JSMARTech
Journal of Smart Bioprospecting and Technology **p-ISSN**: 2686-0805 **e-ISSN**: 2714-7894
April 2023, VOL 04 NO 01 **DOI**:https://doi.org/10.21776/ub.jsmartech.2023.004.01.14

Secondary Metabolite Composition and Bioactivity of Genus *Albizia*: A Review

Momodou Salieu Sowe[1*] and Anayo Christian Etonihu[1]

[1]Chemistry Unit, Division of Physical & Natural Sciences, School of Arts & Sciences, University of The Gambia, Brikama Campus, The Gambia. P.O. Box 3530

Submission: 21 March 2023; **Revised**: 23 April 2023; **Accepted**: 24 April 2023

*__Corresponding author__: Momodou Salieu Sowe; **e-mail**: mssowe@utg.edu.gm

ABSTRACT. *Traditional medicine is being revalued all around the world because of considerable research on various plant species and their therapeutic properties. Traditional medicinal beliefs and practices are deeply rooted in The Gambia, and forest resources are a source of plants for medicine. A study has estimated the presence of one hundred and fifty (150) plant species in The Gambia, distributed between 28 different plant families. Among the plant species, Albizia seems to possess numerous pharmacological properties. Albizia plants are high in secondary metabolites, according to phytochemical investigations, and pharmacological tests of plant extracts have demonstrated antibacterial, anti-inflammatory, and analgesic effects. Albizia plant components are used in traditional medicine to cure a variety of diseases like lung infections, asthma, pile, diarrhea, gonorrhea, ulcers, hemorrhoids, anxiety, depression, and insomnia. Different solvent extracts of the genus Albizia have demonstrated excellent efficacy against S. Typhimurium, S. Enteritidis, S. Dublin, S. aureus, E. coli, V. parahaemolyticus, B. cereus, S. aureus, and S. pyogenes. The radical scavenging activity of the genus Albizia exhibits a significant antioxidant activity with relatively high EC_{50} and IC_{50} values.*

Keywords: g*enus Albizia, secondary metabolite, The Gambia, traditional medicine*

INTRODUCTION

The Gambia is the smallest mainland country in Africa. It has an estimated population of 2 million and a land size of 11,295 square kilometers [1]. Located in the Sahel region of West Africa, The Gambia is bordered in the North by the Atlantic Ocean and divided into North and South banks by the River Gambia. The country has two distinct seasons with a semi-arid climate condition, a dry season that spans from November to May and a wet season (June to early October) with an average rainfall of 750 – 1,200 mm per annum. About 505,300 acres, or 43% of The Gambia, are covered in forests, with 10% being woodlands [2].

Forests are a natural habitat for a variety of plant species. Traditional medicinal beliefs and practices are deep-rooted in The Gambia, and forest resources serve as a vital source of plants for medicine, food, and other domestic purposes. A study has estimated the presence of one hundred and fifty (150) plant species in The Gambia, distributed between 28 different plant families [3]. These plant species are an important and cheap source of traditional medicine for diseases and other health problems in The Gambia. Indigenous trees and shrubs with traditional and herbal medicinal potency found in The Gambia are *Afzelia africana*, *Annona senegalensis*, *Bridelia micrantha*, *Cassia sieberiana*, *Combretum spp. Guiera senegalensis*, *Cordyla pinnata*, *Ficus spp.*, *Khaya senegalensis*, *Kigelia africana*, *Lannea acida*, *Lophira lanceolata*, *Moringa oleifera*, *Nauclea latifolia*, *Securidaca longepedunculata*, *Sterculia setigera*, *Tamarindus indica*, *Terminalia macroptera*, *Vernonia spp*, *Voacanga Africana* and *Waltheria lanceolate* [3].

The plant part material of interest for folk medicinal purposes are roots, stem bark, seeds, and leaves [4,5]. The body parts are obtained, sometimes dried, and crushed into powder for oral ingestion, application on skin surfaces, or boiled with water before drinking [6,7]. Plants obtained from the forest treat fevers, respiratory infections, stomach aches, headaches, backaches, toothaches, and male sexual dysfunctions [8-10]. The traditional approach to treating and managing diseases with herbs and plants is widespread in Africa and Asia [11,12]. Despite the prevalence of conventional medicine, traditional and herbal medicine still serves most people around the globe due to cultural attachment [13-15]. Data suggests that the global population will reach 9.8 billion by 2050 [16]. Food security is becoming a big concern for many countries around the world. Luckily, the forest is a go-to-get source of edible plants, fruits, leaves, tubers, nuts, and seeds. The

forest is a reliable source of cheap, fresh, and nutritious food for people in low-income countries.

Plant species such as *Adansonia digitata* (Leaves and Seeds), *Anacardium occidentale* (Fruits and Nuts), *Annona senegalensis* (Fruits), *Bombax costatum* (Leaves), *Cordia senegalensis* (Fruits), *Detarium senegalensis* (Fruits), *Dialium guineanses* (Fruits and lLeaves), *Elaeis guineensis* (Seeds, as a source of palm oil), *Fagara zanthoxyloides* (Leaves), *Guierea senegalensis* (Leaves), *Hexalobus monopetalous* (Leaves), *Lippia chevalieri* (Stem), *Moringa oleifera* (Fruits, Seeds, Flowers and Leaves), *Parinari excelsa* (Fruits for porridge), *Parkia biglobosa* (Pulp for juice), *Sopondias mombin* (Fruits), *Tamarindus indica* (Fruits for beverage) and *Ziziphus mauritiana* (Fruits) are popular food and fruit trees highly consumed in The Gambia [17]. They are a source of carbohydrate-containing staple food for many households.

The genus *Albizia* is one of 770 genera found in the third-largest angiosperm Fabaceae family and belongs to the Mimosoideae sub-family [18,19]. It is estimated that more than 150 plant species are categorised as members of the genus *Albizia* with a wide range of global distribution in tropical and subtropical regions of Africa, Asia, Australia, and the Americas [20, 21]. Across West Africa, trees and shrubs of the genus *Albizia* are widespread in Ghana, Nigeria, Senegal, and The Gambia [22]. Similarly, plants of the genus *Albizia* can be found in Southeast Asia in countries like Indonesia, Malaysia, and Thailand [23]. Plants of this genus are for fodder, ornamental trees, and timber, and they play a vital role in traditional and local medicine. As a result, plants of this genus are of high ecological, economic, and medicinal value. Phytochemical analyses have revealed that plants of the genus Albizia are rich in secondary metabolites [24]. Plant extracts from the genus *Albizia* have exhibited analgesic, antibacterial and anti-inflammatory effects [25].

Medicinal plants are plant species whose body parts are used in various forms, for example, powder, brew, or infusion as therapeutic and medicinal agents. Many plant species of the genus *Albizia* have been used in traditional and herbal medicine to treat and manage diseases like wounds, coughs, body aches, and diarrhea. For the longest, it has been known that the leaves, flowers, roots, pods, and barks of *Albizia* plants are therapeutic agents against malaria, diabetes, and anti-inflammation in traditional medicine [26,27]. Medicinal plants are sources of bioactive phytochemicals like alkaloids, terpenoids, flavonoids, saponins, and tannins [28,29]. Medicinal plants have drawn research interests to establish the direct scientific evidence for their healing ability in traditional herbal medicine. Phytochemicals derived from medicinal plants have been the foundation for many modern pharmaceutical and nutraceutical products [30,31].

