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Acacia farnesiana (L.) Willd : ecology, uses and phytochemical composition

Samir Chekchaki[1]*, Mohamed Djalil Zaafour[2], Narimene Chekchaki[34]

[1]*BIOTECHNOLOGY AND ENVIRONMENT DIVISION, BIOTECHNOLOGY RESEARCH CENTER (CRBT), ALI MENDJLI NEW CITY UV 03, BP E73, CONSTANTINE, 25000, ALGERIA

[2]DEPARTMENT OF BIOLOGICAL SCIENCES, FACULTY OF LIFE AND NATURAL SCIENCES, EL BACHIR EL IBRAHIMI UNIVERSITY, BP 373, BORDJ BOU ARRERIDJ, 34000, ALGERIA

[3]LABORATORY OF BIOCHEMISTRY AND ENVIRONMENTAL TOXICOLOGY, DEPARTMENT OF BIOCHEMISTRY, FACULTY OF SCIENCES, BADJI MOKHTAR UNIVERSITY, BP 12, ANNABA, 23000, ALGERIA

[4]DEPARTMENT OF BIOLOGY, FACULTY OF LIFE AND NATURAL SCIENCES, CHAFLIU BENDJEDID UNIVERSITY, BP 261, EL TAREF, 36000, ALGERIA

Corresponding author contact information :

BIOTECHNOLOGY AND ENVIRONMENT DIVISION, BIOTECHNOLOGY RESEARCH CENTER (CRBT), ALI MENDJLI NEW CITY UV 03, BP E73, CONSTANTINE, 25000, ALGERIA , PHONE : +213699236414

E-MAIL : s.chekchaki@crbt.dz

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Abstract

Acacia farnesiana (L.) Willd. of the Fabaceae family is a species whose individual parts are commonly used in traditional medicine in several countries in their native form and as an extract, for the treatment of various symptoms and diseases.
In North Africa, very few pharmacological or ecological studies have been carried out on this species.
The main objective of this present work is to take stock of research and knowledge on the botanical and ecological characteristics of *A. farnesiana*, its geographical range, traditional uses, chemical composition and pharmacological activities.
Data were obtained from books, theses, and peer-reviewed articles stored in electronic databases from Scopus, Web of Science, Medline, and Google scholar.
The results obtained show that *A. farnesiana*, widely used in the perfume industry, is an important producer of secondary metabolites and has several medicinal properties such as antidiabetic, antiulcer, antispasmodic, antidiarrheal, antirheumatic and antimalarial.
Keywords : Acacia, biological activity, ecology, uses

1. Introduction

Plants are a popular form of complementary and alternative medicine, widely used since ancient times as the main source for the prevention and treatment of different diseases or disorders in human beings (Gurib-Fakim, 2006). Considerably effective, they are socially accepted and economically viable and are mostly the only means available (Suthari et al., 2018).

In Algeria, there are different ethnic groups with diverse medicinal plant traditions because it is one of the richest Arab countries in terms of plant diversity. This is linked to its large size and its climatic diversity, between the North where the climate is Mediterranean, the Atlas Mountains in the center and the Sahara Desert in the South (Hamza et al., 2019). However, few ethnobotanical investigations have been carried out in this country, and are insufficient to document ancestral knowledge (Hammiche and Maiza, 2006; Reguieg, 2011; Sari et al., 2012; Benhamou and Fazouane, 2013; Boudjelal et al., 2013; Benderradji et al., 2014; Benarba et al., 2015 and Telli et al., 2016).

The traditional use of plants around the world has encouraged various phytochemical and pharmacological screens and provided an unlimited source for drug discovery efforts (Gabr et al., 2018). This healing property is attributed to the presence of various classes of bioactive compounds (Hernández-García et al., 2019).

