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REVIEW ARTICLE

A review on medicinal plants used in the management of liver diseases in West Africa

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Abstract
In West Africa, there is an extensive demand of plants traditionally used against liver diseases. This review gathered information on the plants used for the traditional management of liver diseases in West Africa. A literature review was used to gather information on medicinal plants such as the scientific names, the parts used, the forms prepared and the main liver diseases treated. Citation frequency and convergence score were calculated for each species. The findings presented 24 articles published in West Africa with a total of 401 species distributed in 283 genera belonging to 103 families. The Fabaceae family was the most represented with 73 species. The most cited species were *Carica papaya* L. (Caricaceae), *Citrus aurantifolia* (Christm.) Swing. (Rutaceae), *Cochlospermum tinctorium* Perr. ex A. Rich (Cochlosmarmaceae), *Entada africana* Guill. And Perr. (Fabaceae), *Parkia biglobosa* (Jacq.) R.Br. ex G.Don (Fabaceae) and *Phyllanthus amarus* Schumach. & Thonn. (Euphorbiaceae). These plant species presented the highest citation frequencies and convergence scores. The leaves were mostly used in the form of decoction. The main diseases recorded were related to jaundice. Safety, quality and efficacy data on some of these plants justify their traditional uses and will contribute to the development of new phytomedicines against liver diseases.

Keywords: Medicinal plants, Liver diseases, West Africa

INTRODUCTION

Liver diseases, dominated by viral hepatitis, are today a major public health problem. Viral hepatitis caused 1.34 million deaths in 2015. In 2017, the number of people with chronic hepatitis B virus (HBV) infection was estimated at 257 million while the one for hepatitis C virus (HCV), is about 71 million [1]. Hepatitis B is highly endemic in West Africa, with a prevalence of 8 %, and it represents the highest in the world [2]. In Mali, 90 % of medical consultations from the medical sciences department of the Department of Traditional Medicine (known as DMT derivative from the French name Département Médecine Traditionnelle)

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concern patients with liver diseases [3]. In addition, 62.37% of hospitalized patients in the hepato-gastroenterology department of the university hospital center "Gabriel TROURE" used medicinal plants to treat liver diseases, in particular hepatitis B (28.3%) [4]. The modern drug used to manage liver diseases are very expensive and often ineffective. In this context, the use of medicinal plants is an important alternative path to explore in order to validate traditional uses. The main plants used have already been identified during ethnobotanical surveys and have been scientifically investigated by the DMT. The results of experimental researches from DMT led to the development of Improved Traditional Medicines (ITM) with marketing authorization. These ITM include HEPATISANE® based on the leaves of *Combretum micranthum* G. Don. (Combretaceae), SAMANERE® based on the roots of *Entada africana* Guill. And Perr. (Fabaceae) and COCHLOS® based on the rhizome of *Cochlospermum tinctorium* Perr. ex A. Rich (Cochlospermaceae). These ITM are indicated in the management of liver disorders, in particular hepatitis. Several researches have already been done on the management of liver diseases.

In the process of finding new ITM, the present study aimed to record medicinal plants used in West Africa for the traditional treatment of liver diseases.

METHODS

A relevant literature review was carried out in order to gather information about the plants used in the traditional treatment of liver diseases in West Africa. The search engines used were mainly Google, Google Scholar, PubMed, ScienceDirect and Prota. The data were collected using defined search terms including plants, traditional treatment, traditional management, liver ailments, liver diseases, liver disorders, West Africa (the names of West African countries were often cited instead of West Africa). The collected data concerned the scientific names of plants, the parts of plants used, the administration and dosage forms of use, and the different types of liver disorders treated with the medicinal plants. A literature investigation about the safety, efficacy and quality data was performed on the most cited plants. The efficacy data concerned the pharmacological activities which justify the traditional use in the management of liver diseases.

