studies have shown that *Cochlospermum tinctorium*, which is the most widely used species, has hepatoprotective properties (Etuk et al., 2009). By comparing the listed species with those of the literature consulted, it is found that they are used in traditional medicine in other countries for the management of liver diseases (Guinnin et al., 2015; Sangaré et al., 2012). The leaves were the most used organs as indicated by some studies (Megersa et al., 2013); but other studies (Teklehaymanot, 2009) have shown that roots are the most commonly used organs of traditional medicine. Seventy-four percent (74%) of the receipts are decocts, which are close to those

of Afolayan and Wintola (2014) who found 61%. However, these results are contrary to those of Gueye et al. (2012) who found that 57% of the recipes were macerated.

Antioxidant Activities and Phenolic Compounds

Hepatitis B or C virus infection causes free radicals to be produced in order to destroy the virus. These free radicals, produced in excess, attack the lipid and protein constituents of the hepatocytes and cause cellular lesions (Gulam Waris and Haseeb Ahsan, 2006). These lesions may develop, in the event of chronicity to fibrosis, cirrhosis and hepatocellular carcinoma. Antioxidants, known for their anti-free radical properties, could be a therapeutic means in viral hepatitis. In this study, both tests (ABTS and FRAP) showed that the extracts contained antioxidants. The FRAP test expresses the potential of the extracts to supply electrons to ferric ions (Fe^{3+}) in order to reduce them to ferrous ions (Fe^{2+}) (Wojdylo et al., 2007). This shows that the extracts contain reducing compounds capable of allowing them to react with the free radicals by converting them into stable products. All the extracts studied could be classified as having a strong reducing power according to the classification of Wojdylo et al. (2007), which shows that

extracts which have a reducing power greater than 5 µM ET/g are said to be extracts with a high reducing power. The ABTS test reveals that the extracts have the ability to stabilize the ABTS^{•+} cationic radical by trapping. This shows the ability of the extracts to trap free radicals. Molecules in the extracts transferred hydrogen to the radical to neutralize it (Mukherjee et al., 2011).

A low correlation ($R^2 = 0.63$) has been obtained between total phenolic contents and TEAC antioxidant capacities of the extracts compared to that obtained 0.94 by Ewa et al. (2009). This could be explained, on the one hand, by the non-specificity of the Folin-Ciocalteu reagent to phenolic compounds (Athamena et al., 2010) and on the other hand by the existence in the extracts of other non-phenolic compounds with antioxidants properties such as carotenoids, sterols, terpenoids. Studies have reported that the roots of *C. sieberiana* possess antioxidant power (Nartey et al., 2012) and contain terpenes, sterols, polyphenols and flavonoids (Traoré et al., 2015). Tannins, flavonoids and terpenoids have been characterized in the leaves of *D. mespiliformis* (Dangoggo et al., 2012). Studies have also reported that root and leaf extracts of *P. thonningii* have good anti-knocking activities ABTS and FRAP (Dieng et al., 2017). Other studies have shown that the roots of *P. thonningii* contain tannins, terpenoids but do not contain flavonoids (Amon et al., 2013), while the leaves contain flavonoids, tannins and terpenoids (Kwaji et al., 2010). Flavonoids and tannins were characterized in the leaves of *S. latifolius* (Edewor et al., 2015). Koné et al. (2012) showed that the roots of *T. macroptera* contain flavonoids and possess good antioxidant capacity (TEAC). These species would therefore be rich in antioxidant compounds that could protect the liver from the oxidative stress caused by hepatitis viruses (Haque et al., 2014).

Conclusion

The study has gathered traditional medical knowledge of the province in the field of the management of liver diseases. The results obtained thus constitute a safeguard of the local knowledge and especially the materials for a scientific evaluation of the pharmacodynamics substances of the listed species. The results of preliminary

phytochemical evaluation thus make it possible to affirm that the phenolic compounds are not the only compounds responsible for the antioxidant activity of the aqueous extracts of the most cited plants, here evaluated. Other types of extracts, in addition to this, should be carried and tested *in vitro* and *in vivo* in order to better apprehend their hepatoprotective activity.

COMPETING INTERESTS

The authors declare that they have no competing interests.

AUTHORS' CONTRIBUTIONS

The survey and sample collection were carried out by ENS. ENS, JYN, TKT, participated in the extraction, the determination of polyphenols and the antioxidant tests. The results obtained were statistically analyzed by ENS and AT. The work was supervised by NO, AT, AH, PIG and OGN. Finally, the writing of the manuscript was done by ENS, NO, AT and AH.

