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Ethnobotanical survey and phytogeographical study of plants species from genus *Acacia* in Bénin

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The genus *Acacia*, mainly distributed in the tropical and subtropical regions, has been used in traditional medicines for the treatment of microbial infections, malaria, diarrhea, oedema and inflammation. The present study aims to provide a comprehensive data on the distribution and medicinal use of *Acacia* species. Ethnobotanical survey and phytogeographical study were undertook using field interviews. Informant consensus factor (ICF), frequency of citation (Fc), fidelity level (FL) and use value (UV) were also assessed. A total of 16 species belonging to genus *Acacia* were inventoried in Benin. A total of 108 informants were interviewed during ethnobotanical survey. Except *Acacia auriculiformis*, all inventoried species cited by informants were traditionally used to treat various ailments. This species were mostly used as medicinal treatments (93.75 % of the species) and to produce wood and fibers (6.25 %). Leaves, bark and roots were the most used parts and decoction was the most cited method of preparation. *A. macrostachya* (UV = 1.94), *A. nilotica* (UV = 1.21), *A. hockii* (UV = 1.20) and *A. ataxacantha* (UV = 1.17) and *A. sieberiana* (UV = 1.15) were the most used species. *A. nilotica* (75%), *A. dudgeon*ii (67%) and *A. seyal* (50%). *A. nilotica* (FL = 75%) and *A. dudgeonii* (FL = 67%) were the most species cited by informants to treat Digestive System Disorder whereas *A. Hockii* (67%), *A. Senegal* (67%), *A. ataxacantha* (60%), *A. erythrocalyx* (50%) and *A. gerrardii* (50%) were cited for Infectious diseases. The extensive literature survey reveals 16 *Acacia* species distributed in 10 phytogeographic districts in Bénin. These species where mostly used in traditional medicine to treat infectious diseases and Digestive System Disorder. The results of this study open new research perspectives on *Acacia* species not yet studied.

Key words: *Acacia*, ethnobotany, phytogeography, medicinal plants.

INTRODUCTION

Herbal remedies used in traditional medicine are the primary health care resource in many rural communities around the world. In low- and middle-income countries where the number of practitioners of modern medicine may not be enough to meet the health care needs of the country, traditional medicine and its practitioners are

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considered an important resource for population health (Oyinlola et al., 2016).

Traditional medicine is defined as the sum of all knowledge, skills and practices based on the theories, beliefs and experiences of different cultures, whether explicable or not, and which are used in the preservation of health, as well as in the prevention, diagnosis, improvement or treatment of physical or mental illnesses (WHO, 2013). Contrary to traditional medicine, the modern medicine which is defined as a medical system based on western scientific principles, often perceived as a symbol of modernity, development and globalization in the non-Western world, alters care-seeking behaviour and often dismiss traditional medicines (Teixidor-Toneu et al., 2017). However, traditional medicine continues to be used because of people beliefs about the intrinsic efficacy and effectiveness of traditional medicines for many illnesses, the inadequacy of the modern health system, the unavailability of medicines, unaffordable medical bills, the cheap cost, the distance to public health center or a combination of these factors (Mwaka et al., 2015; Thomas, 2013).

The West African savannahs and especially those of Bénin are populated by species belonging to several botanical families including Fabaceae which gathers several genus such as acacia. Several studies reported that *Acacia* species play an important role in the rural health system. They are traditionally used for the treatment of febrile convulsions, tooth decay, bronchitis , cough, dysentery, pneumonia, pneumonia, malaria, primary infection of syphilis, sterility and stomach-ache, cold, congestion, fever, hemorrhoids, leucorrhoea, intestinal pains and acute diarrhea (Amoussa et al., 2014; Kabbashi et al., 2016).

Previous study on *Acacia ataxacantha* in 2013 showed that acacias species are subject to confusion in the market because of their large morphological similarity. The sellers of medicinal plants do not always distinguish these species which are all called "acacia" in the markets. This confusion among *Acacia* species may be one of the reasons for the lack of research data on some *Acacia species*. Indeed, several challenges need to be addressed for the successful implementation of medicinal plant research on *Acacia* species. Thus, this study was undertaken to document the distribution, identification and traditional use of *Acacia* species. Specifically, *Acacia* species were listed, phytogeographic districts of each species were identified and an ethnobotanical survey was conducted to collect data on their vernacular names, their traditional use and the diseases for which they are used.

METHODOLOGY

Study area and demography

The study area covered 77 town belonging to the 12 departments, situated in West Africa between latitudes 6°15' N - 12°25' North and longitudes 0°40 E - 3°45 East (Akoègninou et al., 2006). It covers a total land area of 112.622 km^2 with a population estimated to about 10 million (INSAE, 2013). The profile of the country is an undulating plateau except for a few scattered hills in the center and the north. The altitude varies from sea level to 400-650 m in the northwest, where the Atacora mountain chain is the outstanding feature and a region of great ecological and species diversity in the country (Agbani et al., 2018; Adéoti et al., 2009). The mean annual rainfall varies from 900 to 1300 mm. The mean annual temperature ranges from 26 to 28°C and can exceptionally reach 35 to 40^{o}C in some northern localities (Adéoti et al., 2009).

Phytogeographical study of *Acacia* species in Bénin

In order to provide a better knowledge, to list *Acacia* species in Bénin and identify their phytogeographical district, exhaustive review of literature (Akouehou et al., 2011; Arbonnier, 2000, Akoègninou et al., 2006 ; Alexiades and Sheldon, 1996) available at the National Herbarium of University of Abomey-Calavi were consulted. The major environmental factors such as soil types, plant formation and climate were recorded.