Data analysis. The data obtained were entered and analyzed using Excel version 13 software. The frequency of citation (Fc) of each plant, the score (S) of convergence and geographical spread were calculated according to the equations reported by Haïdara and colleagues in 2020 [5].

$$Fc = \frac{Frequency\ of\ citation}{Total\ number\ of\ citations\ of\ all\ species} \times 100 \ldots. (1)$$

$$S = I1 \times I2 \ldots\ldots\ldots\ldots (2)$$

I1 = Number of articles (excerpts from the literature review) that mention the use of the species in the treatment of liver diseases

I2 = Number of countries where the use of this species is reported for the treatment of liver diseases.

RESULTS

Findings revealed that 24 research articles published in 8 West African countries were examined. These articles are distributed as follow: Benin (3) [6-8], Burkina Faso (4) [9-12], Ivory Coast (2) [13, 14], Ghana (1) [15], Mali (3) [4, 16, 17], Nigeria (8) [18-25], Senegal (1) [26], Togo (2) [27, 28]. A total of 401 species, from 283 genera and belonging to 103 families, were listed. The botanical families mostly represented by the largest number of species are Fabaceae (73 species), Asteraceae (28 species), Rubiaceae (20 species), Euphorbiaceae (18 species) and Combretaceae (16 species). The total number of citations of all species was 885. *Carica papaya* was the most cited species with 11 citations (Fc = 1.24%), *Citrus aurantifolia*, *Cochlospermum tinctorium* were cited 10 times each (Fc = 1.13%). *Entada africana*, *Parkia biglobosa* and *Phyllanthus amarus*

were cited 9 times (Fc = 1.02 %). The score of convergence was also calculated and presented as follow: *C. papaya* (S = 66), *C. aurantifolia* and *C. tinctorium* (S = 60). *P. biglobosa* (S = 54) and *S. latifolius* (S= 48) were each cited in 6 countries and presented the highest scores (see Table 1).

All plant parts are used, the highest citation numbers were respectively for leaves (318 times), stem barks (195 times), roots (139 times), whole plant (89 times), seeds (38 times), fruits (33 times) and other parts were mentioned less than 30 times (see Table 2). Aqueous preparations were the most cited traditional forms, in particular the decoction (301 times), the infusion (43) and the maceration (34 times) (see Table 3). The main diseases cited are reported in Table 4. There is preclinical data on the most cited plants. Some of these data may justify the use of these plants in the management of liver diseases.

***Carica papaya* L. (Caricaceae)**

The aqueous leaf extracts of *C. papaya* significantly reduced biochemical parameters (transaminases, alkaline phosphatase (ALP) and total bilirubin (BT)) and levels of thiobarbituric acid reactive substances (TBARS) but increased antioxidant enzymes such as glutathione reductase (GSH) and superoxide dismutase (SOD) indicating their antioxidant effect in rats with hepatotoxicity induced by ethanol and antituberculosis drugs (isoniazid and rifampicin) [29]. Hepatic damage caused in rats by carbon tetrachloride was significantly reduced (decreased biochemical parameters and decreased in the level of histological damage) by aqueous and ethanolic extracts of seeds and fruits [30, 31]. A benzene fraction of the aqueous extract of the seeds prevents cancer [32]. The leaf extracts have shown inhibitory properties against cancer cells of breast [33], prostate [34], squamous cell carcinoma [35] and pancreas [36]. In 2010 Anaga and Onehi demonstrated the analgesic and anti-inflammatory properties of the methanolic seed extracts [37]. Several types of inflammation induced in laboratory animals were reduced by the ethanolic leaf extract [38, 39] and the methanolic seed extracts [40]. The pure methanolic extract of the fruit showed anti-inflammatory action [41]. The ethanolic, ethyl acetate and n-hexane extracts significantly reduced ($p<0.05$) pain induced by acetic acid in mice [42]. *C. papaya* also has immunostimulating properties [43-45]. Numerous studies have also reported the antiradical and antioxidant properties of *C. papaya* [38, 43]. The aqueous leaf extract of *C. papaya*, up to a dose of 2000 mg/kg (single dose) did not cause mortality or significant changes in body weight and diet of rats after 14 days of monitoring [46]. Laboratory rats did not show mortality or change in general behavior or other physiological activities 42 days after administration of hydroethanolic extracts of leaves and seeds up to a dose of 640 mg/kg [47]. Administration of 10 mL/kg of the aqueous extract of the root (10 g macerated in 500 mL of water) to mice for 14 days showed no obvious signs of toxicity [41].