This review provides a summary of traditional medicinal applications of plant species of the genus *Albizia* found in Africa and Asia. We collate reports in the literature from databases such as Google Scholar, Elsevier, Scopus, and EBSCO on secondary metabolite compounds extracted in a variety of solvents from leaves, roots, stems and stem barks of *Albizia* species. The review also highlights the antibacterial and antioxidant activities of extracts of *Albizia* plants.

MEDICINAL PLANTS OF GENUS *Albizia*

A number of plant species in the genus *Albizia* have been utilised in the treatment of non-communicable illnesses like diabetes and chronic respiratory conditions. *Albizia lebbeck* is a delicious and wild tree found in the tropical regions of Africa and Asia (Figure 1). The bark, roots, and flowers of *Albizia lebbeck* have traditionally been used to treat lung infections and asthma [32]. *A. lebbeck* seeds, on the other hand, have been used in traditional medicine to cure piles, diarrhea, and gonorrhea [33]. *Albizia julibrissin* is a sedative and antidepressant plant native to Asia whose bark extracts have been used in Chinese herbal medicine to treat patients suffering from central nervous system disorders such as depression and anxiety [34]. The bark and flowers of *A. julibrissin* have been used to heal ulcers and hemorrhoids in traditional Asian medicine. [35]. *Albizia procera* L. plant is reported to show efficacy in the treatment of cancer, the bark is used in leprosy and paralysis treatments while the seeds of *A. procera* are recognised for pile and diarrheal treatments in Indian traditional medicine [36]. In Tanzania, it has been reported that the bark, roots, and leaves of *Albizia anthelmintica* are popular traditional medicine for the treatment of malaria, body and abdominal pain [37]. Malaria is a major public health concern in Africa and has been reported to cause several deaths among children annually [38]. Roots and bark of *A. anthelmintica* are well-documented for malarial treatment in Kenya [38]. Diabetes mellitus (DM) is highly prevalent around the globe and reports indicate cases might reach 700 million by 2045 [39]. In Thai traditional medicine (TTM), bark decoctions of *Albizia myriophylla* are used in managing diabetes mellitus [40] and the stem is reported for anti-diabetic properties [41]. *Albizia richardiana* is a

fast-growing tree species native to Africa, Asia, and Australia. In Bangladesh, the bark, fruits, roots, and flowers of *A. richardiana* have been used to treat eye and chest infections (Table 1) [42, 43]. In Kenya, the leaves, and fruits of *A. gummifera* are used as herbal remedies for skin and throat cancer [44]. *Albizia coriaria* is a popular herb in folk medicine in Africa. The leaves, stem, and roots of the deciduous African tree *Albizia zygia* (DC.) J.F. Macbr. are used to treat toothaches, diarrhea, fever, and wounds [45]. The leaves, roots, and flowers of *Albizia saman* are used for anxiety, depression, stomachache, headache, and diarrheal treatment in Indian Ayurvedic medicine [46].

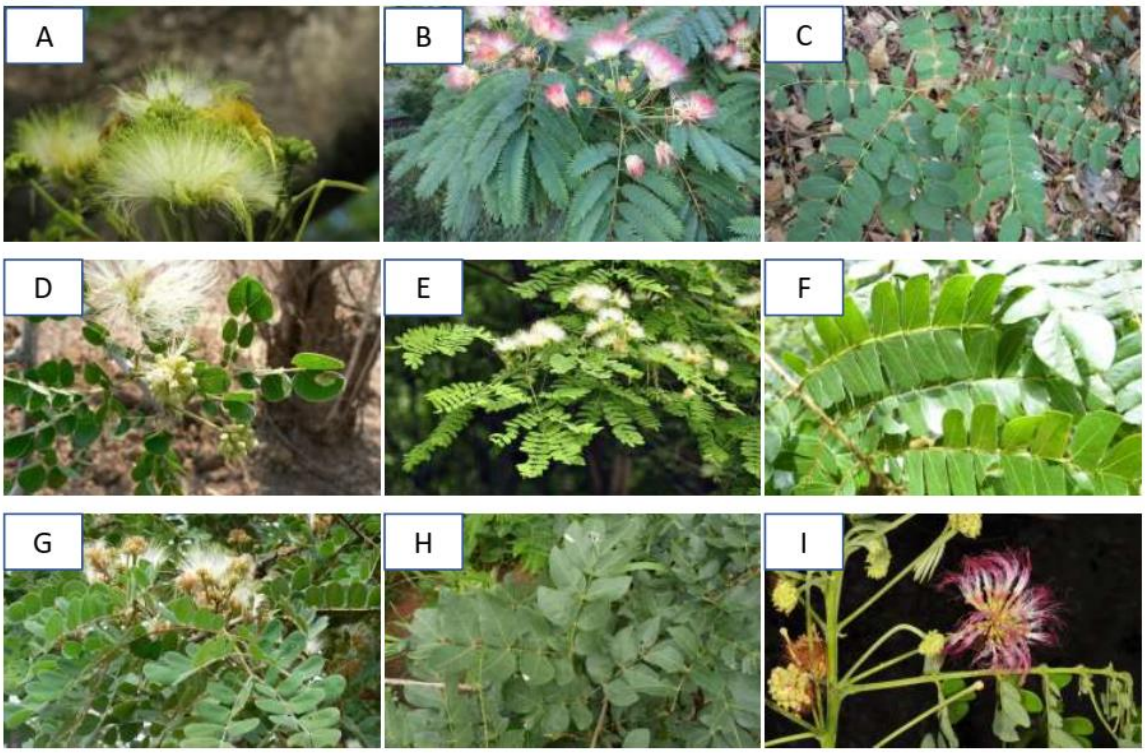


Figure 1. Medicinal Plants of Genus *Albizia*: (a) *Albizia lebbeck* (L.) Benth., (b) *Albizia julibrissin*, (c) *Albizia procera* L., (d) *Albizia anthelmintica*, (e) *Albizia. richardiana*, (f) *Albizia gummifera* (J.F.Gmel.) C.A.Sm., (g) *Albizia coriaria* Welw ex. Oliver, (h) *Albizia zygia* (DC.) J.F. Macbr., (i) *Albizia saman*.

Furthermore, many parts of Africa and Asia have historically employed plants from the genus *Albizia* to cure infectious diseases. For example, boiled roots and bark of *Albizia gummifera* are orally taken in some communities in Ethiopia to treat gonorrheal infections [47]. In Uganda, the leaves, stems, bark, roots, seeds, and flowers of *Albizia coriaria* are used to treat cough [48]. The flowers of *Albizia julibrissin* are used to treat flu and cough in Asian traditional medicine [35].

