A Review on ethnobotanical uses, biological activities and phytochemical aspects of *Acacia senegal* (L.) Willd. and *Acacia seyal* Delile. (Fabaceae)

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**Abstract**

The genus *Acacia* is a group of tropical plants species used in folk medicine due to virtue of its many therapeutic properties. In this document, we review the Ethnopharmacology, biological and phytochemical activities of the two major plant species used. Although, several researchers has been done, *Acacia senegal* (L.) Willd. and *Acacia seyal* Delile. are among the species of the genus for which phytochemical study is limited, few bioactive compounds and properties described. Based on these current traditional uses, it is necessary to carry out more biochemical and pharmaceutical assays in order to identify the precise ingredient that supports the recommendation in traditional medicine. The characterization of the active compound that plays a role for treating human diseases (infection, cancer, etc.) represents a key step in phytochemical research of new compounds. Moreover, this information about the active compound will help the clinician/pharmacist to define a rational and combined use with the synthetic molecules for which resistance mechanisms are currently reported in clinical cases.

**Keywords:** *Acacia Senegal; Acacia seyal; Antimicrobial; Biological activity; Phytochemistry; Tradional medicine*
Introduction

Traditional medical practices vary from country to country and region to region, and are influenced by several factors including culture, history, attitudes and personal philosophy [1]. The renewed interest over the centuries and the transmission of experience from generation to generation are proof of the safety and effectiveness of this medicine. The lack of health care centers in remote areas, often linked to the high cost of conventional medicines, means that 80% of people in African countries use traditional medicine for their primary health needs [2]. Nowadays, developing countries such as Burkina Faso are adopting policies to promote traditional recipes through collaboration between health practitioners and traditional healers. Today, infectious diseases are the leading cause of death in the world and antibiotic resistance has become a global concern [3]. The emergence and spreading of pathogens that present resistance to many if not for all clinically used antibiotics has led WHO to classify them as a human health priority [4-6]. Therefore, researchers are increasingly turning to medicinal plants in search of new approaches to develop new effective drugs against microbial infections. The screening of potential antimicrobial activity of active molecules from medicinal plants is of concern [7]. Some recent reviews point on the possible use of natural products to combat multidrug resistant bacteria (for an example see. Interestingly, Acacia senegal (L.) Willd. and Acacia seyal (Del.), of the Fabaceae-Mimosoideae family, are well known in traditional medicine and often used in combination with other plants to combat microbial infections [12-14]. The available knowledge on these plants was searched using the keywords Acacia senegal (L.) Willd. and Acacia seyal Del. in the databases ‘Google scholar’, ‘NCBI’, ‘Springer Link’, ‘Free Scientific Publications’ and ‘Web of Science’. Their properties are of a major interest in the research and development of new active molecules targeting multidrug resistant pathogens or the identification of adjuvant that can restore the antibiotic activity in resistant bacteria. This review summarizes the current knowledge regarding these two plants and presents some perspectives for a future study and application about their antimicrobial properties to combat antibiotic resistance.

Taxonomy of Fabaceae

Leguminosae Fabaceae previously identified and described by Adanson and de Jussieu are subdivided into three sub-families including Caesalpinioideae, Mimosoideae and Papilionoideae [15-17]. With about 765 genera and more than 19500 species, Fabaceae, constitute the third most important plant family [18,19]. The species in this family are well distributed in all tropical and warm temperate regions of the world. Recent data indicated that the Legume Phylogeny Working Group has subdivided the Fabaceae into six sub-families instead of three, namely Cercidoideae (12 genera, 335 species), Detarioideae (84 genera, 335 species), Detarioideae (84 genera, 335 species) and Cercidoideae (84 genera, 760 species), Duparquetioideae (1 genus, 1 species), Dialioideae (17 genera, 85 species), Caesalpinioideae (148 genera, 4400 species; includes genera of the Mimosoideae) and Papilionoideae with 503 genera, and 14,000 species [20,21]. Acacia genus belongs to the subfamily of Mimosoideae and is the second most important genus in the Fabaceae family, with about 1350 species currently recognized. The highest concentrations of Acacia sp. are found in Australia (955 species), with high numbers also in America (about 185 species), Africa (144 species) and Asia (89 species) [22, 23]. This family represents an important source of molecules that are involved in the treatment of various diseases.
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**Botanical description**