***Citrus aurantifolia* (Christm.) Swing. (Rutaceae).** *C. aurantifolia* had hepatoprotective potential against liver damage caused by paracetamol [48]. Different extracts of leaves, trunk barks, fruits and seeds as well as compounds isolated from the latter were active against cancer cells of larynx and rhabdomyosarcoma [49], lung and breast [50], colon and rectum [51] and pancreas [52]. The decoction of the mixture of fruits and leaves of *C. aurantifolia* and seeds of *Aframomum melegueta* exhibited analgesic activity by increasing the residence time of the paws of guinea pigs in hot water and anti-inflammatory effect by decreasing the formalin induced inflammation to the feet of these same animals [53]. Amorim *et al*. (2016) also reported the analgesic and anti-inflammatory activity of fruit essential oils [54]. *C. aurantifolia* also has antiradical and antioxidant properties [50, 55, 56]. Administration of an aqueous root extract

did not cause acute or subchronic (90 days) toxicity in rats up to the respective doses of 5000 and 1200 mg/kg orally [57].

***Cochlospermum tinctorium* Perr. ex A. Rich (Cochlospermaceae).** The aqueous extracts of leaves and roots of *C. tinctorium* exhibited hepatocurative properties in rats with CCl_4 damaged livers [58, 59]. A clinical study conducted in Benin on a remedy based on *Combretum micranthum* leaves and *C. tinctorium* roots caused clinical and biochemical improvement (decrease in transaminases) and disappearance of the HBs antigen in 4.17% of cases in patients with hepatitis B [60]. A methanolic leaf extract significantly decreased alanine aminotransferase (ALT), aspartate aminotransferase (AST), cholesterol, bilirubin, and malondialdehyde (MDA) in rats with carbon tetrachloride-damaged livers (CCl_4) [61]. Triterpenes isolated from the methanolic extract of *C. tinctorium* rhizomes have demonstrated antitumor properties on skin tumors [62, 63]. The anti-inflammatory and analgesic activity of hydromethanolic extracts of leaves, roots and root bark have been demonstrated by Ahmed *et al*., (2011) [64]. The ethanolic extract of the root showed immunomodulatory properties [65]. The antiradical activity of *C. tinctorium* extracts has also been reported by authors [65-67]. Single dose administration of the aqueous extract of the roots and leaves of *C. tinctorium* at a dose of 5000 mg/kg caused no mortality and no signs of toxicity [68]. Administration of 100 mg to 2 g/kg powder dissolved in 2 ml of water for ten days in rats showed no signs of intoxication [69]. The work carried out at DMT has led to the development of an ITM, "COCHLOS®" based on *C. tinctorium* rhizomes. With hepatoprotective properties, this ITM is used in the treatment of jaundice syndrome and hepatitis.