COMPOUNDS AND PHYTOCHEMICALS IN THE GENUS *ALBIZIA*

Good documentation of plants of the genus *Albizia* exists in the literature showing the presence of phytochemicals. In previous studies on the phytochemical analysis of the genus *Albizia*, alkaloids [24], flavonoids, saponins [34], tannins [36], and terpenes [71], lignanoids and phenolic glycosides [20,35] have been reported. D. Ramya Devi *et al.* [49] isolated glycerin, ethyl α-D-glucopyranoside and n-hexadecanoic acid from an aqueous leaf extract of *Albizia amara*. From the ethanol extract, the two primary chemicals that were identified were phytol and n-hexadecanoic acid. Loganathan *et al*. [50] isolated propane-1, 1-diol diacetate, phytol, and squalene from the ethanol leaf extracts of *A. Amara*. In a review by Maroyi [51], 3-methoxyflavanone, chalcone, and melanoxetin were reported from the stem of *Albizia adianthifolia*. In the root barks and root extracts of *A. adianthifolia*, 3βe, 16βe-dimethoxyolean-12-en-28-21βa-olide, Adianthifoliosides A, Julibroside A3 and Prosapogenin 1 were isolated, respectively. However, *A. adianthifolia's* bark is recognised to be poisonous [52], and the species' roots are utilised as fish poison in Mozambique [53]. Likewise, the gum from *A. adianthifolia's* bark is used as a hunting poison in southern Cameroon, and the bark and leaves are used as fish poison in the Central African Republic [54]. These results emphasise the necessity of conducting comprehensive toxicological investigations of the chemicals identified from *A. adianthifolia* as well as the extracts of the species to determine the potential toxicity and/or adverse

effects that may occur when the species and its products are used as herbal remedies. Andrade *et al*. [55] isolated lupenone from the petroleum ether leaf extract of *Albizia inundata*. Noté *et al*. [56] reported Chevalierosides A, Chevalierosides B, and Chevalierosides C isolation from stem barks ethanol extract of *Albizia chevalieri*. The compounds were determined by NMR analysis as oleanane saponins. Ramaraj *et al*. [57] reported the isolation of novel 3′, 5-dihydroxy-4′, 6, 7-trimethoxyflavone compound from chloroform stem extract of *A. odoratissima*.

Table 1. Traditional Medicinal Uses of Genus *Albizia*

No.	Botanical name	Plant part (s)	Traditional & Local Uses	Ref
1	*Albizia lebbeck* (L.) Benth.	Bark, roots, flowers	Used for lung infections and asthma treatment	[32]
		Seeds	Treatment of pile, diarrhea and gonorrhea	[33]
2	*Albizia julibrissin*	Bark	Treatment of central nervous system disorders such as anxiety, depression and insomnia	[34]
		Bark, flowers	Treatment of ulcers, hemorrhoids, flu and cough	[35]
3	*Albizia procera* L.	Whole plant, bark, seeds	Cancer, leprosy and paralysis, pile and diarrheal treatment.	[36, [74]
4	*Albizia anthelmintica*	Bark, roots, leaves	Treatment of stomachache, body pain and Malaria.	[37, [38]
5	*Albizia myriophylla* Benth.	Bark, wood	Treatment of diabetes mellitus	[40, 41]
6	*Albizia. richardiana*	Roots, bark, fruits, flowers	Blood circulation, eye and chest infections	[42, [43]
7	*Albizia gummifera* (J.F.Gmel.) C.A.Sm.	Leaves, fruits	Throat and skin cancer treatments	[44]
		Roots, bark	Treatment of sexually transmitted infections like gonorrhea	[47]
8	*Albizia zygia* (DC.) J.F. Macbr.	Roots, stem, leaves	Used to treat wounds, diarrhea, fever and toothaches	[45]

In a study by Sobeh *et al*. [58] quercetin-O-galloyl-hexoside and quercetin-O-pentoside were determined as major compounds in methanol leaves extract of *Albizia harveyi*. Myricetin-O-hexoside, Myricetin-O-pentoside, Kaempferol-O-hexoside, Kaempferol-O-pentoside, Ferulic acid and Gallic acid were detected. Desai and Joshi [59] reported Albiziasaponin A, Albiziasaponin B, Albiziasaponin C, Albiziasaponin D, and Albiziasaponin E from bark extract of *Albizia lebbeck*. Viana *et al*. [60] isolated a triterpenoid saponin from the methanol bark extract of *Albizia lebbeck.* Noté *et al*. [61] revealed saponins in *Albizia lebbeck* by isolating lebbeckosides A and lebbeckosides B from ethanol root extracts. Al-Massarani *et al*. [62] isolated bioactive compounds from the flower ethanol extract of *Albizia lebbeck*. The compounds were identified as benzyl 1-O-β-D-glucopyranoside, benzyl 6-O-α-L-arabinopyranosyl β-D-glucopyranoside, linalyl β-D-glucopyranoside, linalyl 6-O-α-L-arabinopyranosyl-β-D-glucopyranoside and ethyl fructofuranoside.

Li and Yang [34] isolated albibrissinoside B, khaephuoside B, leonuriside A, coniferin, syringing, and dihydrosyringin phenolic derivatives from stem barks of *Albizia julibrissin*. Han *et al.* [63] isolated from fractions of ethanol stem barks extract of *Albizia julibrissin*, ten triterpenoid saponins named julibroside J37 to Julibroside J46. Additionally, Noté et al. [64] demonstrated that *Albizia boromoensis's* ethanol root extract contained triterpenoid saponins which were identified as 3-O-b-[a-L-arabinopyranosyl-(1→6)-[β-D-xylopyranosyl-(1→2)]-b-D-glucopyranosyl]-28-O-[β-D-glucopyranosyl-(1→6)-β-D-glucopyranosyl]-oleanolic acid, 3-O-b-[β-L-arabinopyranosyl-(1→6)-[β-D-xylopyranosyl-(1→2)]-β-D-glucopyranosyl]-28-O-[β-D-glucopyranosyl-(1→6)-[β-D-glucopyranosyl-(1→2)]-β-D-glucopyranosyl]-oleanolic acid 3-O-β-[α-L-arabinopyranosyl-(1→6)-[β-D-xylopyranosyl-(1→2)]-β-D-glucopyranosyl]-28-O-[β-D-glucopyranosyl-(1→6)-β-D-glucopyranosyl-(1→2)-β-D-glucopyranosyl]-oleanolic acid and 3-O-β-[a-L-arabinopyranosyl-(1→6)-[β-D-xylopyranosyl-(1→2)]-b-D-glucopyranosyl]-28-O-[β-D-glucopyranosyl-(1→2)-β-D-glucopyranosyl]-oleanolic acid. Koagne *et al.* [65] isolated flavonoid compounds from the methanol leaf extracts of *Albizia zygia* and identified the compounds as phaseoloidin and quercetin 3, 4′-di-O-α-L-rhamnopyranoside. Table 2 summarises the molecules isolated from the genus *Albizia* and their spectroscopic identification methods.