*Acacia senegal* (L.): Willd. *Acacia senegal* is commonly known as white gum tree, with *Acacia verek* Guill. & Perott and *Mimosa senegal* L. as synonyms and vernacular names, *gon péélega* (Moore) and Gommier of Senegal (French). It’s a Sahelian and Sudano-Sahelian species, belonging to the *Fabaceae-Mimosoideae* family [24]. It’s distributed in Senegal to Cameroon and Sudan. *A. senegal* occurs naturally in arid, semi-arid and subtropical regions, and is drought-resistant [25]. It’s also presents in tropical, Southern Africa and India. It is a phanerophytes, a thorny shrub tree of 2-6 or even 12 meters high with very branched and ascending branches [26]. The trunk is about 30 cm in diameter and the bark is light grey with a red slice marbled with white [27]. The leaves are green-grey, alternating and bipinnate, measuring 3.5-8 cm long with grapes of cream color small flowers. Seeds are greenish brown [26]. Pubescent then hairless pods measuring about 7 cm long x 2 cm wide represent the fruits. In Africa, flowering takes place at the foliage before the first rains but also sometimes at the end of the rainy season, especially from July to September. *A. senegal* is one of the species used to create the great African green wall. *A. senegal* is used to fertilize soils, as firewood, local construction and fence posts and the gum Arabic produced is traded internationally [28-30].

*Acacia seyal* (Delile.): *Acacia seyal* also called *Gon-ponsego* (Mooré); Gommier, *Mimosa épineux* (French) is phanerophyte, a thorny tree 6 to 17 m high with smooth and green bark [24]. The twigs are greenish and the leaves are alternating and bipinnate, from 3 to 10 cm long with 3-7 pairs of pinnules. The fruits are represented by narrow pods and contain 6 to 10 seeds that are brown when they are ripened. Flowering and fruiting usually take place in the second half of the dry season, before foliage. It is a species that is Sahelo-Saharan and Sudano-Sahelian. It’s found in low slopes and low ground and generally near rivers. This species has spread from Senegal to Cameroon, Egypt and Somalia [31].

**Ethnobotanical uses (parts, traditional uses, nutritional value) of *A. Senegal* and *A. seyal***

Different parts of the plant species are used dry or in liquid form after maceration or decoction for general treatment of bacterial, viral, parasitic infections or used to treat symptoms in gastroenterology, dermatology, hematology, rheumatology and inflammation (Table 1 and 2). Locally applications can be performed for ophthalmological or dermatological problems.

| Table 1: Different uses and methods of extract preparation of *A. senegal* in different African countries. |