Ethnobotanical survey and consent

Ethnobotanical surveys were conducted from March to august 2015 using field interviews. To collect data on traditional uses of *Acacia* species in study area, a questionnaire was developed to facilitate interviews with informants. They were between the ages of 17 to 72, with the average age of 45. Local dialect such as Dendi, Ditammari, Yoruba, Nagot and Fon were used to conduct interviews. In each area of survey, a local assistant was recruited to facilitate the conversation and avoid any misunderstanding during interview. Demographic data of informants such as gender, age, occupation and education level were documented. The local names of species, medicinal and parts used, mode of preparation and administration and the availability in the area were noted.

Plant collection

Specimens of plants reported by informants were collected immediately with the help of informants or their assistants. At least, the specimens were deposited at National Herbarium of Abomey-Calavi University (Bénin) where the botanical identification was done.

Data processing

A list of species cited by informant was established in Excel. The local and scientific names, family names, ailments treated, part used, preparation and administration mode, and areas in which species grow were also recorded. In order to identify the first disease traditionally treated by *Acacia* species, all listed disease during survey were classified into 13 categories according to Camara-Leret et al. (2012).

Quantitative data analysis

Frequency of citation (Fc)

The most important species in a study area was identified by calculating the frequency of citation (Fc) (Ahmad et al., 2014). Which is the ratio between the number of informants who mentioned a specie and the total number of informants (Tardio and Santayana, 2008).

Factor of informant consensus

Agreement among informants about specie for a particular remedy was determined by calculating the informant consensus factor (ICF) and fidelity level (FL). In this study, the informant consensus factor (ICF) was used to determine the level of similarity among information delivered by various informants. FIC is also explained as the importance of each medicinal plant use category depending on the homogeneity of informant's answer (Trotter and Logan, 1986). The FIC was calculated using the following formula (Heinrich et al., 1998):

$$FIC \frac{Nur - Nt}{Nur - 1}$$

Where Nur = number of use reports for a specific category; Nt = number of species used for the disease category. This factor range from 0 to 1. A higher value of ICF (close to 1) indicates a greater consensus on the use of a given plants to treat a particular ailment category. A low value of ICF (close to 0) indicates that the informants disagree with the category of use of a plant (Andrade-Cetto and Heinrich, 2011).

Fidelity level (FL)

The fidelity level (FL) was also calculated as a tool to get the percentage of informants claiming the use of a certain plant for the same major purpose. It is defined as the ratio between the number of informants who independently claimed a use of a plant species to treat a particular disease (Np) and the total number of informants who mentioned the plants as a medicine to treat any given disease (N) (Friedman et al., 1986):

$$FL = \frac{Np}{N \times 100}$$

Plant species with high fidelity level is important to local people to treat ailments. It is noted that the number of times mentioned for a given plant by all of the informants for a specific disease was considered for this factor.

Use value (UV)

The most important medicinal uses of plants were assessed by calculating the use value (UV) which was used to calculate the citation of plants during interviews (De Albuquerque et al., 2009).

$$UV = \frac{\sum Uis}{ns}$$

ΣUis is the sum of the total number of use citations by all informants for a species; ns is the total number of informants.

RESULTS

Social status of informants

A total of 108 informants composed of sixty men (55.6%) and forty-eight women (44.4%) were interviewed during the study. They were aged between 17 and 72 years. Eighty three were above 40 year old and twenty five were under 40. Informants have a low education level, 82% have not been to school or have primary education while 18% reached secondary school. Belonging to several ethnic speaking Ditammari, Dendi and Fon, informants were spiritual healers, traditional midwives or traditional healers. In addition to traditional medicine, most of informants are farmers or breeders.

Phytogeographic study of *Acacia* species in Bénin

The bibliographic review carried out on species from genus *Acacia* in Bénin, allowed to list sixteen species distributed in all phytogeographic districts. Climate and soil types appeared as the main determinants of phytogeographic districts in which species are identified. The lists of species are presented in Figure 1. The *Acacia* species were mainly distributed in three phytogeographic districts. In the "Ouémé-Valley" district characterized by Hydromorphic soil in southern Benin, 7 species have been identified. In Northern Bénin, two districts, "Borgou-North" and "Mekrou-Pendjari" characterized by ferruginous soil, eight and ten species of *Acacia* were respectively identified. The distribution of species, the types of soil, the major plants formation and exclusive species of each phytogeographical district were documented and summarized in Table 1.

Description and geographical distribution of *Acacia* species in Bénin

Sixteen species from genus *Acacia* were listed in Bénin after bibliographic review (Arbonnier, 2000, Akoègninou et al., 2006; Alexiades and Sheldon, 1996). The description of each *Acacia* species is summarized in Table 2 and the geographical distribution is presented in Figure 2.

Ethnomedicinal data of *Acacia* species

The ethnobotanical survey allowed collecting 117 presumed species from *Acacia* genus. The collected specimen deposited to the National Herbarium of the University of Abomey-Calavi in Bénin allowed identifying 108 specimens grouped into sixteen species (*A. auriculiformis, A. ataxacantha, A. erythrocalyx, A. farnesiana, A. macrostachya, A. nilotica, A. polyacantha, A. ehrenbergiana, A. sieberiana, A. dudgeonii, A. amythethophylla, A. gerrardii, A. hockii, A. senegal, A. seyal, A. gourmaensis*) belonging to genus *Acacia* (Fabaceae) and nine specimens not belonging to the *Genus* acacia. The traditional used of collected species, vernacular name and parts used were summarized in Table 3.