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REFERENCES

- Abdel-Hameed. 2009. Total phenolic contents and free radical scavenging activity of certain Egyptian Ficus species leaf samples. *Food Chemistry*, **114**: p1271-1277. DOI: <https://doi.org/10.1016/j.foodchem.2008.11.005>
- Afolayan AJ, Wintola OA. 2014. A survey of medicinal plants used in the treatment of dysentery in amathole district municipality, South Africa. *Pak. J. Bot.*, **46**(5): 1685-1692.
- Amon TT, Vershima AJ. 2013. Phytochemical evaluation and antibacterial activity: A comparison of various extracts from some Nigerian trees. *Peak Journal of*

- Medicinal Plant Research*, **1**(2): 13-18. DOI: 10.13140/RG.2.2.30726.16966
- Athamena S, Chalghem I, Kassah-Laouar A, Laroui S, Khebri S. 2010. Activité antioxydante et antimicrobienne d'extraits de *Cuminum cyminum* L. Lebanese. *Science Journal*, **11**(1): 69-81.
- Dangoggo SM, Hassan LG, Sadiq IS, Manga SB. 2012. Phytochemical Analysis and Antibacterial Screening of Leaves of *Diospyros Mespiliformis* and *Ziziphus Spina-Christi*. *Journal of Chemical Engineering*, **1**(1): 31-35.
- Dieng SIM, Fall AD, Diatta-Badji K, Sarr A, Sene M, Sene M, Mbaye A, Diatta W, Bassene E. 2017. Evaluation de l'activité antioxydante des extraits hydro-ethanoliques des feuilles et écorces de *Piliostigma thonningii* Schumach. *Int. J. Biol. Chem. Sci.*, **11**(2): 768-776. DOI: <https://dx.doi.org/10.4314/ijbcs.v11i2.19>
- Edewor TI, Owa SO, Oladipupo SS, Oyelakin RA. 2015. Determination of the Total Phenolic, Flavonoid Contents; Antioxidant Activity and GC-MS Study of the leaves of the Medicinal Plant *Sarcocephalus latifolius*. *Int. J. Pharm. Sci. Rev. Res.*, **34**(2): 82-86.
- Etuk EU, Francis UU, Garba I. 2009. Regenerative action of *Cochlospermum tinctorium* aqueous root extract on experimentally induced hepatic damage in rats. *African Journal of Biochemistry Research*, **3**(1): 001-004.
- Ewa J-R, Marta Z-K, Janusz K. 2009. Antioxidant capacity, ascorbic acid and phenolics content in wild edible fruits. *Journal of Fruit and Ornamental Plant Research*, **17**(2):115-120.
- Gulam Waris, Haseeb Ahsan. 2006. Reactive oxygen species: role in the development of cancer and various chronic conditions. *Journal of Carcinogenesis*, **5**: 1-8. DOI: 10.1186/1477-3163-5-14
- Gueye M, Cissé A, Diatta CD, Diop S, Koma S. 2012. Etude ethnobotanique des plantes utilisées contre la constipation chez les Malinké de la communauté rurale de Tomboronkoto, Kédougou (Sénégal). *Int. J. Biol. Chem. Sci.*, **6**(2): 773-781. DOI: <http://dx.doi.org/10.4314/ijbcs.v6i2.19>
- Guinnin FDF, Sacramento TI, Sezan A, Atebo J-M. 2015. Etude ethnobotanique des plantes médicinales utilisées dans le traitement traditionnel des hépatites virales B et C dans quelques départements du Bénin. *Int. J. Biol. Chem. Sci.*, **9**(3): 1354-1366. DOI: <http://dx.doi.org/10.4314/ijbcs.v9i3.20>
- Haque A, Tahmina ASK, Sarker IR, Hossain M, Islam S, Islam A. 2014. Antioxidant and hepatoprotective effects of aqueous and ethanol extracts of *Dendrophthoe falcata* Linn leaves. *Pharmacology OnLine*, **1**: 90-101.
- Hinneburg I, Damien-Dorman HJ, Hiltunen R. 2006. Antioxidant activities of extracts from selected culinary herbs and spices. *Food Chemistry*, **97**(1): 122-129. DOI: 10.1016/j.foodchem.2005.03.028
- Koné D, Diop B, Diallo D, Djilani A, Dicko A. 2012. Identification, Quantitative Determination, and Antioxidant Properties of Polyphenols of Some Malian Medicinal Plant Parts Used in Folk Medicine. *Macro to Nano Spectroscopy*, **2012**: 131-142, www.intechopen.com
- Kwaji A, Bassi PU, Aoill M, Nneji CM, Ademowo G. 2010. Preliminary studies on *Piliostigma thonningii* Schum leaf extract: Phytochemical screening and in vitro antimalarial activity. *African Journal of Microbiology Research*, **4**(9): 735-739.
- Megersa M, Asfaw Z, Kelbessa E, Beyene A, Woldeab B. 2013. An ethnobotanical study of medicinal plants in Wayu Tuka District, East Welega Zone of Oromia Regional State, West Ethiopia. *Journal of Ethnobiology and Ethnomedicine*, **9**(1): 68.
- Mukazayire MJ, Minani V, Ruffo CK, Stévigny EB, Stévigny C, Duez P. 2011. Traditional phytotherapy remedies used in Southern Rwanda for the treatment of liver diseases. *Journal of Ethnopharmacology*, **138**: 415– 431. DOI: 10.1016/j.jep.2011.09.025
- Mukherjee S, Pawar N, Kulkarni O, Nagarkar B, Thopte S, Bhujbal A, Pawar P. 2011. Evaluation of free-radical quenching properties of standard Ayurvedic formulation Vayasthapana Rasayana. *BMC Complementary and Alternative Medicine*, **11**: 38. DOI: 10.1186/1472-6882-11-38
- Nartey ET, Ofosuhene M, Kudzi W, Agbale, CM. 2012. Antioxidant and gastric