***Entada africana* Guill. and Perr (Fabaceae)** A clinical study conducted by Douaré in 1991 on patients with hepatitis B showed that after a month and a half of treatment, jaundice disappeared in 93.33% of cases with 100% normalization of transaminases ALT and AST [70]. Tietcheu et al. (2014) demonstrated a significant inhibition of hepatitis C virus replication by dichloromethane/methanol (DCM/MeOH) extracts of stem bark [71]. The hepatoprotective properties of root decoction in mice with CCl_4-damaged livers have been reported by Sanogo et al. (1998) [72]. DCM/MeOH extracts from stem bark protected against paracetamol-induced intoxication on isolated rat liver hepatocytes [73]. The F_{10} fraction of the DCM/MeOH extract of trunk bark showed hepatoprotective effects in mice poisoned by CCl_4 and on normal human liver cells of the L-02 hepatocyte line [74]. The root, stem bark and leaf decoctions significantly reduced the level of transaminases (ALT and ASP) in rats poisoned by CCl_4 [75]. The flavonoids (apigenin and robinetin) isolated from the roots have demonstrated anti-angiogenic properties [76]. The cytotoxic activity of *E. africana* has also been reported [77, 78]. Studies of Owona *et al*. (2013a and 2013b) demonstrated the efficacy of DCM/MeOH extracts from trunk barks on lipopolysaccharide (LPS)-induced inflammation in a mouse microglia N9 cell line and in the macrophage RAW 264.7 model [79, 80]. The *in vitro* anti-inflammatory activity of ethanolic leaf extracts and its fractions was also demonstrated by Toafode et al. (2021) [81]. Polysaccharides isolated from the roots have immunostimulant properties [82]. Kouam et al. (2020), Njayou et al. (2016), Kwaji et al. (2017), Tibiri et al. (2010) reported the antioxidant and radical-scavenging properties of *E. africana* [73, 74, 83, 84]. Decoctions of leaves stem bark and roots of *E. africana* did not show acute toxicity up to a dose of 2000 mg/kg by gavage in mice [75]. Repeated administration of extemporaneous 1% decoction (the traditional form of use) of the roots at a dose of 10 ml/kg per os once daily for 3 months in rats did not cause death [85].

"SAMANERE®" is an ITM of DMT based on the root of *E. africana* which has hepatoprotective properties and is used in the treatment of jaundice syndrome and hepatitis.

***Parkia biglobosa* (Jacq). R.Br. ex G.Don (Fabaceae).** Administration of methanolic stem bark extracts significantly reduced AST, ALT and ALP levels initially elevated by paracetamol in rats [86]. The methanolic extract of *P. biglobosa* significantly decreased AST, ALT, lactate dehydrogenase (LDH), lipid peroxidation and increased catalase (CAT), SOD and GSH in ethanol poisoned rats [87]. The lectin isolated from the seeds exhibited potent antinociceptive activity and inhibited the inflammatory process [88]. The methanolic stem extracts reduced inflammation induced by various proinflammatory products in rats [89]. The ethanol extracts of leaves and stem bark showed activities against lipopolysaccharide-induced inflammation [90]. *P. biglobosa* also exhibited immunostimulant [91], antiradical and antioxidant properties [87, 92, 93]. The aqueous fractions from the methanolic extract of the leaves, stem barks and roots of *P. biglobosa* are only slightly toxic with respective LD_{50} of 3807; 565.7 and 1131 mg/kg intraperitoneally (IP) in mice [94]. The LD_{50} of aqueous and methanolic extracts of stem bark is greater than 5000 mg/kg per os in rats [95].

***Phyllanthus amarus* Schum. and Thomas. (Euphorbiaceae).** The treatment of hepatitis B patients with *P. amarus* significantly reduced lipid peroxidation and increased the activity of SOD, GPx (glutathione peroxidase), CAT, the level of vitamins E and C [96]. Aqueous extracts of *P. amarus* roots showed significant activity against bovine viral diarrhea virus, a surrogate for hepatitis C virus [97]. Aqueous leaf extracts of *P. amarus* significantly lowered biochemical parameters (AST, ALT, ALP, total protein (TP)) in rats poisoned by acetaminophen [98]. The methanolic extracts of the whole plant of *P. amarus* inhibited pancreatic, colon, ovarian, lung, skin, prostate, neuroblastoma, breast, and glioblastoma cancer cell lines [99]. The lignan-rich fraction of crude methanolic extract induces apoptosis in cervical cancer cells [100]. The pretreatment with a mixture of leaf-isolated lignans significantly decreased proinflammatory cytokines and hepatotoxic markers *in silico* approach and *in vivo* in mice [101]. The 80% methanolic extracts of *P. amarus* significantly inhibited the production of proinflammatory mediators (TNF-α, IL-β, PGE2) and the expression of COX 2 in human macrophages [102]. In 2013 Kiran and Rao reported the anti-inflammatory activity of lignans and phyllanthines isolated from *P. amarus* [103]. Some authors have also demonstrated the *in vitro* and *in vivo* antioxidant activity of extracts of *P. amarus* [99, 104] . Up to a dose of 1600 mg/kg per os, aqueous leaf extracts did not cause deaths or visible signs of toxicity [105]. The aqueous and hydroethanolic extracts of the whole plant do not show acute toxicities at 5000 mg/kg and subchronic at 3000 mg/kg orally in mice and rats respectively [106].