| Medical uses | Plant parts | Forms | Plant association | Medication administration | Country | References |
|--------------|-------------|-------|-------------------|--------------------------|---------|-----------|
| Respiratory infections, Flue, sinusitis | Bark, Gum | Decoction, Powder | *Diospyros mespiliformis* Hochst. Ex A. DC. | Oral | Burkina Faso | [14,32] |
| Toothaches | Young leaves, Thorns | Powder | | Inhalation gargles | Senegal | [33] |
| Stomac ulcer Colic | Bark, Stems, Gum | Powder, Decoction | | Oral | | [34] |
| Condition                  | Part Used | Preparation          | Route | Location |
|---------------------------|-----------|----------------------|-------|----------|
| Malaria fever             | Gum       | water                | Oral  | [35]     |
| Malaria                   | Bark      | Decoction            | Bath  | Oral     | Mali    | [36]     |
| Hemorrhoids STIs          | Roots     | decoction            | Oral  | [37]     |
| Liver diseases            | Roots     | Decoction            |       | Niger    | [38]     |
| Laxative Cirrhosis Hepatitis| Roots   | Powder               | Oral  | [39]     |
| wounds                    | Bark      | Decoction            | Oral  | [40]     |
| Malaria                   | Stems     | Decoction            | Oral  | Nigeria  | [41]     |
| Stomach aches Purgative STIs Diarrhea Stomach aches | Roots | Decoction | Oral   | Kenya   | [42]     |
| Wounds                    | Gum       | Paste                | Topical| [43]     |
| Bleedings                 | Gum       | Paste                | Oral  | [44]     |
| Stomach aches             | Bark      | Macerate             | Oral  | [45]     |
| Laxatives                 | Bark      | Macerate             | Oral  | [46]     |
| Food supplement           | Leaves    | eaten by livestock   | Oral  | [46]     |
| Stomach aches             | Bark      | Decoction            | Oral  | [46]     |
| Against Evil spirits      | Seeds     | Crushed              | Oral  | Ethiopia | [47]     |
| Eyes injuries             | Fresh     | gum                  | Oral  | [48]     |
| Back pain                 |           |                      |       |          |         |
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| Condition                        | Plant Parts | Form             | Medication Administration | Country       | Refs |
|----------------------------------|-------------|------------------|----------------------------|---------------|------|
| Constipation                     | Bark        | Drops            | Local                      |               | [49] |
| Stomach aches                    |             |                  |                             |               |      |
| Eyes injuries                     | Bark        | Drops            | Local                      | Angola        | [50] |
| Mumps                            | Leaves      | Topic            | Oral                       |               |      |
| Fertility                         | Roots       | Topic            | Oral                       |               |      |
| Diarrhoea                        | Roots       | Decoction        | Local                      | Tanzania      | [51,52]|
| Mouth inflammation               |             |                  |                             |               |      |
| Abscesses and boils Cough        | Roots       | Decoction        | Local                      | Tanzania      | [51,52]|
| Haemorrhagic Diarrhea            | Barks and roots | Decoction    | Oral                       |               | [53] |
| Headaches                        | Roots       | Powder           | Smoked                     | Uganda        | [54] |
| Delivery pain in animals         | Bark        | Maceratio        | Oral                       |               | [55] |
| Pospartum pain in animals        | Bark and roots | Maceratio   | Oral                       |               |      |
| Diarrhea                         | Gum         | Powder           | Oral                       | Sudan         | [56,57]|
| Ulcers                           | Fruits      | Powder           | Oral                       |               |      |
| diabetes, Kidney failure         |             |                  |                             |               |      |
| Stomach ulcers and aches         | Stem bark   | Decoction        | Oral                       | Mauritania    | [58] |
| Abdominal pain                    |             |                  |                             |               |      |
| Eyes drop                         | Gum         | eyewash          | Local                      | Morocco       | [59] |
| Lung disases                      |             |                  |                             |               |      |
| Stomach aches                     |             |                  |                             |               |      |
| Liver diseases                    | Powder      |                  | Oral                       |               |      |
| Anti-inflammatory                 |             |                  |                             | External use  |      |

Table 2: Different uses and methods of extract preparation of *A. seyal* in different African countries.

| Medical use                      | Plant parts | Forms     | Plant association | Medication administration | Country    | Refs  |
|----------------------------------|-------------|-----------|-------------------|---------------------------|------------|-------|
| Dysentery Gastrointestinal pain   | Bark and roots | Decoction |                   | Oral                      | Burkina Faso | [60]  |
| Condition            | Part Used          | Preparation      | Dosage/s         | Reference |
|----------------------|--------------------|------------------|------------------|-----------|
| Leprosy              | Root bark          | Infusion         | Oral             | [61]      |
| Nervous sensory      | Bark gum           | Decoction        | Crushing, Instillation, Oral bashing | [33] |
| Digestive disorders  | bark and leaves    | Decoction        | Oral             |           |
| Toothaches           | Bark and leaves    | Decoction        | Oral             | [61]      |
| STIs                 | Bark stems, trunks, twigs | Decoction, Mytragyna inermis (Willd.) Kuntze, Gossypium sp | Oral     |           |
| Bleeding             | Keratitis, Eyes aches | Bark stems, chew, Salt, Instillation |           |           |
| Keratitis eyes aches | Keratitis eyes aches | Bark stems, chew, Salt, Instillation |           |           |
| Dysentery            | Bark, stems        | Powder, Honey    | Oral, Senegal    |           |
| Snake bites          | Bark stems         | Infusion         | Oral and local   |           |
| Purgative Fortifying | Bark, stem, trunk, or twig | Decoction | Oral             | [13,14] |
| STIs                 | Leprosy            | bark, stem, trunk, or twig | Decoction | Oral    |
| Headaches            | bark, stem, trunk, or twig | Decoction | Oral             |           |
| Eye diseases         | Leaves             | Leptadenia hastata (Perr.) Decne Ziziphus mucronata Wild. |           |           |
| Biliary fever and jaundice Urinary infections | Roots | Decoction | Combretum glutinosum Perr. Ex DC. And milk | Local wash |
| Leprosy              | Red bark of trunk  | Decoction        | Oral             |           |
| Wound injuries       | Leaves             | Decoction        | Milk             | Niger     |
| Malaria Spleen dilatation fever | Bark | Powder | Milk, Millet | Oral    |