Table 2. Molecules of Genus *Albizia*

No.	Plant Species	Plant part	Class of Secondary Metabolite	Molecules	Spectrometric analysis	Ref
1.	*Abizia amara*	Leaves	n.d	Ethyl a-d-glucopyranoside n-hexadecanoic acid Glycerin	GC-MS	[49]
			n.d	n-hexadecanoic acid Phytol		
			n.d	Phytol Propane-1,1-Diol Diacetate Squalene		[50]
2.	*Albizia adianthifolia*	Stem	Flavonoid	3-methoxyflavanone Chalcone Melanoxetin	MS	[51]
		Root stem	Triterpenoid	3βe,16βe-dimethoxyolean-12-en-28-21βa-olide	NMR	
		Roots	Terpene saponin	Adianthifoliosides A Julibroside A3 Prosapogenin 1	HRESIMS NMR	
3.	*Albizia inundata* (Mart.) Barneby & J.W.Grimes	Leaves	Triperpenoid	Lupenone	NMR	[55]
4.	*Albizia chevalieri* harms	Stem bark	Oleanane saponin	Chevalierosides A Chevalierosides B Chevalierosides C	NMR HRESIMS	[56]
5.	*Albizia odoratissima*	Stem	Flavone	3′,5-dihydroxy-4′,6,7-trimethoxyflavone	NMR ESI-MS	[57]
6.	*Albizia harveyi*	Leaves	Flavonoid glycoside	Myricetin-*O*-hexoside Myricetin-*O*-pentoside Kaempferol-*O*-hexoside Kaempferol-*O*-pentoside	HPLC-PDA-MS/MS	[58]
			Phenolic acid	Ferulic acid Gallic acid		
7.	*Albizia lebbeck* (L.) Benth.	Bark	Saponin (Oleanene triterpene)	Albiziasaponin A Albiziasaponin B Albiziasaponin C	HPTLC	[59]
			Triterpenoid saponin	21-[[(2E,6S)-6-[6-deoxy-4-O-[(2E,6S)-6-hydroxy-2-(hydroxymethyl)-6-methyl-1-oxo-2,7-octadienyl]-[(β-D-glucopyranosyl)oxy]-2-(hydroxymethyl)-6-methyl-1-oxo-2,7-octadienyl]-[(β-D-glucopyranosyl)oxy]-2,6-dimethyl-1-oxo-2,7-octadienyl]oxy]-16-hydroxy-3-[[O-β-D-xylopyranosyl-(1→2)-O-α-L-arabinopyranosyl-(1 → 6)-2-(acetylamino)-2-deoxy-β-D-glucopyranosyl]oxy]-(3β,16α,21β)-olean-12-en-28-oic acidO-α-L-arabinofuranosyl-(1 → 4)-O-[β-D-glucopyranosyl-(1 → 3)]-O-6-deoxy-α-L-mannopyranosyl-(1 → 2)-β-D-glucopyranosyl ester	NMR	[60]
		Roots	Triterpenoid Saponin	Lebbeckosides A Lebbeckosides B	NMR	[61]
		Leaves	Acyclic farnesyl sesquiterpene	1-O-[6-O-a-L-arabinopyranosyl-b-D-	NMR	[62]

No.	Plant Species	Plant part	Class of Secondary Metabolite	Molecules	Spectrometric analysis	Ref
			glycoside	glucopyranoside] -(2E,6E-)-farnesol		
			Squalene derivative	2,3-dihydroxy-2,3-dihydrosqualene		
			Benzyl glycosides	Benzyl 1-O-b-D-glucopyranoside Benzyl 6-O-a-L-arabinopyranosyl b-D-glucopyranoside		
			Acyclic monoterpene glycosides	Linalyl b-D-glucopyranoside Linalyl 6-O-a-L-arabinopyranosyl-b-D-glucopyranoside (2E)-3,7-dimethylocta-2,6-dienoate-6-O-a-L arabinopyranosyl-b-D-glucopyranoside		
			Oligoglycosides	n-hexyl-a-L arabinopyranosyl-(1→ 6)-b-D-glucopyranoside (creoside) n-octyl a-L-arabinopyranosyl-(1→6)-b-D-glucopyranoside		
			n.d	Ethyl fructofuranoside		
8.	*ia julibrissin*	Stem bark	Phenolic derivatives	Albibrissinoside B Khaephuoside B Leonuriside A Coniferin Syringing Dihydrosyringin	NMR MS	[34]
			Triterpenoid saponin (Oleanane type)	Julibroside J_{37} Julibroside J_{38} Julibroside J_{39} Julibroside J_{40} Julibroside J_{41}	NMR	[63]
9.	*Albizia boromoensis* Aubre´v. & Pellegr.	Roots	Triterpenoid saponins (Oleanane-type)	3-O-β-[α-$_{L}$-arabinopyranosyl-(1→6)-[β-$_{D}$-xylopyranosyl-(1→2)]-β-$_{D}$-glucopyranosyl]-28-O-[β-$_{D}$-glucopyranosyl-(1→6)-β-$_{D}$-glucopyranosyl-(1→2)-β-$_{D}$-glucopyranosyl]-oleanolic acid 3-O-β-[a-L-arabinopyranosyl-(1→6)-[β-$_{D}$-xylopyranosyl-(1→2)]-b-D-glucopyranosyl]-28-O-[β-$_{D}$-glucopyranosyl-(1→2)-β-$_{D}$-glucopyranosyl]-oleanolic acid 3-O-b-[a-L-arabinopyranosyl-(1→6)-[β-D-xylopyranosyl-(1→2)]-b-D-glucopyranosyl]-28-O-[β-$_{D}$-glucopyranosyl-(1→6)-β-$_{D}$-glucopyranosyl]-oleanolic acid 3-*O*-b-[β-$_{L}$-arabinopyranosyl-(1→6)-[β-$_{D}$-xylopyranosyl-(1→2)]-β-$_{D}$-glucopyranosyl]-28-*O*-[β-$_{D}$-glucopyranosyl-(1→6)-[β-	HRESIMS NMR	[64]

No.	Plant Species	Plant part	Class of Secondary Metabolite	Molecules	Spectrometric analysis	Ref
				$_{D}$-glucopyranosyl-(1→2)]-β-$_{D}$-glucopyranosyl]-oleanolic acid		
10.	*Albizia zygia* (DC.) J.F. Macbr.	Leaves	Flavonoid	Phaseoloidin Kaempferol 3-O-α-L-rhamnopyranoside Quercetine Quercetin 3,4′-di-O-α-L-rhamnopyranoside Kaempferol 3,4′-di-O-α-L-rhamnopyranoside Quercetin 3-O-α-L-rhamnopyranoside	NMR	[65]

ANTIBACTERIAL ACTIVITY OF GENUS *ALBIZIA*

To determine the antibacterial activity of *Albizia adianthifolia*, Abubakar and Majinda [66] tested n-hexane and chloroform extracts of *A. adianthifolia* heartwood against *E. coli*, *P. aeruginosa*, *B. subtilis* and *S. aureus* in an agar assay. The n-hexane and chloroform extracts showed effective antibacterial activity with minimum inhibition quantity (MIQ). Joycharat *et al*. [67] investigated the antibacterial activity of ethanol wood extract and identified components from *Albizia myriophylla* in a broth microdilution assay. According to Joycharat *et al.*, lupinifolin had the best effectiveness against *B. cereus* and *S. aureus*, with MIC values of 15.63 g/mL. With a MIC value of 62.6 g/mL, 2, 3-dihydroxylupinifolin demonstrated superior efficacy against *B. cereus*. The ethanol extract had no effect on *B. cereus* or *S. aureus*.

Mahlangu *et al.* [68] tested different solvent extracts of *Albizia gummifera* leaves against *S. Typhimurium*, *S. Enteritidis*, *S. Dublin*, and *S. Gallinarum* in microplate dilution assays. Methanol extract showed the best activity with MIC values of 0.13 mg/mL for *S. Typhimurium* and *S. Gallinarum* and 0.25 mg/mL for *S. Enteritidis* and *S. Dublin*. The acetone and DCM extracts of *A. gummifera* showed moderate activity, 1 mg/mL for all the tested bacterial strains. The ethanol leaf extracts of *Albizia multiflora* were tested by María *et al.* [69] for antibacterial activity against *S. aureus*, *E. coli*, and *V. parahaemolyticus* using disc diffusion assay. However, the extract showed no significant activity against the three bacterial strains. Aurélie *et al.* [70] evaluated two different methods for antibacterial activity determination of methanol leaves extract of *Albizia tulearensis*. The methods were disc diffusion and microdilution assays. The leave methanol extract of *A. tulearensis* was most active against *B. cereus*, *S. aureus*, and *S. pyogenes* with MIC values of 156.2 µg/mL in the microdilution assay compared to the disc diffusion assay with inhibitory zone diameters of 6 mm respectively.