***Cochlospermum planchonii* Hook.f. (Cochlospermaceae).** Zinc formate, isolated from the aqueous extract of the rhizome and an inhibitor of cytochrome P450, protects rats against hepatic damage induced by CCl_4 [107]. The methanolic leaf extracts prevent prostaglandin synthesis by selectively inhibiting COX1 [108]. The hydroethanolic leaf and root extracts have also shown anti-inflammatory properties by different experimental methods in mice and rats [109-111]. Pain induced in animals by acetic acid and formalin was reduced by hydroethanolic leaf and root extracts and hydromethanolic root extracts [109, 110]. The hydromethanolic root extracts significantly inhibit acetic acid and formalin-induced pain and carrageenan-induced inflammation [109]. *C. planchonii* extracts have also demonstrated antiradical and antioxidant activities *in vivo* and *in vitro* [108, 111, 112]. The hydromethanolic root extracts

did not cause death after 48 hours of observation up to the dose of 1000 mg orally; however, some clinical signs could be observed (drowsiness, depression, reduced activity and common agglutination) [109].

***Coco nucifera* L. (Arecaceae)**

The methanolic stem bark extracts of *C. nucifera* significantly reduced the level of transaminases (AST and ALT), ALP, bilirubins and histological damage in rats with livers damaged by paracetamol [113]. The administration of *C. nucifera* water vinegar to mice intoxicated by acetaminophen decreased biochemical parameters (AST, ALT and ALP), the level of cytochrome P450, hepatic inflammation; restored the level of prooxidant and antioxidant enzymes and improved histological damage [114]. Compounds isolated from ethyl acetate extract of coconut endocarp were active against SARS-Cov-2 [115]. The aqueous extract of coconut fiber and one of its catechin-rich fractions exhibited inhibitory activity against acyclovir-resistant Herpes simplex virus type 1[116]. Various studies carried out on extracts and compounds isolated from *C. nucifera* have demonstrated inhibitory properties against colon cancer [117], human erythroleukemia [118], cervix and prostate cancer [119]. Previous authors have reported the analgesic and anti-inflammatory activities of aqueous extracts of fruit fibers on experimental models of pain and inflammation [120, 121]. Oil extracted from coconut has analgesic and anti-inflammatory properties [122]. *C. nucifera* extracts reduced oxidative stress and inhibited several free radicals [114, 119, 123]. Coconut oil did not show chronic toxicity at 5000 mg/kg and subchronic toxicity at 2000 mg/kg in rats by the oral route [124]. Administration of aqueous leaf extracts by the IM route for 4 days at 1000 mg/kg did not cause death or major signs of toxicity in mice [125].