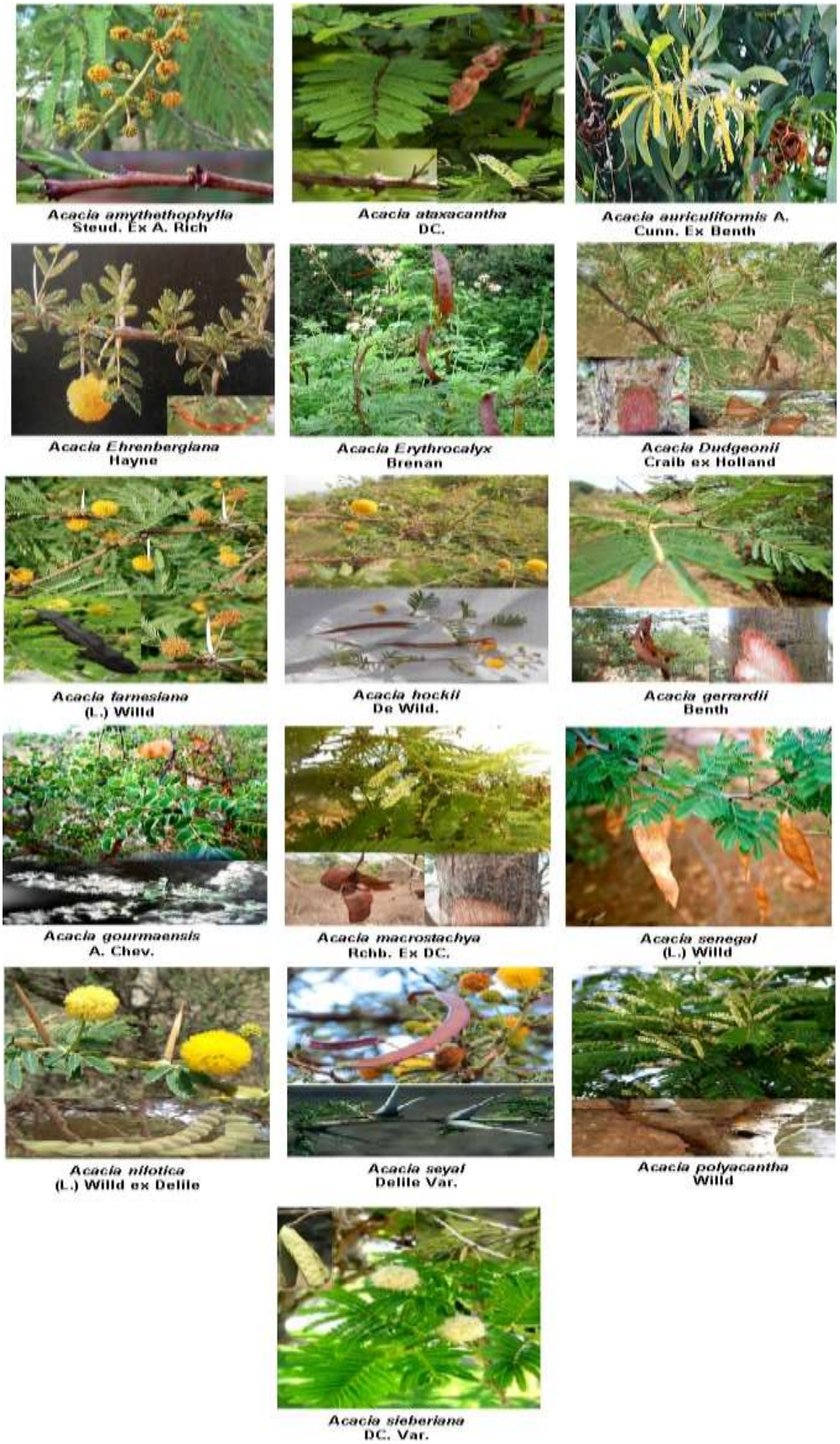

Figure 1. Pictorial description of *Acacia* species inventoried in Bénin.

Table 1. Phytochorological zones based on major soil types, major plant formation and species exclusive.

Phytogeographic districts	Species exclusive to the phytogeographical district	Major plant formation	Major soil type
Coast	*A. auriculiformis*	Coastal forest and derived thickets, Mangrove	Sandy + Hydromorphic and halomorphic soils
Pobè	None found	Semi-deciduous forest	Ferrallitic soils and without concretions
Ouémé-Valley	*A. auriculiformis, A. ataxacantha, A. erythrocalyx, A. farnesiana, A. macrostachya, A. nilotica, A. polyacantha*	Swamp and semi-deciduous forest	Hydromorphic soils
Kouffo	*A. ataxacantha, A. polyacantha, A. sieberiana*	Semi-deciduous forest	Ferrallitic soils with, vertisoils
Zou	*A. macrostachya, A. sieberiana*	Dry forest, woodland, and riparian forest	Ferruginous soils on and crystalline rocks
Borgou-South	*A. gourmaensis, A. hockii, A. macrostachya*	*A. gourmaensis, A. hockii, A. macrostachya*	Ferruginous soils on and crystalline rocks
Borgou-North	*A. ataxacantha, A. ehrenbergiana, A. erythrocalyx, A. macrostachya, A. nilotica, A. polyacantha, A. sieberiana, A. dudgeonii*	Dry forest, woodland, and riparian forest	Ferruginous soils and crystalline rocks
Atacora Chain	*A. farnesiana, A. gourmaensis, A. hockii, A. seyal*	Riparian forest, dry forest, and woodland	Poorly evolved and mineral soils
Mékrou-Pendjari	*A. amythethophylla, A. ehrenbergiana, A. erythrocalyx, A. dudgeonii, A. gerrardii, A. nilotica, A. polyacantha, A. hockii, A. senegal, A. seyal*	Tree and shrub savannahs, dry forest and riparian forest	Ferruginous soils, with concretions and sedimentary rocks
W du Niger	*A. macrostachya, A. nilotica, A. sieberiana*	Tree and shrub savannahs, dry forest and riparian forest	Ferruginous soils, with concretions and sedimentary rocks

Table 2. Botanical description of *Acacia* species inventoried in Bénin.