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| Condition                                      | Part Used  | Preparation   | Administration | Reference  |
|------------------------------------------------|------------|---------------|----------------|------------|
| Asthenia Avitaminosis Sickle cell disease      | Roots      | Maceration    | Oral with millet milk porridge | [66]       |
| Arthritis Inflammation Liver disease           | Bark       | Decoction     | Oral           | [67,68]    |
| Epilepsy                                       | Bark       | Maceration    | Oral Mauritanie | [58]       |
| Pneumonia                                      | Bark, Stem Trunk twig | Decoction | Oral Kenya | [69]       |
| Malaria                                        | Roots      | Decoction     | Oral           | [70]       |
| Joint pain                                     | Bark stems leaves | boiled | Oral Strychnos henningsii *Pvetta crassipes* (K. Schum.) | [71]       |
| Intestinal parasites                           | Roots      |               | Oral Ethiopia  | [49]       |
| Jaunice                                        | Leaves     |               | Oral           | [47]       |
| Chest pain                                     | Roots crushed |            | Oral Uganda   | [55]       |
| Diarrhoea                                      | Roots      | Maceration    | Oral           | [55]       |
| Viral skin necrosis nodules                    | Bark leaves | Maceration    | Oral           | [73]       |
| Bleeding and leaves                            | Bark       | Decoction     | external Sudan | [72]       |
| Leprosy                                        | Wood       |               | smoked         | [73]       |

*References:*

- [47]: Chughtai, 1991
- [49]: Mekonnen, 2013
- [55]: Asrat, 2010
- [58]: El-Mahallawy, 2012
- [59]: Solhia, 2013
- [66]: Habbal, 2014
- [67,68]: Kharbouch, 2015
- [69]: Zerihun, 2016
- [70]: Yosef, 2017
- [71]: Ayele, 2018
- [72]: Abdeh, 2019
- [73]: Kaye, 2020
| Condition                        | Part Used | Preparation | Treatment | Location          |
|---------------------------------|-----------|-------------|-----------|-------------------|
| Inflammation and stomach aches  | Leaves    | Decoction   | Oral      | Mauritania        |
| Laxative                        | Stem bark | Decoction   | Oral      | Togo              |
| Painful period                  | Roots     | Decoction   | Oral      | Benin             |
| Appendicitis                    | Roots     | Decoction   | Oral      | Mali              |
| Conjonctivitis trachoma         | Gum       | Maceratio   | Oral      | Rwanda            |
| Conjonctivitis trachoma         | Leafed    | Decoction   | Oral      | Djibouti          |
| Purgative                       | Bark      | Decoction   | Oral      | Algeria, Egypt, Morocco |
| Syphilis Leprosy Headaches      | Bark      | Decoction   | Oral      |                 |
| Chest pain                      | Bark      | Decoction   | Oral      |                 |
| Fistula                         | Leaves    | Powder      | Oral      |                 |
| Fistula                         | Bark      | Powder      | Oral      |                 |
| Fistula                         | Seed      | Powder      | Oral      |                 |
| Dyentery                        | Bark      | Crushed     | Oral      |                 |
| Post-abortion care              | Bark      | Maceratio   | Oral      |                 |
| Stomach aches                   | Bark      | Maceratio   | Oral      |                 |
| Infected wounds                 | Seed      | Powder      | Local     |                 |
| Fever                          | Seed      | Decoction   | Oral      |                 |
| Dysmenorrhea Eye infections     | Seed      | Decoction   | Oral      |                 |
| Stomach ulcers Rheumatisms      | Leaves    | Decoction   | Oral      |                 |
| Rheumatism Infecions post delivery | Wood | Fumigation | Oral      |                 |
| Rheumatism Respiratory tract infection | Gum |          | Oral      |                 |
| Gastric ulcer                   | Leaves    |             | Oral      |                 |
Phytochemistry, pharmacology and toxicological studies on the plants extracts

The Fabaceae family is an important source of biologically active molecules. However, few species have been examined specifically for these substances; in fact, the secondary metabolites of only a small proportion of Acacia species have been examined in detail [81]. Acacia senegal and Acacia seyal are among the few that have been studied.