Researchers have shown that acacia species are among the richest resources of bioactive flavonoids, alkaloids, phenolics, saponins, polysaccharides, tannins and terpenoids (Seigler, 2003). They are used in traditional medicine for their antiatherosclerotic, antibacterial, antihypertensive, antiinflammatory, antioxidant, antiplatelet, cytotoxic and hypoglycemic activities (Jelassi et al., 2016 and Gabr et al., 2018). The most important species are : *Acacia nilotica* (L.) Willd. ex Delile, *Acacia polycantha* Willd., *Acacia farnesiana*, *Acacia leucophloea* (Roxb.)Willd., *Acacia sinuata* (Lour.)Merr., *Acacia ferruginea* DC. and *Acacia catechu* (L.f.) Willd. (Deshmukh and Bhajipale, 2018). To this end, Algeria seems to harbor a diversity of acacias, namely: *Acacia albida* Del., *Acacia laeta* R.Br. ex Benth., *Acacia ehrenbergiana* Hayne., *Acacia nilotica*, *Acacia seyal* Delile., *Acacia tortilis* (Forssk.) Hayne, *Acacia farnesiana*, *Acacia karroo* Hayne, *Acacia saligna* (Labill.) H.L.Wendl., *Acacia deccurens* (J.C.Wendl.) Willd., *Acacia dealbata* Link and *Acacia mearnsii* De Wild. (Kheloufi, 2019 and Chekchaki et al., 2019, 2020, 2021).

Among these species, *A. farnesiana* was chosen for this present work. Its main objective is to take stock of research and knowledge on its botanical and ecological characteristics, geographical distribution, its traditional uses, its chemical composition and its pharmacological activities.

2. Materials and Methods

The investigations were carried out on the internet and at the library of the University of Annaba. Information on medicinal plants of the genus *Acacia* and species *A. farnesiana* was taken from books; Doctoral theses; peer-reviewed reports and articles. The main electronic databases consulted are Scopus, Web of Science, Medline, Google scholar and Google search engines. The specific keywords used during this search are: "Acacia", "farnesiana", "Acacia + Algeria", "farnesiana + Algeria", as well as "Acacia + Algeria", and "farnesiana + Algeria".

3. Results and Discussion

Nearly 110 documents on the species *A. farnesiana* were collected. No pharmacological or ecological study has been undertaken, neither in Algeria nor in neighboring countries (Tunisia and Morocco). The only ones listed are that of Doumandji and Doumandji-Mitiche (1976); Boubekeur et al. (2017) and Kheloufi (2019). The majority of the work has been carried out in the United States of America, Mexico, Egypt, and India. These are essentially pharmacological studies; phytoremediation; rehabilitation; restoration of degraded environments and management because the species described as invasive has become problematic in some countries.

3.1. Botanical description of *A. farnesiana*

The pantropical genus *Acacia* is the second largest in the family Fabaceae and the largest in the clade Mimosoideae (subfamily Caesalpinioideae) (LPWG, 2017). According to the current circumscription based on molecular phylogenetic studies, *Acacia* has been divided into five genera: *Senegalia* Raf., *Mariosousa* Seigler and Ebinger, *Vachellia* Wight and Arn., *Acaciella* Britton and Rose and *Acacia* Mill. s.s. retained for Australian acacias (Kyalangalilwa et al., 2013). Native acacia species in Africa and Asia all belong to the new genera Vachellia and Senegalia (Choudhary et al., 2020). Although the new nomenclature of *Acacia* classifies *A. farnesiana* in the genus *Vachellia*, in this study the name *Acacia* was used to maintain consistency with historical references.