Species	Height	Leaves	Flowers	Bark	Pods	Spines	Efflorescence
Acacia amythethophylla Steud. ex. A. Rich.	Tree up to 15 m, fairly branched	20 pairs of pinnae each with 36-48 leaflets	Yellow, drying red, 8-13 mm in diameter	Rough, scaly	Pods ± oblong, about 11.5 x 1.7 cm	Stipular, 2 per node, 3-10 mm	Dry season
Acacia ataxacantha DC.	Climbing shrub or liana	5-12 pairs of pinnae each with 30-40 leaflets	4-8 cm long, dense, subsessile in axillary white spikes	Yellow-brown	6 - 7 seeds thin, flattened, 6-10 cm long, purplish brown mature	Curved spines	Flowers in august - November, fruits in October- November
Acacia auriculiformis A. Cunn. ex Benth.	False phyllodes tree, 15 - 30 m	Dense foliage open, spreading crown, 10-16 and 1.5-2.5 cm	8 cm long, creamy yellow and sweet scented.	Vertically fissured	Flat (6.5 x 1.5 cm), Initial : straight Mature : twisted irregular spirals	None	flowering occurs June – July; pods ripen august - October

Table 2. Contd.

Acacia dudgeonii Craib. ex Holl.	Spiny shrub, 2.5- 7 m height	3-7 cm, 20-30 pairs of leaflets with 20 pairs of pinnae	White, 2.5-6.0 cm long, shorter than the leaves	Fissured, flaking	Oblong, flattened, glabrous, 3.0-8.0 x 1.5-2.5 cm, pale brown	Stipular, 2 per node, 3-9 mm	Flowers (March to June), fruits (July to September)
Acacia ehrenbergiana Hayne	Branched shrub up to 6 m	1-2 pairs of pinnae, 6-12 pairs of leaflets	Yellow with 1.0 to 1.5 cm in diameter	Brown, shiny, peeling	Sickle pods, 12 x 0.5 cm approx. red-brown in maturity.	Stipular, 1 cm, sometimes 6 cm	Dry season, after the rainy season
Acacia erythrocalyx Brenan	Creeping shrub up to 3 m	7-15 pairs of pinnules with 17-38 pairs of leaflets	White, globular, 9 mm in diameter approx	Smooth, brownish-grey, with papery scales	Flattened, 9-15 x 1.3-5 cm, glabrous, brown-red, seeds (10-12)	Spines non-stipular, curved, 1-5 mm	Flowers in August, fruits in November, December
Acacia farnesiana (L.) Willd.	Thorny shrub 1.5-4 m	4-8 pairs of pinnae, 10-12 leaflets	Yellow; fragrant; 1-1,5 cm in diameter	Brown, black, scaly at maturity	Pods ± spindle-shaped, 5-8 x 0.5-0.8 cm with 7-8 seeds	Stipular thorns straight and slender	Flowers août, October, November
Acacia hockii De Wild.	Small tree, 5 m approx	6-8 pairs of pinnules with 15-30 leaflets	Globular, 2 cm diameter approx., yellow-orange	orange-red, dark spots, often scaly	Linear, falcate, puberulous, 5-7.5x0.5 cm	Stipular spines 2 per node, 1-3 cm approx	Dry season beginning
Acacia gerrardii Benth	Tree or shrub 3-15 m height	5–10 pairs of pinnae; 12-28 leaflets	Cream-white heads of 7-12 mm diameter	Cloves falcates (curved), ± 7-16 cm.	Flattened, curved or rarely straight	Paired, mostly straight, 1.5 cm, sometime long and/or recurve	Flowers and pods November
Acacia gourmaensis A. Chev.	Shrub or small tree up to 4.5 m	3-5 pinnules to 1 pair of leaflets	Inflorescence in loose ears 4 cm long	Cracked or scaly, orange-brown	Pods ± oval, 3.7 x 1.5 cm approx. with 1-3 seeds	Non-stipulated spurs. 2 per node	Rain season
Acacia macrostachya Reichenb. ex DC.	Shrub or small tree up to 4.5 m	17-27 pairs of pinnules with 21-56 pairs of leaflets	Cream-colored with 5-10	Cracked brown-red	Flat, ± oval, 9.3 x 2.3 cm, at 2-5 seeds	Shaped curved claws, red-brown	During the first rains and in the dry season after foliage
Acacia nilotica (L.) Willd. ex Delile	Small tree from 2.5 to 14 m high	2-11 pairs; leaflets 7-25 pairs, 1.5-7 mm	Bright yellow, in axillary heads 6-15 mm in diam	Thin, rough, cracked, dark red-brown	Pods especially variable, linear, indehiscent, 8-17 cm	Gray-pubescent, slightly curved, 3 cm long	Flower (october-december); fruit (march-june)

Ailments treated with *Acacia* species

Acacia species cited by informants were used to treat 61 various ailments classified in 13 categories such as: Blood and cardio-vascular problem (BCVP), cranial system (CS), dental health (DH), digestive system disorder (DSD), general ailments (GA), infectious diseases (ID), muscular skeletal system (MSS), nervous