Acacia senegal

The data contained in Table 3 summarize the biological activities and molecules or groups of molecules that have been informed by the different authors about Acacia senegal (L.) Willd. and their supposed involvement in biological activities. The dichloromethane extract from the root wood of A. senegal showed good activity against two bacterial species, E. coli and S. aureus while the ethanolic extract, dichloromethane and ethyl acetate showed significant antifungal activity against C. albicans. From the wood of the root, ten molecules were isolated, including eicosanyl 3-O-teruloyl-quinate, isolated from nature for the first time. The molecules of 3a-hydroxyeuph-25-ene and a-amyrynn were isolated for the first time from this species [82]. The a-amyrynn and its derivatives have presented various biological activities e.g. anti-HIV and anti-acyl coenzyme A: cholesterol acyltransferase (ACAT) activities [83]. Other authors have reported the antifungal activity of β-sitosterol isolated from the methanolic fraction of M. azedarach leaves against Ascochyta rabiei [84]. A recent study demonstrated by bio-autograpic analysis that extracts of A. senegal leaves (Acetone, chloroform, ethanol and petroleum ether) possesses antioxidant derivatives (DPPH) and an antibacterial activity against Pseudomonas aeruginosa. Analysis revealed antibacterial activity of four fractions of acetone extract, four fractions of chloroform extract, two fractions of ethanolic extracts and four fractions of petroleum-ether extracts. The phytochemical compounds present in the extracts are glycosides, alkaloids and flavonoids. In addition, ethanolic extract was the richest in secondary metabolites and the antibacterial and oxidative activity observed is believed to be related to the presence of its compound groups [85]. However, to date, no molecules have been isolated and identified from the various fractions and certified to be responsible for the activity. Furthermore, methanol and ethanol extracts from the trunk bark of A. senegal showed antibacterial activity against K. pneumoniae, Proteus vulgaris, Salmonella typhi, Salmonella dysenteriae and E. coli. According to the authors, the tannins and saponins contained in the extracts are responsible for the observed activity. In addition, toxicity studies of ethanolic extract from stem bark revealed any significant toxicity against Artemia salina [86]. According to some authors, the hexanic fraction of A. senegal stem bark is active against respiratory pathogenic bacteria including Klebsiella pneumonia and Streptococcus pneumoniae [87]. Two flavonoids, namely Vicenin [Apigenin-6,8-bis-C-bis-C-b-D-glucopyranoside] and Quercetin-3-O-rutinoside (Rutin) are most commonly found in the genus Acacia [81]. Vicenin et al. isolated these flavonoids from Ocimum sanctum and showed an antibacterial effect against Escherichia coli and Proteus with inhibition zone diameters of 18.84 and 17.16 mm respectively [88]. Several authors have reported the antibacterial effect of rutin against Escherichia coli, Proteus vulgaris, Shigella sonnei, Klebsiella sp., Pseudomonas aeruginosa and Bacillus subtilis [89-91]. In addition, the combination of rutin with other flavonoids has shown strong antibacterial
activity against *Bacillus cereus* and *Salmonella enteritidis* [92]. Ethanolic extract from the leaves of *A. senegal* has decreased the activity of the sucrose enzyme and appears to facilitate the control of carbohydrate hydrolysis and therefore reduces postprandial increases in blood glucose levels in diabetics [93]. Ethyl acetate extract from the bark of the stem of *A. senegal* significantly reduced blood glucose, serum TC, serum TTG, serum LDL, serum urea and creatinine levels, and increased serum HDL levels in alloxane-induced diabetic albino rats [94]. Neutral sugar gums (rhamnose, arabinose and galactose), acids (glucuronic acid and 4-methoxyglucuronic acid), calcium, magnesium, potassium and sodium have been identified [26].