***Combretum micranthum* G. Don. (Combretaceae).** The administration of aqueous extracts of *C. micranthum* leaves to rats poisoned by paracetamol significantly reduced the biochemical parameters (AST, ALT, ALP and PT) [126]. A clinical study conducted in Benin on a remedy based on *C. micranthum* leaves and *C. tinctorium* roots showed clinical and biochemical improvement (decrease in transaminases) and disappearance of the HBs antigen in 4.17% of patients cases in patients with hepatitis B [60]. The methanolic extracts of the leaves showed activities against Herpex simplex viruses 1 and 2 [127]. The inflammation induced in rats and mice by different algogenic products was significantly reduced by the methanolic leaf extracts [128]. Aqueous leaf extracts also possessed analgesic and anti-inflammatory properties [129]. Several types of free radicals were inhibited by *C. micranthum* extracts [130-132]. The LD_{50} of infused leaves of *C. micranthum* was greater than 2000 mg/kg in rats [133]. The hydroethanolic extracts of the leaves do not show acute toxicity at 5000 mg/kg and subchronic toxicity at 1000 mg/kg in rats per os [131]. In Mali, there is an ITM, "HEPATISANE®", based on the leaves of *C. micranthum*. It has cholagogue properties and it is used in the symptoms of hepatic insufficiency with digestive-biliary manifestations.

***Mitragyna inermis* (Willd.) O. Kuntze. (Rubiaceae).** The methanolic root extracts significantly improved biochemical parameters (ALT, ASP, ALP, bilirubins) and raised the level of antioxidant enzymes (vit A and E, CAT, SOD, GSH, GPx) in rats with paracetamol-damaged livers [134]. ALT and ASP levels were significantly lowered by the etheric extract of stem bark in rats poisoned with CCl_4 [135]. Methanolic and dichloromethane extracts of *M. inermis* leaves exhibited antiviral activities against Poliovirus, Rhinovirus 2 and Herpes simplex virus 1[136]. The decoction of leafy twigs inhibited pain induced by acetic acid in mice [137]. *M. inermis* had immunostimulating properties [138]. Studies have also reported

antioxidant activity *in vivo* and *in vitro* [134, 139]. The LD_{50} of aqueous extracts of stem bark was greater than 2000 mg/kg orally and equal to 1587.5 mg/kg in rats administered IP [140]. The aqueous macerated fruits of *M. inermis* did not show any deaths or signs of toxicity up to a dose of 2000 mg/kg per os in rats [141]. In subacute toxicity studies (300-3000 mg/kg per os) of 14 days, no significant change in body weight and no adverse effects on liver function were observed, but, on the other hand, a decrease in liver weight and increased white blood cell count at doses ≥ 1000 mg/kg of the aqueous extract were noted [41].

***Sarcocephalus latifolius* (J.E Sm.) Bruce Magpar (Rubiaceae).** The aqueous root bark extracts caused a decrease in mortality due to CCl_4 in mice [142]. In 2010 Yesufu *et al*. showed that aqueous root bark extracts protect against CCl_4-induced hepatotoxicity in rats by significantly lowering levels of ALT, AST, and total (TB) and conjugated (CB) bilirubins [143]. The methanol and methanol/acetone extracts of fruits, rich in polyphenols, significantly restored the activity of biomarkers of liver functions (ALT, ASP, PAL, BL, PT, albumin), decreased the relative weights of the liver compared to the weight and improved liver damage in rats poisoned with lead acetate [144]. The leaf extracts demonstrated hepatoprotective and rat-protective activities, while root extracts showed antihepatotoxic effects [41]. The ethanolic root extract showed virucidal activity against Herpes simplex virus type 1 and African swine fever virus [145]. The ethanolic and aqueous leaf extracts showed antiviral activity against Newcastle disease virus [146]. The lung, breast and prostate cancer cells were inhibited by methanol/dichloromethane solvent mixture extracts of the roots [147]. The extracts of total alkaloids from leaves, stem barks and roots also showed activity against breast cancer cells [148]. Several studies have reported the analgesic activity [148, 149] and anti-inflammatory property [150, 151] of *S. latifolius*. Polysaccharides from aqueous extracts of the trunk bark of *S. latifolius* showed immunostimulant activity [152]. *S. latifolius* also possessed antiradical and antioxidant properties *in vivo* and *in vitro* [144, 151, 153]. The aqueous macerated fruits of *S. latifolius* did not show any deaths or signs of toxicity up to a dose of 2000 mg/kg per os in rats [141]. Subchronic administration of ethanolic root extracts did not show significant changes in biochemical parameters (ALT, AST, ALP) and in the liver at a dose of 500 mg/kg in rats [154].