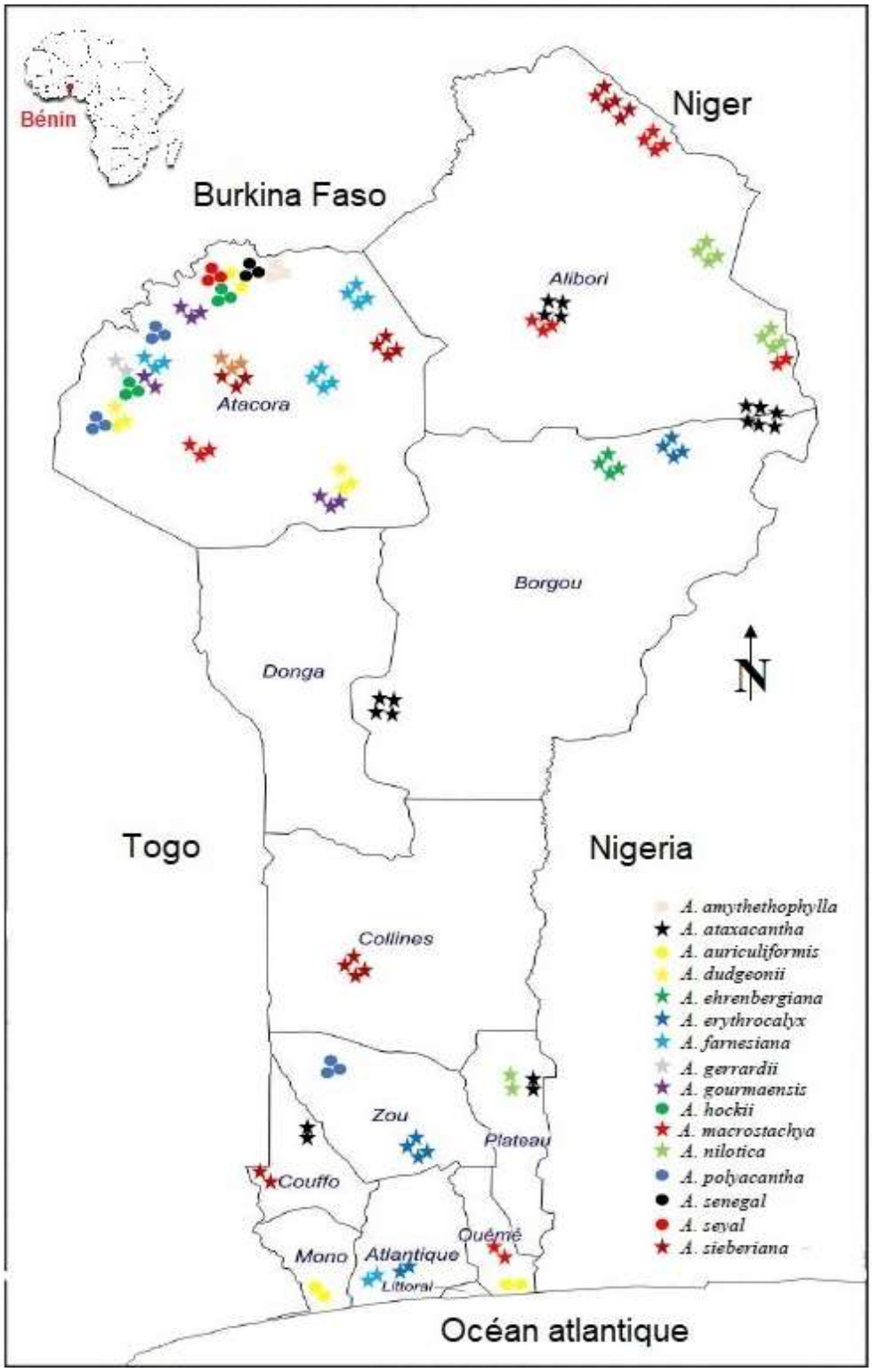

Figure 2. Phytogeographical distribution of species from genus *Acacia* in Bénin.

system (NS), pregnancy, birth and puerperium (PBP), reproductive system (ReprS), respiratory system (RespS), sensory system (SS) and veterinary (Vet). Frequencies of citation of disease categories range from 0.93 to 37.96%. ID (37.96%) and DSD (35.18%) were the most cited category (Table 4). BCVP, CS, DH, GA, MSS, NS and SS

Table 3. Name, traditional uses of *Acacia species* in Bénin.

Botanical name	Voucher number	Vernacular name	Part(s) and traditional used	UV
A. amythethophylla Steud. ex A. Rich	YH 284/HNB	Acacia	Entire plant extract drunk to treat diarrhea, wounds, cutaneous infections; root bark extract drunk as uterine sedative, psychosis	0.97
A. *ataxacantha* DC.	YH290/HNB	vèwunkan (f, g); pofi (g); èwun, èwunagogo, èwunadele, èlèèwon (y, n); gairi (ba); Buisson de rocher (fr), moraré (pl)	Dough of the leaves used as abscess medicine; leaves decoction: used as convulsions medicine, drunk to treat dysentery, headache, infections and pneumonias	1.17
A. auriculiformis A.Cunn. ex Benth	YH291/HNB	None found	None found	-
A. Dudgeonii Craib ex Holland	YH 292/ HNB	Pattuki yanorgo (pl)	Whole plant extract drunk as antiseptic; root is used to treat the snakebite; peels extract drunk as dysenteries and enteritis medicine	0.71
A. Ehrenbergiana Hayne	**	Bakanichili, Djilukii (pl), Karamnaga (pl)	Peel: anti-inflammatory, flatulences and diuretic medicine properties; Pods taken as emollient; Leaves and fruits are also edible; wood used as paralysis problems	0.49
A. Erythrocalyx Brenan	YH 293/ HNB	Olusoèlèèwon, èwon, èwan, èwanadele (y, n).	Entire plant used as snakebite medicine; roots are taken as aphrodisiac; leaves: as emetics and febrifuges, angina, injury and dermatose medicine (Arbonier, 2000).	1.04
A. farnesiana (L.) Willd	YH 294/ HNB	boni (y); ban (ba)	Whole plant used to treat diarrhea, liver problems and inflammation	0.81
A. hockii De Wild.	AA 6615/HNB	Dandanechi (pl)	Leaves: Used to treat malaria and abscess; Root: taken as gastritises and hookworm problems; Plant taken as emollient in north Africa	1.20
A. gerrardii Benth.	YH 285/ HNB	Gonponyalehi (pl)	Peel decoction drunk as diarrhea, emetic medicine, vomitive, cough, and asthma medicine. Root and Leaves for stomach ache. Root: as bilharzia (schistomiasis) medicine and pain	0.87
A. gourmaensis A. Chev.	AA6614/ HNB	Koukounkoumbou (ba), PƆN yara (So).	Root is used against the cough; peels are used as icterus, malaria and renal affection and purgative medicine	0.46
A. macrostachya Rchb. ex DC.	AA 6616/HNB	Onaré, Tschildi pl)	Root used as gonorrhea^{+} and syphilis; Peels as aphrodisiac, gastritis, disinfecting, anthelmintic; to treat gastro-intestinal, diarrhea, vomiting, cholera, flatulences, tooth decay and gingivitis; Leaves are used as angina and antidote of snakebite	1.94
A. nilotica (L.) Willd. ex	YH 295/ HNB	Gabaruwa (wa); bani (ba); kaara(So)	Whole plant: to treat digestive candidiasis; pods and seeds: to treat hemorrhoid, diarrhea, cough, vomiting, stomach aches, dysenteric and scorbutic. In Mali whole plant is taken as gastric ulcer, oral wounds, rates and amoebic.	1.21