| Table 3: Summary of known molecules from *Acacia senegal* (L) Willd. |
|---|
| **Organs** | **Extraction Solvent (s)** | **Biological Activity** | **Family/Molecules** | **Active molecules isolated** | **Refs** |
| Leaves | Ethanol | Diabète (reduce the increase in blood sugar levels) | Carbohydrates, phenol, glycosides, Quinones /anthraquinones, alkaloids, anthocyanins and leuco anthocyanins, volatile oils | | [97] |
| | 80% ethanol | Antioxidant (DPPH) | Phenolic compounds | | [93] |
| | Acetone | Antioxydant/ Antibacterial (*Pseudomonas aeruginosa*) | Glycosides, saponins/glycosides, alkaloids, flavonoids | | [85] |
| | Chloroform | Antioxidant/ Antibacterial (*Pseudomonas aeruginosa*) | Carbohydrates, Amino acid and protein, phenols, sterols and steroids, alkaloids, flavonoids, anthocyanins and leucoanthocyanins, volatile oils | | |
| | Ethanol | Antioxidant/ Antibacterial (*Pseudomonas aeruginosa*) | Carbohydrates, Steroids, triterpenoids, quinic acid diester, cyclohexitol | | |
| | Petroleum ether | Antioxidant/ Antibacterial (*Pseudomonas aeruginosa*) | Leucoanthocyanin, Glycoside | | |
| Stem Root (heart Wood) | Ethanol, DCM and Ethyl acetate | Antibacterial (*E. coli* and *S. aureus*). | Ceryl cerotate, Eicosanoic acid, Tetracosanol, Docosanoic acid, 3α- | [82] |
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| Plant Part | Activity | Extracts | Compounds |
|------------|----------|----------|-----------|
| Stem Bark  | Antifungal | Ethanol, Methanol | Hydroxyeuph-25-ene, α-Ameyrin, Stigmasterol, β-Sitosterol, Betulin-3-O-stearate, Eicosanyl 3-O-feruloyl-quinate, β-Sitosterol-β-D-glucoside, D-Pinitol |
|            |          |          | [86]      |
|            |          |          | Antibacterial (K. pneumoniae: P. vulgaris, S. typhi, S. dysenteriae, E. coli) | Saponin, tannin and Sterols |
|            |          | Ethyl acetate | Flavonoids |
|            |          | Methanolic | Anthelmintic activity (Fasciola gigantica) |
|            |          | Ethanol, Aqueous | No Antioxidant activity and Enzymatic inhibition |
|            |          | Ethanol, Aqueous | All extract exhibit high toxicity on Brine shrimp |
|            |          | 70% ethanol | Neurotoxicity Hepatotoxicity |
|            |          | 70% ethanol | antiatherosclerotic cardioprotective |
|            |          | 70% ethanol | Neurotoxicity Hepatotoxicity |

However, the study did not pay any attention to the relationship between activity and the chemical compounds produced by the gum. Methanolic extract from the bark of the stem showed 100% mortality against adult *Fasciola gigantica* worms in vitro at concentrations of 1000, 500 and 250 ppm after 6, 12 and 24 hours respectively [95]. A recent study evaluated the efficiency of *Acacia senegal* extracts against improving DEHP-induced liver and brain toxicity. Sprague Dawley rats in which acute hepatotoxicity and neurotoxicity was induced by Di-2- Ethylhexyl phthalate (DEHP), received as oral treatment ethanolic extract at 70% of *A. senegal* pods for 28 days under several conditions. The results showed that the extract of *A. senegal* has an ameliorative effect by restoring the activities of antioxidant enzymes to normal by reducing the level of LPO in both tissues. Also, the extract improved the levels of cerebral amino acids, monoamines and their metabolites [96].
**Acacia seyal**