Table 1: Frequency of citation and score of convergence of the main plants cited

Plant	Family	Number of citations	Frequency of citations	Number of countries	Score of convergence
Carica papaya	Caricacae	11	1.24	6	66
Citrus aurantifolia	Rutaceae	10	1.13	6	60
Cochlospermun tinctorium	Cochlospermaceae	10	1.13	6	60
Entada Africana	Fabaceae	9	1.02	4	36
Parkia biglobosa	Fabaceae	9	1.02	6	54
Phyllantus amarus	Euphorbiaceae	9	1.02	5	45
Cochlospermum planchonii	Cochlospermaceae	8	0.90	5	40
Coco nucifera	Arecaceae	8	0.90	5	40
Combretum micranthum	Combretaceae	8	0.90	4	32
Mytagyna inermis	Rubiaceae	8	0.90	5	40
Sarcocephalus latifolius	Rubiaceae	8	0.90	6	48
Securidaca longepedunculata	Polygalaceae	7	0.79	6	42

Table 2: frequency of citation of plant parts used in treatment of liver diseases

Parts of plant	Number of citations	Frequency of citations
Leaf	318	34.00
Stem bark	195	20.90
Root	139	14.90
Whole plant	89	9.50
Seed	38	4.10
Fruit	33	3.50
Leafy twig	24	2.60
Rhizome	23	2.50
Stem	15	1.60
Flower	13	1.40
Leafy stem	13	1.40
Root bark	8	0.90
Latex	4	0.40
Aerial part	4	0.40
Young shoot	3	0.30
Flowering top	3	0.30
Tuber	2	0.20
Bud	1	0.10
Empty shell	1	0.10
Leafy mistletoe	1	0.10
Pod	1	0.10
Sling	1	0.10
Gum tear	1	0.10
Flowering plant	1	0.10
Leaf sap	1	0.10
Resin	1	0.10
Thallus	1	0.10
Nut	1	0.10
Total	935	100

Table 3: Frequency of citation of traditional use forms of plants in the treatment of liver diseases

Form	Number of citation	Frequency of citation
Decoction	301	74.70
Infusion	43	10.70
Maceration	34	8.40
Powder	12	3.00
Calcination	5	1.20
Crushing	2	0.50
Fruit juice	2	0.50
Akylation	1	0.20
Fruit water	1	0.20
Essential oil	1	0.20
Sucking powder	1	0.20
Total	403	100

DISCUSSION

Pharmacopoeia and traditional medicine play an essential role in the health system of several countries around the world. This is the case for Mali and most other West African countries. Throughout history, several molecules with therapeutic interests have been isolated from plants. Today, plants are still a great hope in the search for remedies for common diseases including liver disease. In this review, several plants traditionally used in the treatment of liver diseases have been identified on the basis of ethnobotanical surveys carried out in West African countries. The plants appearing as the most cited are already known for their wide use in traditional medicine. Experimental studies have shown that these plants have numerous pharmacological properties, in particular hepatoprotective, anti-cancer, antiviral, analgesic and anti-inflammatory, which may justify their use in the treatment of liver

diseases. The Fabaceae, Asteraceae and Rubiaceae families were the most represented with respective frequencies of 20.28, 7.78 and 5.56%. Forty families (Caricaceae, Loranthaceae, Urticaceae…) were cited once (0.28 %). The Fabaceae represent one of the largest angiosperm families, the third in terms of the number of species, after the Asteraceae and the Orchideae [155]. In 2018, Geredew and Bizuayehu, through a review on plants used in liver problems in Ethiopia, found out that the most represented plant families were Euphorbiaceae, Asteraceae and Fabaceae [156]. While Asteraceae, Berberidaceae and Polygonaceae were the most represented according to another similar study in India [157].