Table 3. Contd.

A. nilotica (L.) Willd. ex	YH 295/ HNB	Gabaruwa (wa); bani (ba); kaara(So)	Whole plant: To treat digestive candidiasis; pods and seeds: to treat hemorrhoid, diarrhea, cough, vomiting, stomach aches, dysenteric and scorbutic. In Mali whole plant is taken as gastric ulcer, oral wounds, rates and amoebic	1.21
A. polyacantha Willd.	AA6617/ HNB	Hilikan, dènwi (t); dégà (g); èdè, ègè-èdè (y, n); gaja (a); bokosaka ba); maarukokobè (d).	Plant: used as unrests gastrointestinal and astringent. Root: used as œdema, tooth decay, asthma, gonorrhea, malaria. Peel: used as œdema, hemorrhoids, syphilis; Peel, pods and leaves are taken as dysentery medicine; Pods: as sore throats	1.07
A. senegal (L.) Willd	YH 296/ HNB	Gommier blanc (fr)	Plant is applied as pains of heart in Niger. In Mali, leaves: as the bilharzia, abdominal pains and sore throats; eraser: as pain of chest and otitis; root: as wounds	0.63
A. seyal Delile var.	YH 297/ HNB	menèn (d), puwituani (So);	Plant is used as peritonitis, stomach aches and œdema medicine; peel to treat dysentery, bacterial infections, leprosy and rheumatism	0.65
A. sieberiana DC. var.	YH 298/ HNB	kukumbu, sagunu kpika, sakiburo kpika, lepusia (ba) ; sihe (y, n); Konkompieli, aduwè, caga (f).	Peels of root and leaves are used to treat snakebite, osteoarthritises and rheumatism. Stem leafed against hyperyretique convulsions or infantile, syncopates, tetanus, œdema and sickle cell disease	1.15

Bariba (ba), Dendi (d), Fon (f), Nago (n), Somba (So), Yoruba (y), Waama (wa), Peul (pl) plants in Red list (**).

Table 4. Frequency and informant consensus factor of each category of ailments

Category of ailments (list of diseases)	Number of plant cited	Number of informants citing the category	Frequency of citation (%)	Informant consensus factor (IFC)
Blood and Cardio-Vascular System (BCVS): Cardiac problems in children, low blood pressure	2	2	1.85	0
Cranial System (CS): Early and late closing of baby's fontanel	1	1	0.93	0
Dental Health (DH): Caries, causes teeth nerves insensitivity, dental abscess syndesmotome	2	4	3.70	0.67
Digestive System Disorder (DSD): Carminative, colic, diarrhea, constipation, anti-emetic, indigestion, liver disorders, intoxication from meat eating, laryngitis, gastric ulcer, intestinal ulcer, orexigenic after diarrhea, intestinal pain, dysentery	14	38	35.18	0.65
General ailments (GA): Weakness, headache, fever, side stitch, yellow fever	2	2	1.85	0
Infectious Diseases (ID): Malaria, measles, scabies, tetanus, infected and syphilitic wounds, bilharzia	15	41	37.96	0.65
Muscular-Skeletal System (MSS): Twists, fractures, low back pain, muscle aches, sprains, broken member	4	5	4.63	0.25

Table 4. Contd.

Nervous System (NS): Calming nerves, epilepsy, nerves swelling	1	2	1.85	1
Pregnancy, Birth and Puerperium (PBP): Menstrual pain, contraception, infertility treatment, pain and dizziness during pregnancy, prenatal care, induce labor, post partum recovery, healing wound after delivery, post partum hemorrhage, remove rest of placenta in uterus, promote lactation	0	0	0.00	0
Reproductive System (ReprS): Painful menstruation, sexually transmitted diseases (syphilis and gonorrhea), aphrodisiacs, contraceptive	5	7	5.55	0.32
Respiratory System (RespS): Flu, cold, bronchitis, asthma, pulmonary infection, bronchitis, cough	3	7	5.55	0.67
Sensory System (SS): Eye infections, conjunctivitis, mouth infection, boils, eye stye	2	3	2.77	0.50
Veterinary (Vet): Treatment of cattle's diseases	0	0	0.00	0

were the least mentioned by informants, with less than 5% of citation (Figure 3A). The ICF values ranged from 0 to 0.67. High consensus was obtained for DSD, ID, DH and RS. The highest ICF value (0.67) was obtained with RS and DH categories treatment followed by species used to treat DSD and ID (0.65). However, Informants Consensus factor was low (ICF < 0.50) for plants used as remedies for RS and MSS. Frequency and Informant Consensus Factor of each category of illness were summarized in Table 4.