Omara *et al.* [46] reported on the antibacterial activity of ethanol, ethyl acetate, and aqueous leaf extracts of *Albizia coriaria* by an agar disc diffusion method. The ethanol extract showed antibacterial potency against *E. coli* and *S. typhi* with inhibition zone diameters of 10.00 ± 1.73 mm and 16.00 ± 1.73 mm. The ethyl acetate extract showed activity of IZD 4.00 ± 2.00 mm for *E. coli* while the aqueous extract was inactive for all the tested strains. He *et al.* [20] reported that *A. odoratissima* methanol and ethyl acetate leaf extracts showed good antibacterial activity against *K. pneumoniae*, *E. coli*, *P. aeruginosa*, *P. vulgaris*, and *S. aureus* with values of minimum inhibitory concentration ranging 136-546 µg/mL. Similarly, He and team said that the methanol leaves extract of *A. adianthifolia* was determined for antibacterial activity against several bacterial strains. MIC values were between 64 and 1024 µg/mL for *K. pneumoniae*, *E. coli* and *S. aureus*. Overall, the literature suggests that the genus *Albizia* consists of plants with bioactive components.

ANTIOXIDANT ACTIVITY OF GENUS *ALBIZIA*

The radical scavenging activity of different solvent extracts of *Albizia odoratissima* was tested in DPPH, ABTS, and H_2O_2 assays by Banothu *et al.* [71]. The highest antioxidant activities were noticed for methanol and ethyl acetate leaf extracts at 8.59 ± 0.39 and 4.35 ± 0.07 µg/mL in ABTS. For the DPPH assay, IC_{50} values were 16.62 ± 0.85 and 10.96 ± 0.40 µg/mL. Poor radical scavenging activity was observed for chloroform and hexane extracts of *A. odoratissima*. Ethanol and distilled water leaf extracts of *Albizia lebbeckoides* were investigated for antioxidant capacity using DPPH assay by Hajrawati *et al.* [72]. The ethanol and distilled

water extracts showed good radical scavenging activity with IC_{50} values of 2.82 ± 0.02 and 3.69 ± 0.06 mg/mL. Islam *et al.* [43] reported an antioxidant potential of methanol and chloroform extracts, n-hexane, and aqueous fractions of stems of *Albizia richardiana* by DPPH assay. The chloroform extract and n-hexane fraction had the maximum capacity, with IC_{50} values of 5.49 g/mL and 11.26 g/mL, respectively. The aqueous fraction showed moderate activity of IC_{50} 81.99 µg/mL, and the methanol extract was inactive (155.32 µg/mL). The bark of *Albizia myriophylla* was evaluated for radical scavenging activity using DPPH after being extracted in methanol and fractionated in water, chloroform, and n-hexane by Meng *et al.* [23]. The highest activity was shown by ethyl acetate fraction with 72.55% inhibition. Chloroform, aqueous, and methanol extracts showed moderate inhibition, and poor inhibition was observed for the n-hexane extract.

Sobeh *et al.* [58] evaluated the radical scavenging activity of *Albizia harveyi* leaves methanol extract in DPPH and found antioxidant activity of 16.3 g/mL (EC_{50}). Bakasatae *et al.* [73] reported strong antioxidant activity for ethanol wood extract and DCM fraction of *Albizia myriophylla*. DPPH assay revealed promising radical scavenging power of IC_{50} value of 64.22 µg/mL for ethanol extract while DCM fraction showed a better activity of IC_{50} of 29.54 µg/mL. The antioxidant capacity of the DCM fraction was stronger in the DPPH compared to the ABTS assay which showed an IC_{50} value of 40.36 µg/mL. Srivastava *et al.* [74], reported that the ethanol leaves extract of *Albizia procera* showed strong antioxidant potential with 90% inhibition concentration (IC_{50}) in DPPH radical scavenging assay. In another report by Vinodhini *et al*. [46], good antioxidant activity in the DPPH assay was highlighted for the n-hexane fraction of bark extracts of *Albizia saman* with IC_{50} value of 14 µg/mL. With an IC_{50} of 65g/mL, the carbon tetrachloride (CCl_4) fraction demonstrated moderate radical scavenging activity. The crude methanol extract was a weak antioxidant.

CONCLUSIONS

Herbal medicines have treated many human and animal diseases. The richness of plants with a plethora of bioactive metabolites motivated scientists to explore their extraction and application in pharmaceuticals. Consequently, new strategies for the replication processes involving mass spectrometry or gas chromatography integrated with online databases have attracted more attention to allow the rapid identification of bioactive metabolites in a complex extract.

In herbal medicine, genus *Albizia* plants in tropical Africa and China, India, and Indonesia are effective against human ailments. We have had a significant breakthrough in the last four decades in elucidating phytochemicals and determining the pharmacological properties of plants. However, there are still some research gaps regarding correlating the ethnomedicinal applications of plants with the chemical compounds and pharmacological properties of the compounds and extracts of plants, including detailed in vivo studies on the pharmacokinetics and clinical research involving compounds isolated to determine the toxicity and any potential negative effects that can arise from species and their products use in medicine.

ACKNOWLEDGMENTS

We appreciate the collaboration between Brawijaya University and the University of The Gambia, whose resources are used in the literature survey.

REFERENCES

[1] Gambia Bureau of Statistics (GBOS, 2013). Population and Housing Census, 2013: Spatial Distribution.

[2] Ministry of Agricultural and Natural Resources (MNAR, 1995). Gambia: Country Report to the FAO International Technical Conference on Plant Genetics Resources. Ministry of Agricultural and Natural Resources, Banjul.

[3] Danso, A. A. 2001. State of Forest Genetic Resources in The Gambia. Forest Genetic Resources Working Papers, Forestry Department, The Gambia.

[4] Getachew, M., Belayneh, A., Kebede, B., Alimaw, Y., Biyazin, Y., Abebaw, A., Abebe, D. 2022. Medicinal Plants Used for Management of Hemorrhoids in Ethiopia: A Systematic Review. *Heliyon*, 8(8).

[5] Anand, U., Tudu, C. K., Nandy, S., Sunita, K., Tripathi, V., Loake, G. J., Dey, A., Proćków, J. 2022. Ethnodermatological use of Medicinal Plants in India: From Ayurvedic Formulations to Clinical Perspectives – A Review. *Journal of Ethnopharmacology*, 284, 114744.

[6] Raimi, I. O., Kopaopa, B. G., Mugivhisa, L. L., Lewu, F. B., Amoo, S. O., Olowoyo, J. O. 2020. An appraisal of Documented Medicinal Plants Used for the Treatment of Cancer in Africa Over a Twenty-Year Period (1998–2018). *Journal of Herbal Medicine*, 23, 100371.

[7] Salmerón-Manzano E., Garrido-Cardenas J.A., Manzano-Agugliaro F. 2020. Worldwide Research Trends on Medicinal Plants. *Int. Journal Environ Res Public Health*, 12; 17(10):3376.