Table 4 : Frequency of citations of liver diseases treated by plants identified

Disease	Number of citations	Frequency of citations
Liver disorders	211	34.60
Jaundice	140	23.00
Hepatitis	131	21.50
Hepatitis B and C	54	8.90
Cirrhosis	36	5.90
Hepatitis B	15	2.50
Hepatocellular carcinoma	9	1.50
Liver abscess	3	0.50
Liver problem	3	0.50
Hepatitis A	2	0.30
Viral hepatitis	2	0.30
Hepatitis C	1	0.20
Chronic hepatitis	1	0.20
Strengthens liver activity	1	0.20
Total	609	100

C. papaya, *C. aurantifolia*, *C. tinctorium*, *E. africana*, *P. biglobosa*, *P. amarus*, *C. planchonii*, *C. nucifera*, *C. micranthum*, *M. inermis* and *S. latifolius* were the most cited species with the best convergence scores. This suggests a great importance of these plants in the management of liver diseases in the sub-region. These results are similar to those reported by Bitsindou *et al*. (1993) who found out that most of these plants also appear among the most cited in a review of plants used against liver disease in traditional African medicine [158].

Leaves, stem barks and roots were the most used organs with the highest citation frequencies. Roots and leaves were the most used parts according to Geredew and Bizuayehu in 2018 [156] while data obtained by Moradi *et al*. (2016) in India are in favor of fruits, seeds and roots [157]. The traditional methods of preparation frequently used were decoction, infusion and maceration. The results obtained by Geredew and Bizuayehu in 2018 show that brewing, crushing and decoction are the most used forms in the treatment of liver diseases in Ethiopia [156].

Most liver diseases treated with plants were undefined (34.6%). Jaundice represented 23.0 % and hepatitis 21.5 %. The high frequency of jaundice could be explained by the fact that jaundice is involved in most liver diseases [159]. Data on hepatitis confirm those in the literature that hepatitis is one of the leading causes of liver disease [1, 160].

In Mali, like other West African countries, the State has adopted a policy aimed at developing the resources of traditional medicine. One of the objectives of this policy was the development of improved traditional medicines (ITM). Thus, research on traditional Malian pharmacopoeia and medicine has led to the development of 7 ITMs on the list of essential medicines. These are, BALEMBO® Antitussive Syrup (*Crossopteryx febrifuga* Benth. Rubiaceae), DYSENTERAL® Antidysenteric (*Euphorbia hirta* L.

Euphorbiaceae), GASTROSEDAL® Gastric Ulcer (*Vernonia kotschyana* Sch. Bip. Asteraceae), HEPATISANE® Choleretic (*Combretum micranthum* G . Don. Combretaceae), LAXA-CASSIA®, Laxative (*Senna italica* Mill. Cesalpiniaceae), MALARIAL® antimalarial (*Senna occidentalis* L. Cesalpiniaceae + *Lippia chevalieri* Moldenke. Verbenaceae + *Acmella oleracea* L. (Jansen) Asteraceae) and PSOROSPERMINE® Antieczematous ointment (*Psorospermum guineense* Hochr. Hypericaceae).

ITMs have also emerged in other West African countries. This is the case of, Elooko® antitussive (*Guiera senegalensis* J.F.Gmel.) in Senegal, Guinex-HTA® antihypertensive (*Hymenocardia acida* Tul.) in Guinea Conakry, Duba® antitussive (*Entada africana* Guill. Et Perr.) in Burkina Fasso , Drepanostat® (*Zanthoxylum zanthoxyloides* Lam.) in Togo. These ITMs show that in West Africa there are already herbal solutions to several common diseases. These phytomedicines have been developed using traditional recipes from West African countries. This confirms the importance of pharmacopoeia and traditional medicine in the health system of these different countries. The results of this review may contribute to the development of new ITMs for the treatment of liver diseases.

Conclusion

It appears from this study that several plants are used in the traditional management of liver diseases in West Africa. These plants belong to various genera and families. This review also shows the existence of numerous efficacy and safety data on the main plants listed. These data can be useful for the development of new ITMs used in the management of liver diseases.

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