Part used and mode of preparation

Medicinal plants in the study area were prepared in many different ways depending on the species, part used and the ailments treated. Parts of the plants mainly used for the preparation of herbal remedies were leaves (24%), followed by bark (22%), roots (21%), whole plant (19%) and fruits (14%) (Figure 3B). Decoction (56%) was the most common process of preparation. The species were also dried, powdered (22%) and used directly in food. Sometimes the fresh part of plant was chewed (20%) or used as cold infusion (2%) (Figure 3C).

Use value of *Acacia* species

In this study, use values (UV) have demonstrated the importance of medicinal uses of *Acacia* species in Benin. UV values ranged from 0.46 to 1.94 (Table 3). *A. macrostachya* (UV = 1.94), A*. nilotica* (UV = 1.21), *A. hockii* (UV = 1.20), *A. ataxacantha* (UV = 1.17) and *A. sieberiana* (UV = 1.15) were the most used species. *A. gourmaensis* have the lowest Use Value (UV = 0.46) and *A. auriculiformis* was not cited by informants.

Fidelity level (FL) of *Acacia* species

The fidelity level index (FL) is used to identify the most commonly species used by populations for the treatment of a certain diseases. The most used species have a maximum FL. In the present study, the fidelity level varied from 6 to 75% in all categories of ailments. The highest value of FL was obtained for *A. nilotica* (75 %), *A. dudgeon*ii (67 %) and *A. seyal* (50 %) used to treat DSD. In the treatment of ID, the most cited species included *A. Hockii* (67%), *A. Senegal (*67%), *A. ataxacantha (*60%), *A. erythrocalyx* (50%) and *A. gerrardii* (50%). Indeed, five species had the highest fidelity level (≥ 50%) for ID and three species (≥ 50%) for DSD.

DISCUSSION

Many species of plants are used in traditional medicine in several forms by the populations for the management of diseases. In previous studies on *Acacia ataxacantha*, it was found that several species have the *Acacia* name in markets and these species are not always differentiated by

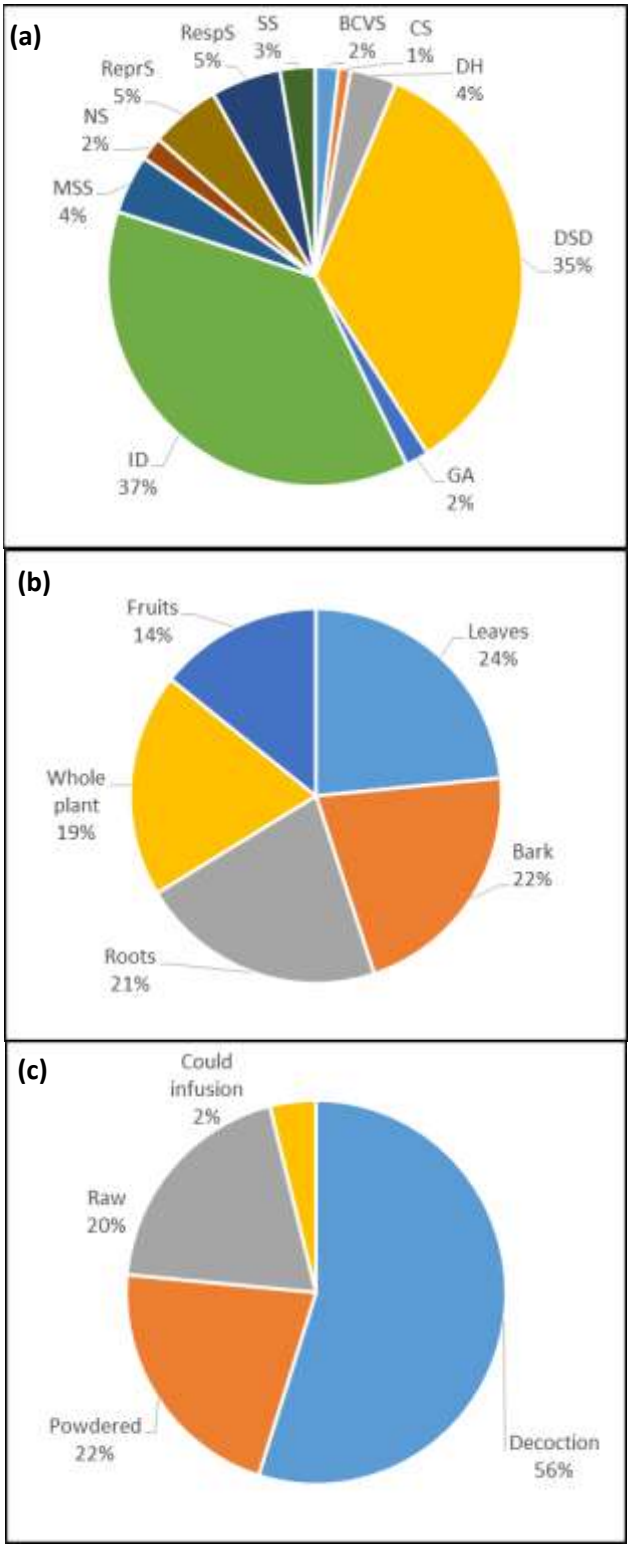

Figure 3. Ailments treated (**A**), parts used (**B**) and preparation methods (**C**). Blood and Cardio-Vascular System (BCVS), Cranial System (CS), Dental Health (DH), Digestive System Disorder (DSD), General ailments (GA), Infectious Diseases (ID), Muscular-Skeletal System (MSS), Nervous System (NS), Pregnancy, Birth and Puerperium (PBP), Reproductive System (ReprS), Respiratory System (RespS), Sensory System (SS), Veterinary (Vet).

sellers of medicinal plants. Indeed, the botanical description of some species of the *Acacia* genus is very close. This leads to this confusion in the markets. The objective of this study was to identify the species of *Acacia* listed in Benin in the literature, and carry out a phytogeographical study as well as an ethnobotanical survey on the medicinal use of different species from genus acacia.