- cytoprotective prostaglandins properties of *Cassia sieberiana* roots bark extract as an anti-ulcerogenic agent. *US National Library of Medicine National Institutes of Health*, p1-10
- N'Guessan K, Kadja B, Zirih GN, Traoré D, Aké-Assi L. 2009. Screening phytochimique de quelques plantes médicinales ivoiriennes utilisées en pays Krobou (Agboville, Côte-d'Ivoire). *Sciences & Nature*, **6**(1): 1-15
- OMS, 2012. Prévention et lutte contre l'hépatite virale : Cadre pour l'action mondiale. WHO/HSE/PED/HIP/GHP 2012.1
- OMS, 2014. Hépatites. Soixante-septième assemblée mondiale de la santé. <http://www.who.int/csr/disease/hepatitis/GHP>
- Re R, Pellegrini N, Prottegent A, Pannala A, Yang, M, Rice-Evans, C. 1999. Antioxidant activity applying an improved ABTS radical cation decolorization assay. *Free Radical Biology and Medicine*, **26**(9/10): 1231-1237.
- Sangaré MM, Sina H, Dougnon J, Bayala B, Ategbo J-M, Dramane KL. 2012. Etude ethnobotanique des plantes hépatotropes et de l'usage traditionnel de *Gomphrena celosoides* Mart. (Amaranthaceae) au Bénin. *Int. J. Biol. Chem. Sci.*, **6**(6): 5008-5021. DOI : <http://dx.doi.org/10.4314/ijbcs.v6i6.20>
- Schwierz C, Thiry N, Van de Sande S. 2011. *Évaluation économique du traitement antiviral de l'hépatite B chronique en Belgique – Tome 2*. Centre fédéral d'expertise des soins de santé (KCE).
- Singleton VL, Orthofer R, Lamuela-Raventós RM. 1999. Analysis of total phenols and other oxidation substrates and antioxidants by means of folin-ciocalteu reagent. In P. Lester (Ed.), *Methods in Enzymology*, **299**: p152-178. DOI: [https://doi.org/10.1016/S0076-6879\(99\)99017-1](https://doi.org/10.1016/S0076-6879(99)99017-1)
- Teklehaymanot T. 2009. Ethnobotanical study of knowledge and medicinal plants use by the people in Dek Island in Ethiopia. *Journal of Ethnopharmacology*, **124**(2009): 69-78. DOI: [doi:10.1016/j.jep.2009.04.005](https://doi.org/10.1016/j.jep.2009.04.005)
- Thevenot T, Martini VD, Lunel-Fabiani F, Vanlemmens C, Becker M, Bronowicki J, Bresson-Hadni S, Miguet J. 2006. Traitements complémentaires de l'hépatite chronique virale C. *Gastroenterol Clin Biol*, **30**: p197-214
- Tibiri A, Rakotonandrasana O, Nacoulma GO, Banzouzi J.T. 2007. Radical Scavenging Activity, Phenolic Content and Cytotoxicity of *Entada africana* Guill. et Perr. (Mimosaceae). *Journal of Biological Sciences*, **7**(6): 959-963. DOI: [10.3923/jbs.2007.959.963](https://doi.org/10.3923/jbs.2007.959.963)
- Traoré L, Bekro Y, Pirat J, Bekro JA. 2015. Study of crude extracts from *Cassia sieberiana* root bark and *Khaya grandifoliola* trunk bark: phytochemical screening, quantitative analysis and radical scavenging activity. *International Journal of Current Pharmaceutical Research*, **7**(3): 22-26.
- Twedt DC. 2006. Nouvelles approches thérapeutiques des affections hépatiques: la SAME. *Pratique médicale & chirurgicale de l'animal de compagnie*, **41**(4): 269-272.
- WHO, 2004. Department of Measurement and Health Information. Estimated total deaths by cause and WHO Member State, 2002. www.who.int/evidence/bod
- Wojdyło A, Oszmianski J, Czemerys R. 2007. Antioxidant activity and phenolic compounds in 32 selected herbs. *Food Chemistry*, **105**: 940-949. DOI: <https://doi.org/10.1016/j.foodchem.2007.04.038>.