Table 4 also summarizes the molecules or groups of molecules identified from *Acacia seyal* (Del.). Ethanolic extracts (leaves, root bark and trunk) and dichloromethane from *Acacia seyal* showed interesting activity against *Klebsiella pneumoniae* [99]. Previous work on other species of the same genus (*Acacia nilotica* (L.) Willd ex Del., *Acacia sieberiana* DC.) has shown good antibacterial activity against *Escherichia coli* and *Klebsiella pneumoniae* [99]. Many authors have reported of acacia genus, many biologically active compounds e.g. ethyl gallate, octasanol, β-amyrin, α-betulin and flavonoids [100, 101]. Concerning *A. seyal*, we have few information on the phytochemical composition of the different parts. However, the authors attribute the activity found by the species to the presence of similar compounds. The methanolic extract from the bark showed good antibacterial activity. Four compounds were isolated (epicatechin, catechin, digallic catechin and β-sitosterol) and tested for their activities. The author indicated that the activity of the isolated compounds was less interesting compared to tobum [102]. This shows a synergy of activity between the compounds. In addition, different teams have reported the activity of β-sitosterol on inhibiting the growth of *S. aureus* and *E. coli* [103, 104]. Methanolic extract from the leaves of *A. seyal* reduced the incidence of green mold (*Penicillium digitatum*) by 56.1% on fruits inoculated per injury. The extract of *A. seyal* revealed a high content of gallic acid, salicylic acid, p-coumaric acid, caffeic acid, 3,4 dihydroxy benzoic acid, ferulic acid [105]. Isolated p-coumaric acid from *Nauclea pobeguinii* (Pobeg.) Merr. did not activate against bacteria tested (*E. coli, E. aerogenes, K. pneumoniae, P. aeruginosa, P. stuartii*) at a concentration of 256 µg/mL [106]. In other hand, researchers have reported that caffeic and p-coumaric acid cause membrane damage of 44% and 59%, respectively, in Gram-positive bacteria, *Oenococcus oeni* [107]. Also, p-cummaric and ferulic acids have shown synergistic activity with amikacin against *E. coli, E. aerogenes* and *S. aureus* [108]. Ethyl gallate has shown antibacterial activity and synergistically when combined with tetracycline and fusidic acid against specific resistant and methicillin-sensitive strains of *Staphylococcus aureus* [109]. Ethanolic extracts (leaves, bark) and dichloromethane extract from the bark of *Acacia seyal* showed an activity higher than 85% with respect to the enzyme acetylcholinesterase. Alkaloids are known to have many pharmacological properties, including inhibition of acetylcholinesterase enzyme activity and the author associate the activity with alkaloids [99]. A recent study showed that methanolic extract from the bark of *A. seyal* showed 100% mortality against *Biomphalaria Pfeifferi* at different doses used [110]. The root extract of *A. seyal* has demonstrated antimicrobial activity against fungal and bacterial pathogens [111]. The cytotoxic study of the hydroethanolic extract of the stem bark of *A. seyal* to reduce the protein content of Bcl-xL and Bcl-2 which in turn promotes the intrinsic induction of apoptosis. In addition, the phytochemical analysis of this extract shows that it is rich in pro-apoptotic components such as flavonoids [112]. The structure of the gum of *A. senegal* (L.) and *A. seyal* has recently been revised by methylation analysis and nuclear magnetic resonance (NMR) spectroscopy. It has been found that *A. seyal* gum is more strongly branched than *A. senegal* and is composed of galactopyranosyl bound to 1,3. Galacturonic acid was recently identified for the first time in *A. seyal* [113] (Figure 1-5).
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**Tableau 4: Summary of known bioactive molecules from Acacia seyal (Del.).**

| Organs | Extraction Solvent (s) | Biological Activity | Family/Molecules | Active molecules isolated | References |
|--------|------------------------|---------------------|------------------|--------------------------|-----------|
| Leaves | Ethanol, Dichlorométhane, Ethyl acetate | Inhibition of acetylcholinesterase Anti-inflammatory Antibacterial | | | [99,114] |
|        | Methanol, acetone, water | Antifungal (Penicillium digitatum) | Phenolic compounds | gallic acid, salicylic acid, p-coumaric acid, caffeic acid, 3,4 dihydroxy benzoic acid and ferulic acid | [105,111] |
| Leaves | | | | | |
| Roots | | | | | |
| Stem | Dichloromethane Ethyl acetate | Antiinflammatory (Inhibition of prostaglandin synthesis) Antimicrobial (Staphylococcus) | | | [99,114] |
| Root | méthanol, chloroform water | anti-trichomonal activity | | | [115] |
| Stem | Ethanol, Dichloromethane Ethyl acetate | Inhibition of acetylcholinesterase, Antimycobacterial (M. aurum A +) | | | [99,116] |
| Bark | 70% Ethanol | Anti-cancer | | | [102] |
|      | Ethanol | Antimicrobial (Staphylococcus) | Flavonoids, saponins, | | [117] |