[8] Siddig Hamad, M., Elsafi, H., Saeed, A., Fadul, E. 2017. A Review on the Taxonomy, Ethnobotany, Phytochemistry and Pharmacology of Guriea

Senegalensis J.F.Gmel. (Combretaceae). *Med. Aromat Plants*, 06 (04).

[9] Bello, H., Mohammed, Z., Katsayal, U. 2016. Pharmacognostic Evaluation of the Root *Cassia sieberiana* D C: A Promising Ethnomedicinal Plant. *Journal of Pharmacognosy and Phytochemistry*, 5 (3), 270-275.

[10] Dior FALL, A., Dieng, S. I. M., Sarr, A., Dieng, M. 2019. Phytochemical Screening and Antioxidant Effect of Ethanol Leaf and Trunk Bark Extracts of Cordyla Pinnata (Lepr. Ex A. Rich.) Milne-Redh. (Caesalpiniaceae). *Pharmacognosy Journal*, 11 (6s), 1415–1418.

[11] Cahyaningsih, R., Phillips, J., Brehm, J. M., Gaisberger, H., Maxted, N. 2021. Climate Change Impact on Medicinal Plants in Indonesia. *Global Ecology and Conservation*, 30, e01752.

[12] Papo, L. A., Van Vuuren, S. F., Moteetee, A. N. 2022. The Ethno-botany and Antimicrobial Activity of Selected Medicinal Plants from Ga-Mashashane, Limpopo Province, South Africa. *South African Journal of Botany*, 149, 196-210.

[13] Cock, I. E., Luwaca, N., Van Vuuren, S. F. 2023. The Traditional use of Southern African Medicinal Plants to Alleviate Fever and Their Antipyretic Activities. *Journal of Ethnopharmacology*, 303, 115850.

[14] Khumalo, G. P., Van Wyk, B. Erik., Feng, Y., Cock, I. E. 2022. A Review of the Traditional use of Southern African Medicinal Plants for the Treatment of Inflammation and Inflammatory Pain. *Journal of Ethnopharmacology*, 283, 114436.

[15] Tembo, N., Lampiao, F., Mwakikunga, A., Chikowe, I. 2021. Ethnobotanical Survey of Medicinal Plants Used for Cervical Cancer Management in Zomba District, Malawi. *Scientific African*, 13, e00941.

[16] https://www.un.org/en/desa/world-population-projected-reach-98-billion-2050-and-112-billion-2100. [Accessed: 18th January 2023].

[17] Bojang, L. 1999. Non-Wood Forest Products in The Gambia. Data Collection and Analysis for Sustainable Forest Management in ACP Countries - Linking National and International Efforts, EC-FAO Partnership Programme.

[18] Nguyen, H. B., Huang, J., Do, V. T., Srivastava, G., Nguyen, H. M. T., Li, S-F., Chen, L-L., Nguyen, M. T., Doan, H. D., Zhou, Z-K., Su, T. 2023. Pod fossils of Albizia (Fabaceae: Caesalpinioideae) from the late Miocene of northern Vietnam and their phytogeographic history. *Review of Palaeobotany and Palynology*, 308, 104801.

[19] Hazra, T., Hazra, M., Spicer, R. A., Spicer, T. E. V., Mahato, S., Bera, S., Kumar, S., Ali Khan, M. 2022. Pliocene Albizia (Fabaceae) from Jharkhand, Eastern India: Reappraisal of Its Biogeography during the Cenozoic in Southeast Asia. *Palaeoworld*, 31 (1), 153-168.

[20] He, Y., Wang, Q., Ye, Y., Liu, Z., Sun, H. 2020. The Ethnopharmacology, Phytochemistry, Pharmacology and Toxicology of Genus Albizia: A Review. *Journal of Ethnopharmacology*, 257, 112677.

[21] Arasu, M. V., Al-Dhabi, N. A., Choi, K. C., Bensy, A. D. V., Rajaselvam, J. 2022. Bioactive potential of *Albizia lebbeck* extract against phytopathogens and protective properties on tomato plant against speck disease in greenhouse. *Physiological and Molecular Plant Pathology*, 117, 101750.

[22] Avoseh, O. N., Mtunzi, F. M., Ogunwande, I. A., Ascrizzi, R., Guido, F. 2021. *Albizia lebbeck* and *Albizia zygia* Volatile Oils Exhibit Anti-Nociceptive and Anti-Inflammatory Properties in Pain Models. *Journal of Ethnopharmacology*, 268, 113676.

[23] Meng, Y. G., Abas, R., Syakroni, N., Abdul Razak, N. I., Mohd. Nor, N. H., Mohamad Asri, Salihan, S., S. F., Mohamad Zainal, N. H., Mohd. Thani, S., Saat, A. 2020. Evaluation and Determinations of Secondary Metabolites and its Antioxidant Activities of Various Fractions of *Albizia myriophylla* bark. *Proceedings*, *61*(1), 7.

[24] Sobeh, M., Rezq, S., Sabry, O. M., Abdelfattah, M. A. O., El Raey, M. A., El-Kashak, W. A., El-Shazly, A. M., Mahmoud, M. F., Wink, M. 2019. *Albizia anthelmintica*: HPLC-MS/MS Profiling and *in vivo* Anti-Inflammatory, Pain-Killing and Antipyretic Activities of Its Leaf Extract. *Biomedicine & Pharmacotherapy*, 115, 108882.

[25] Khumalo, G. P., Van Wyk, B. E., Feng, Y., Cock, I. E. 2021. A Review of the Traditional Use of Southern African Medicinal Plants for the Treatment of Inflammation and Inflammatory Pain. *Journal of Ethnopharmacology*, 114436.

[26] Mangang, K. C. S., Chakraborty, S., Deka, S. C. 2020. Optimized Microwave-Assisted Extraction of Bioflavonoids from *Albizia myriophylla* Bark Using Response Surface Methodology. *Journal of Food Sci. Technol*., 57 (6), 2107–2117.

[27] Nabil, M., El Raey, M. A., Abdo, W., Abdelfattah, M. A. O., El-Shazly, A. M., Sobeh, M., Mahmoud, M. F. 2021. Gastro-Protective Effects of *Albizia anthelmintica* Leaf Extract on Indomethacin-Induced Gastric Ulcer in Wistar Rats: In Silico and *in vivo* Studies. *Antioxidants*, 10 (2), 176.

[28] Clemen-Pascual, L. M., Macahig, R. A. S., Rojas, N. R. L. 2022. Comparative Toxicity, Phytochemistry, and use of 53 Philippine Medicinal Plants, *Toxicology Reports*, 9, 22-35.

[29] Maphetu, N., Unuofin, J. O., Masuku, N. P., Olisah, C., Lebelo, S. L. 2022. Medicinal Uses, Pharmacological Activities, Phytochemistry, and the Molecular Mechanisms of *Punica granatum* L. (pomegranate) plant extracts: A Review. *Biomedicine & Pharmacotherapy*, 153, 113256.

[30] Yusoff, I. M., Taher, Z. M., Rahmat, Z., Chua, L. S. 2022. A Review of Ultrasound-assisted Extraction for Plant Bioactive Compounds: Phenolics, flavonoids, thymols, saponins and proteins. *Food Research International*, 157.