According to Maire (1987), *A. farnesiana* is a very branchy and very spiny shrub or small tree, reaching 3-6 m in height, entirely glabrous or ± pubescent on the petioles and peduncles. Leaves shortly petiolate, with 4-6 pairs of secondary rachis, each bearing 10-20 pairs of glabrous or pubescent leaflets, green, linear, c. 4 mm long; primary rachis usually devoid of glands. Stipules are represented by fairly thin spines, short or sometimes up to 15-17 mm long, sometimes all very small or even absent. Axillary glomeruli, usually in pair or ternate, globose, multiflorous, yellow-orange, very fragrant, about 15 mm in diameter, with a slender peduncle, 2.5-3.5 cm long. Bracts are small, the external ones oval and acute, forming a kind of involucre under the glomerulus, the internal ones long attenuated in a petiole, spatulate. Pentamerous flower. Calyx membranous, campanulate, equaling about half of the corolla, briefly toothed. Pod indehiscent, indurate, brown-black, cylindrical, obtuse, 5-8 x l-1.5 cm, filled with a pulp that surrounds the seeds. Seeds are obliquely transverse, ovoid, slightly compressed, black, dull, with short funicles. n = 26 (Figure 1).

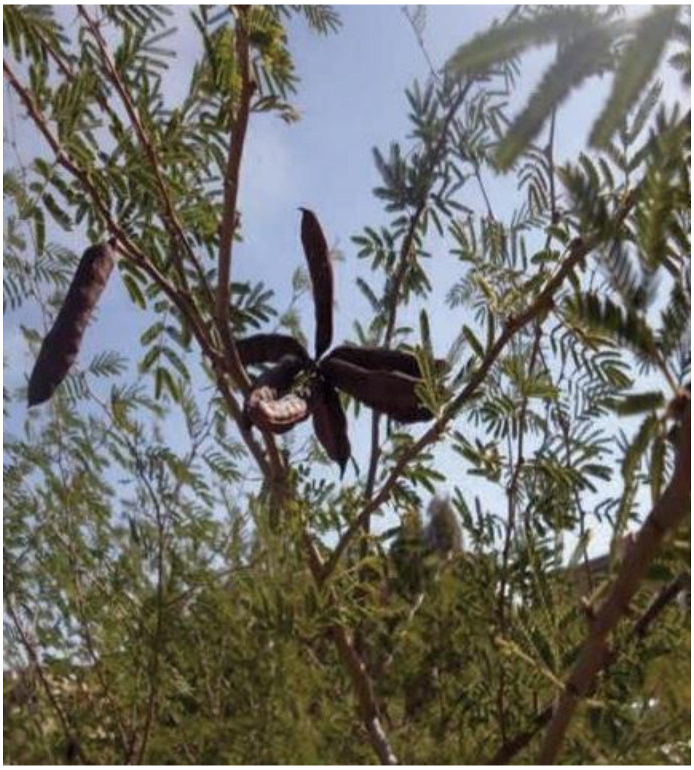

Figure 1. Leaves, flowers and mature pods of *A. farnesiana*, Relizane, Algeria (source : Kheloufi, 2019)

3.2. Biological characteristics and ecological requirements

A. farnesiana is a versatile tree propagated by seed or stem cuttings. Its continuous flowering and fruiting result in an annual yield of 13,000 seeds per plant. Seeds have a high germination potential, especially after scarification such as passage through the digestive tract of animals (Cheek and Boon, 2019). According to Maire (1987), in North Africa the flowering cycle of the species begins in April and continues throughout the summer until October.

Gilman and Watson (1993) considered this species to be very slow growing in its native range, with a lifespan of up to 50 years. But according to Soliman and Sakr (2017), it is a fast-growing tree that grows all over the world.

The species has flexible ecological requirements. It prefers full sun to shade and can be grown in a wide range of acidic, neutral or basic pH soils including sandy, loamy and clayey soils as well as disturbed, nutrient-depleted, saline or loamy soils. very rocky (Vozzo, 2002). It is extremely tolerant of drought becoming deciduous thanks to its unique root system allowing it to absorb water from lower soil levels (Maldonado-Magaña et al., 2011). It is readily adaptable to temperature extremes such as freezing in Mediterranean climates to fire and other growth-limiting conditions (Gilman and Watson, 1993).