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|                  | Antioxydant (DPPH)                                             | terpenoids, steroids, alkaloids, phenols and tannins.                                                                 |
|------------------|---------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------|
| (Wood) Aqueous,  | Antibacterial Staphylococcus aureus, Escherichia coli and      |                                                                                                                 |
| ethyl acetate,   | Salmonella                                                    | [118]                                                                                                           |
| chloroform       |                                                               |                                                                                                                 |
| Gum Arabic       |                                                               | Complex of polysaccharides containing calcium, magnesium, potassium salts, protein, gallic, ellagic and chlorogenic acids |
| n-hexane         |                                                               |                                                                                                                 |
| Ethanol          | Anticonvulsant                                                | Flavonoids, saponins, terpenoids, steroids, alkaloids, coumarin and tannins.                                      |
| Methanol         |                                                               |                                                                                                                 |
| Fruits           | methanol, chloroform water                                   | anti-trichomonal activity                                                                                       |

**Figure 1:** Phylogeny and Classification of Fabaceae [20].
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**Figure 2**: (a) fruit, inflorescence, (b) leaves of *Acacia senegal* (L.) Willd. [Marco Schmidt, (CC BY-NC-SA)].

**Figure 3**: (a) leaves, (b) inflorescence of *Acacia seyal* (Delile.) [P. Poilecot].

**Figure 4**: Some molecular structure from *Acacia senegal* (L.) Willd.
Conclusion

This literature review provides an opportunity to learn about the therapeutic potentialities of *Acacia senegal* (L.) Willd. and *Acacia seyal* (Delile.). Although phytochemical knowledge of both species is limited, it appears to be a rich source of various active compounds with a wide range of pharmacological and therapeutic properties. For traditional use, it has become more common for several plants to be used in combination to treat a disease. This shows that the synergy of activity is well known to traditional healers. Among the diseases traditionally managed by *A. senegal* and *A. seyal*, infectious diseases occupy a prominent place. The pharmacological activity is objectively based on empirical experience and with the recent development of tools/methods based on Omics technologies (e.g. genomic, proteomic, transcriptomic, membranomic, etc.), it is important to measure the effects of these natural compounds on the physiology and metabolism of selected targeted cells (cancer cells, parasites, bacteria). Interestingly, this panel of research will be used to characterize the antimicrobial potential of *Acacia* species found in Burkina Faso. With the rise of resistant infections, natural extracts could be assayed in combination with usual antibiotics on multi-resistant bacterial strains (MDR) to formulate future combined therapeutic strategies. To this aim, different approaches could be envisaged in this way. For instance, today a main resistance mechanism is associated with the lack of internal concentration of active antibiotics close to its target [120]. It will be interesting to test the capability of Acacia extracts to permeabilize the bacterial membrane and improve the activity of antibiotics in resistant bacterial strains as previously reported for some other natural products [106, 121, 122]. Alternatively, it will be interesting to use the purified extracts in order to impair the activity of efflux pumps present in multidrug resistant bacteria that expel the antibiotic before it blocks the target [123, 124]. This mode of action has been reported for different natural compounds.
that block or inhibits the antibiotic flux across the pump channel [125-127]. These different perspectives are especially attractive taking into account the methods recently reported that allow measuring the drug transport across bacterial membrane [120]. Another approach can be to research some compound having new activity against bacterial physiology [128, 129]. To conclude, the Acacia represents an attractive source for future development of antimicrobial compounds that could be identified and characterized using the new tools available in biochemical, physicochemical and biological domains.

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Authors’ contributions

RDM, HMK and AH had collected all data reported. RDM wrote the paper. AH and ADR supervised the study. All authors read and approved the final manuscript.

Availability of data and materials

Data can be requested from the corresponding author.

Ethics approval and consent to participate

All participants were asked for their free prior informed consent.

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