[31] Erhabor, J. O., Omokhua, A. G., Ondua, M., Abdalla, M. A., McGaw, L. J. 2020. Pharmacological Evaluation of Hydro-Ethanol and Hot Water Leaf Extracts of *Bauhinia galpinii* (Fabaceae): A South African Ethnomedicinal

Plant. *South African Journal of Botany*, 128, 28–34.

[32] Malaikolundhan, H., Mookkan, G., Krishnamoorthi, G., Matheswaran, N., Alsawalha, M., Veeraraghavan, V. P., Krishna Mohan, S., Di, A. 2020. Anticarcinogenic Effect of Gold Nanoparticles Synthesized from *Albizia lebbeck* on HCT-116 Colon Cancer Cell Lines. *Artificial Cells, Nanomedicine, and Biotechnology*, 48 (1), 1206–1213.

[33] Saleem, U., Raza, Z., Anwar, F., Ahmad, B., Hira, S., Ali, T. 2019. Experimental and Computational Studies to Characterize and Evaluate the Therapeutic Effect of *Albizia lebbeck* (L.) Seeds in Alzheimer's disease. *Medicina*, 55 (5), 184.

[34] Li, W., Yang, H. J. 2020. Isolation and Identification of Lignans and Other Phenolic Constituents from the Stem Bark of *Albizia julibrissin* Durazz and Evaluation of Their Nitric Oxide Inhibitory Activity. *Molecules*, 25 (9), 2065.

[35] Ebrahimzadeh, M. A., Fathi, H., Ziar, A., Mohammadi, H. 2019. Attenuation of Brain Mitochondria Oxidative Damage by *Albizia julibrissin* Durazz: *Neuroprotective and Antiemetic Effects. Drug and Chemical Toxicology*, 42 (2), 122–129.

[36] Sangeetha, M., Chamundeeswari, D., Saravana Babu, C., Rose, C., Gopal, V. 2020. Attenuation of Oxidative Stress in Arthritic Rats by Ethanolic Extract of Albizia Procera Benth Bark through Modulation of the Expression of Inflammatory Cytokines. *Journal of Ethnopharmacology*, 250, 112435.

[37] Hilonga, S., Otieno, J. N., Ghorbani, A., Pereus, D., Kocyan, A., de Boer, H. 2019. Trade of Wild-Harvested Medicinal Plant Species in Local Markets of Tanzania and Its Implications for Conservation. *South African Journal of Botany*, 122, 214–224.

[38] Omara, T. 2020. Antimalarial Plants Used across Kenyan Communities. *Evidence-Based Complementary and Alternative Medicine*, 2020:4538602, 1–31.

[39] Saeedi, P., Petersohn, I., Salpea, P., Malanda, B., Karuranga, S., Unwin, N., Colagiuri, S., Guariguata, L., Motala, A. A., Ogurtsova, K., Shaw, J. E., Bright, D., Williams, R. 2019. Global and Regional Diabetes Prevalence Estimates for 2019 and Projections for 2030 and 2045: Results from the International Diabetes Federation Diabetes Atlas, 9th Edition. *Diabetes Research and Clinical Practice*, 157, 107843.

[40] Andrade, C. Gomes, N. G. M., Duangsrisai, S., Andrade, P. B., Pereira, D. M., Valentão, P. 2020. Medicinal Plants Utilized in Thai Traditional Medicine for Diabetes Treatment: Ethnobotanical Surveys, Scientific Evidence and Phytochemicals. *Journal of Ethnopharmacology*, 263, 113177.

[41] Thengyai, S., Thiantongin, P., Sontimuang, C., Ovatlarnporn, C., Puttarak, P. 2020. α-Glucosidase and α-Amylase Inhibitory Activities of Medicinal Plants in Thai Antidiabetic Recipes and Bioactive Compounds from *Vitex glabrata* R. Br. Stem Bark. *Journal of Herbal Medicine*, 19, 100302.

[42] Hossen, K., Iwasaki, A., Suenaga, K., Kato-Noguchi, H. 2021. Phytotoxic Activity and Growth Inhibitory Substances from *Albizia richardiana* (Voigt.) King & Prain. *Applied Sciences*, 11 (4), 1455.

[43] Islam, M. N., Tasnim, H., Arshad, L., Haque, Md. A., Tareq, S. M., Kamal, A. T. M. M., Rahman, Md. M., Reza, A. S. M. A., Chowdhury, K. A. A., Tareq, A. M. 2020. Stem Extract of *Albizia richardiana* Exhibits Potent Antioxidant, Cytotoxic, Antimicrobial, Anti-Inflammatory and Thrombolytic Effects through in Vitro Approach. *Clin Phytosci*, 6 (1), 60.

[44] Raimi, I. O., Kopaopa, B. G., Mugivhisa, L. L., Lewu, F. B., Amoo, S. O., Olowoyo, J. O. 2020. An Appraisal of Documented Medicinal Plants Used for the Treatment of Cancer in Africa over a Twenty-Year Period (1998–2018). *Journal of Herbal Medicine*, 23, 100371.

[45] Avoseh, O. N., Mtunzi, F. M., Ogunwande, I. A., Ascrizzi, R., Guido, F. 2021. *Albizia lebbeck* and *Albizia zygia* Volatile Oils Exhibit Anti-Nociceptive and Anti-Inflammatory Properties in Pain Models. *Journal of Ethnopharmacology*, 268, 113676.

[46] Vinodhini, S., Rajeswari, D., V. 2018. Review on Ethnomedical Uses, Pharmacological Activity and Phytochemical Constituents of *Samanea saman* (Jacq.) Merr. Rain Tree. *Pharmacognosy Journal*, 10 (2), 202–209.

[47] Silva, O., Caldeira, G., Serrano, R. 2020. A Review of the Role of Medicinal Plants on Neisseria Gonorrhoeae Infection. *European Journal of Integrative Medicine*, 39, 101211.

[48] Omara, T., Kiprop, A. K., Kosgei, V. J. 2021. Intraspecific Variation of Phytochemicals, Antioxidant, and Antibacterial Activities of Different Solvent Extracts of *Albizia coriaria* Leaves from Some Agroecological Zones of Uganda. *Evidence-Based Complementary and Alternative Medicine*, 2021:2335454, 1–14.

[49] Ramya Devi, D., Sowmiya Lakshna, S., Veena Parvathi, S., Vedha Hari, B. N. 2018. Investigation of Wound Healing Effect of Topical Gel of *Albizia amara* Leaves Extract. *South African Journal of Botany*, 119, 400–409.

[50] Loganathan, Y.; Jain, M.; Thiyagarajan, S.; Shanmuganathan, S.; Mariappan, S. K.; Kizhakedathil, M. P. J.; Saravanakumar, T. 2021. An Insilico Evaluation of Phytocompounds from *Albizia amara* and *Phyla nodiflora* as Cyclooxygenase-2 Enzyme Inhibitors. *DARU J Pharm Sci*., 29, 311–320.

[51] Maroyi, A. 2018. Albizia Adianthifolia: Botany, Medicinal Uses, Phytochemistry, and Pharmacological Properties. *The Scientific World Journal*, 2018, 1–18.

[52] Watt, J. M.; Breyer-Brandwijk, M. G. *The Medicinal and Poisonous Plants Of Southern and Eastern Africa: Pharmacological Effects and Toxicology in Man and Animals.* Edinburgh, UK: E. Livingstone; 1962.