In the present study, a total of sixteen (16) *Acacia* species belonging to the family of Fabaceae were reported in Benin. Except *Acacia auriculiformis*, all inventoried species were used in traditional medicine. These results show that almost all species from genus *Acacia* are used in traditional medicine and most ailments treated were ID and DSD. All over the world, the use of *Acacia* species was also reported in traditional medicine (Zahoor et al., 2017; Kefalew, 2015; Tahani et al., 2018; Teklehaymanot, 2017). Among these species, eight (8) are essentially distributed in the Sudanese region (Northern Benin): *A. amythetophylla*, *A. dudgeoni, A. ehrenbergiana*, *A. gerrardii, A. gourmaensis, A. hockii, A. senegal* and *A. seyal;* one (1) in the Congolese zone (south Bénin): *A. auriculiformis* and four (4) in the whole of the country: *A. ataxacantha, A. erythrocalyx, A. macrostachya and A. sieberiana*. Except *A. ataxacantha, A. auriculiformis* and *A. ehrenbergiana*, the limits of the areas of distribution of the reported species seems to cross North Benin.

Similar species were found in Burkina Faso and Niger with the exception of *A. laeta, A. albida* and *A. tortilis* (Wittig et al., 2004; Guinko, 1997). This distribution suggests that *Acacia* species have a distribution area characterized by a Sudanese climate. During the ethnobotanical survey, a total of 108 informants were interviewed, 32 female and 76 male, ranging from 17 to 72 years old. Informants possessing a high knowledge on plants and their uses were targeted and were selected by resource persons. The majorly used parts for the preparation of herbal remedies were leaves, bark, roots, whole plant and fruits. Leaves were the most used part. Many previous studies showed the use of leaves in the preparation of various recipes in traditional medicine (Akinwunmi and Amadi, 2019; Zahoor et al., 2017; Odewo and Adeyemo, 2018; Balcha, 2014).

Conversely, other studies reported roots as the most used part in preparing drugs (Chalabra et al., 1993). Generally, when the roots are used, the whole plant is torn off. It is then unlikely to survive. Indeed, the use of leaves in the preparation of traditional remedies offers a certain advantage to the preservation of biodiversity unlike the devastating effects caused by the use of roots and barks. The use of leaves is less dangerous than to the use of underground parts or the use of whole plants (Giday et al., 2003; Zheng and Xing, 2009).

Medicinal remedies were usually used as a decoction, infusion, powder or chew. These results are in accordance with previous investigations (Bulut et al., 2017; Demie et al., 2018; Palheta et al., 2017). It is well documented that african traditional medicine is a form of holistic health care system organized into three levels of specialty, namely divination, spiritualism, and herbalism. The traditional healer provides health care services based on culture, religious background, knowledge, attitudes, and beliefs that are prevalent in his community (Ozioma and Chinwe, 2019).

Indeed, the informants met during the study confirmed that traditional treatment methods are usually accompanied by halucinogenic rites and evocations of spirits (according to each local healer). These practices are essential for effective treatments. As previous reports on medicinal plants in Benin, this study revealed that ID and DSD (like diarrhea and dysentery) were the most cited by informants whereas pregnancy, PBP and veterinary were not cited by informants (Arbonnier, 2000). Blood and cardio-vascular system, dental health, general ailments, muscular-skeletal system, reproductive system, respiratory system, nervous system and sensory system were rarely cited by local people as they do not seem to suffer or do not know the symptoms of these categories of ailments. Fifteen and fourteen *Acacia* species were cited respectively to cure infectious diseases and digestive system disorder which are the most important diseases in Bénin according to Arbonier (2000). More than 37 and 35% of informants respectively agreed on the use of *Acacia* to treat ID and DSD.

The species with high FL, *A. nilotica*, *A. dudgeonii* and *A. hockii, A. senegal,* and *A. ataxacantha* used respectively for DSD and ID treatment were good candidates for further pharmacological prospection. In fact, data collected during the study showed men and women have very good knowledge on medicinal plants in all categories of diseases. The reason is that women learn about medicinal plants during their young age in order to take care of their household when they become adults. Young people and men are responsible for collecting these medicinal plants. It was also found that people of different ages had comparable knowledge of the *Acacia* species. This is justified by the fact that young people work with their parents and are responsible for harvesting the plants. This role played by young people facilitated the sharing of knowledge between seniors and the younger generation. In contrast, studies undertaken in Ethiopia and China showed an interest loss on the use of medicinal plants among young people caused by the influence of modernization (Giday et al., 2009; Hong et al., 2015).

Conclusion

This study showed that sixteen species from genus *Acacia* are found in Benin. Ethnobotanical survey results allowed highlighting the similarities between *Acacia* species and the difficulties related to the knowledge and

identification of these species by sellers and traditional healers. Ethnobotanical survey showed that infectious diseases and digestive system disorders were the most treated using *Acacia* species. Indeed, the number of *Acacia* species used in traditional medicine for the treatment of infectious diseases is a good indicator of the potential that exists locally. These results could help to identify new research topics especially regarding the discovery of new compounds to fight infectious diseases.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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