[53] Neuwinger, H. D. Plants used for poison fishing in tropical Africa. Toxicon. 2004, 44(4), 417–430.
[54] Lemmens R.H.M.J., Louppe Dominique, Oteng-Amoako A.A. 2012. Plant resources of tropical Africa. Prota 7(2): timbers 2. Wageningen: PROTA, 1 Cd-Rom ISBN 978-92-9081-496-2. 978-92-9081-498-6.
[55] Andrade, E., Teixeira, J., Silva, D., dos Santos, T., Korn, M., Brandão, H., Ferraz, C., Meira, C., Soares, M., Guimarães, E., Neta, L., Júnior, A. 2020. Phytochemical Analysis, Multi-Element Composition and Biological Activities of Extracts and Lupenone from *Albizia inundata* (Mart.). *J. Braz. Chem. Soc.*, 31 (9), 1825-1837.
[56] Noté, O. P., Messi, L. M., Mbing, J. N., Azouaou, S. A., Sarr, M., Guillaume, D., Muller, C. D., Pegnyemb, D. E., Lobstein, A. 2017. Pro-Apoptotic Activity of Acylated Triterpenoid Saponins from the Stem Bark of *Albizia chevalieri* Harms. *Phytochemistry Letters*, 22, 95–101.
[57] Ramaraj, D., Rathinasamy, G., Vairathevar Sivasamy, V. 2018. Isolation of Eupatorin (3′,5-Dihydroxy-4′,6,7-Trimethoxyflavone) from *Albizia odoratissima* and Its Application for l-Tryptophan Sensing. *Res Chem Intermed*, 44 (11), 6917–6931.
[58] Sobeh, M., Hassan, S., El Raey, M., Khalil, W., Hassan, M., Wink, M. 2017. Polyphenolics from Albizia Harveyi Exhibit Antioxidant Activities and Counteract Oxidative Damage and Ultra-Structural Changes of Cryopreserved Bull Semen. *Molecules*, 22 (11), 1993.
[59] Desai, T. H., Joshi, S. V. 2019. Anticancer Activity of Saponin Isolated from *Albizia lebbeck* Using Various *in vitro* Models. *Journal of Ethnopharmacology*, 231, 494–502.
[60] Viana, E. O. R., Cruz, M. de F. S. J., da Silva, M. J., Pereira, G. M., da Silva, B. P., Tinoco, L. W., Parente, J. P. 2019. Structural Characterization of a Complex Triterpenoid Saponin from *Albizia lebbeck* and Investigation of Its Permeability Property and Supramolecular Interactions with Membrane Constituents. *Carbohydrate Research*, 471, 105–114.
[61] Noté, O. P., Jihu, D., Antheaume, C., Zeniou, M., Pegnyemb, D. E., Guillaume, D., Chneiwess, H., Kilhoffer, M. C., Lobstein, A. 2015. Triterpenoid Saponins from *Albizia lebbeck* (L.) Benth and Their Inhibitory Effect on the Survival of High Grade Human Brain Tumor Cells. *Carbohydrate Research*, 404, 26–33.
[62] Al-Massarani, S. M., El Gamal, A. A., Abd El Halim, M. F., Al-Said, M. S., Abdel-Kader, M. S., Basudan, O. A., Alqasoumi, S. I. 2017. New Acyclic Secondary Metabolites from the Biologically Active Fraction of *Albizia lebbeck* Flowers. *Saudi Pharmaceutical Journal*, 25 (1), 110–119.
[63] Han, Q., Qian, Y., Wang, X., Zhang, Q., Cui, J., Tu, P., Liang, H. 2017. Cytotoxic Oleanane Triterpenoid Saponins from *Albizia julibrissin*. *Fitoterapia*, 121, 183–193.
[64] Noté, O. P., Jihu, D., Antheaume, C., Guillaume, D., Pegnyemb, D. E., Kilhoffer, M. C., Lobstein, A. 2015. Triterpenoid Saponins from *Albizia boromoensis* Aubrév. & Pellegr. *Phytochemistry Letters*, 11, 37–42.
[65] Koagne, R. R., Annang, F., Cautain, B., Martín, J., Pérez-Moreno, G., Bitchagno, G. T. M., González-Pacanowska, D., Vicente, F., Simo, I. K., Reyes, F., Tane, P. 2020. Cytotoxycity and Antiplasmodial Activity of Phenolic Derivatives from *Albizia zygia* (DC.) J.F. Macbr. (Mimosaceae). *BMC Complement Med Ther*, 20 (1), 8.
[66] Abubakar, M., Majinda, R. 2016. GC-MS Analysis and Preliminary Antimicrobial Activity of *Albizia adianthifolia* (Schumach) and Pterocarpus Angolensis (DC). *Medicines*, 3 (1), 3.
[67] Joycharat, N., Boonma, C., Thammavong, S., Yingyongnarongkul, B., Limsuwan, S., Voravuthikunchai, S. P. 2016. Chemical Constituents and Biological Activities of *Albizia myriophylla* Wood. *Pharmaceutical Biology*, 54 (1), 62–73.
[68] Mahlangu, Z. P., Botha, F. S., Madoroba, E., Chokoe, K., Elgorashi, E. E. 2017. Antimicrobial Activity of Albizia Gummifera (J.F.Gmel.) C.A.Sm Leaf Extracts against Four *Salmonella serovars*. *South African Journal of Botany*, 108, 132–136.
[69] María, R., Shirley, M., Xavier, C., Jaime, S., David, V., Rosa, S., Jodie, D. 2018. Preliminary Phytochemical Screening, Total Phenolic Content and Antibacterial Activity of Thirteen Native Species from Guayas Province Ecuador. *Journal of King Saud University - Science*, 30 (4), 500–505.
[70] Aurélie, R. L., Judicael, R. L., Ranjana, R. H., Doll, Rakoto D. A., Thomas, P., Jeannoda Louis. V. 2020. Antimicrobial Activity of *Albizia tulearensis*, an Endemic Fabaceae from Madagascar. *World J. Bio. Pharm. Health Sci.*, 2 (3), 030–034.
[71] Banothu, V., Neelagiri, C., Adepally, U., Lingam, J., Bommareddy, K. 2017. Phytochemical Screening and Evaluation of *in vitro* Antioxidant and Antimicrobial Activities of the Indigenous Medicinal Plant *Albizia odoratissima*. *Pharmaceutical Biology*, 55 (1), 1155–1161.
[72] Hajrawati, H., Malaka, R., Prahesti, K. I., Arifin, T. S. M., Rani, Y. A. A. 2021. Evaluation of Physico-Chemical Properties and Antioxidant Activity of Bali Beef Meatballs Added Cemba (*Albizia lebbeckoides* [DC.] Benth). *IOP Conf. Ser.: Earth Environ. Sci.* 788 012110.
[73] Bakasatae, N. Kunworarath, N., Takahashi Yupanqui, C., Voravuthikunchai, S. P., Joycharat, N. 2018. Bioactive Components, Antioxidant, and Anti-Inflammatory Activities of the Wood of *Albizia myriophylla*. *Revista Brasileira de Farmacognosia*, 28 (4), 444–450.
[74] Srivastava, V., Verma, S. K, Panwar, S., Deep, P., Verma, S. 2020. A Brief Review on Phytopharmacological Reports on *Albizia procera*. *Asian J Pharm Pharmacol*, 6 (2), 144–1