It can grow in soils heavily polluted with heavy metals (Alcántara-Martínez et al., 2018). It also has a great capacity to preferentially bioaccumulate Pb, Cu and Zn in the leaves and As, which suggests a good potential for phytoremediation involving the use of tolerant plant-endosymbiotic bacteria associations to clean up polluted soils (Salazar-Ramírez et al., 2020).

A. farnesiana has high ecological and economic value in its native range (Cheek and Boon, 2019). It is used to control erosion in sandy soils and improve water infiltration, soil structure and fertility through symbiosis with N2-fixing bacteria of the genus Rhizobium and mycorrhizal fungi (Maldonado-Magaña et al., 2011; Boukhatem, 2012 and Soliman and Sakr, 2017).

3.3. Origin and geographic distribution

Due to its fragrant flowers, *A. farnesiana* has experienced extensive circulation in many parts of the world. It is found in the Americas, the Caribbean, southern Europe, Africa, islands in the Atlantic, Indian and Pacific oceans, West, South and Southeast Asia and Australia (Abulizi et al., 2015). It has become naturalized in many countries: in the Indian region of the Himalayas (Sekar, 2012) and the Mediterranean basin (Le Floc'h, 1991).

However, according to Richardson and Rejmánek (2011), *A. farnesiana* is currently considered invasive in 12 out of 15 geographic regions: Hawaii (Egler, 1942), Australia (Lawes et al., 2006), Réunion (Tassin et al., 2006), French Polynesia (Fourdrigniez and Meyer, 2008) and the Canary Islands (Arévalo et al., 2010).

According to Chevalier (1928), *A. farnesiana* is frequently planted and naturalized in North Africa (Algeria, Morocco, Tunisia and Egypt). It is naturalized in middle and northern Atlantic Morocco, on the Mediterranean coast and in the Rif (Benabid, 2000 and Fennane et al., 2007). It is located in the south of Tunisia, in the region of Gafsa and Gabès (Mkaouar et al., 2016).

In Algeria, *A. farnesiana* is indicated in the North-East and North-West of the country. It is listed in two specific areas, in Rélizane to prevent soil erosion from the national road and in Batna (M'doukel) to combat desertification by fixing dunes (Kheloufi, 2019). It is sometimes found in the oases of the Sahara: Biskra and Touggourt (Chevalier, 1928).

3.4. Uses of *A. farnesiana* in traditional medicine

The individual parts of *A. farnesiana* are commonly used in traditional medicine in their native form and extract form, for the treatment of different symptoms and diseases (Hasib et al., 2020 and Zarza-Albarrán et al., 2020). The plant has antispasmodic, aphrodisiac, astringent, antidysenteric and anthelmintic properties (Khare, 2007 and Juárez-Vázquez et al., 2013), stimulant, softening, rheumatic, antidiabetic, antioxidant (Delgadillo-Puga et al., 2015; Konwar and Das, 2015), antimalarial, antifungal (Garavito et al., 2006 and Kingsley et al., 2014), anti-ulcer, anti-pyritic (Biradar and Bhagyashri, 2013; Dwarakanath and Sharathchandra, 2018).

Table 1 summarizes the most important applications of *A. farnesiana* in traditional medicine in some countries:

Table 1. Traditional uses of *A. farnesiana* in some countries

Country	Parts used	Traditional uses	References
Mexico	- Bark, flowers	- Antidiarrheal, antispasmodic, antidyspeptic, astringent	Garcia-Alvarado (2001) and Meckes et al. (2004)
	- Seeds, pods	- Antispasmodics, astringents, against tuberculosis, strengthens teeth, relieves cold sores	Argueta et al. (1994)
Central America	- Bark, flowers	- Antidiarrheal, antispasmodic, anti-dyspeptic, astringent	Garcia-Alvarado (2001)
Colombia	- Flowers	- Relieves stomach pain	Papaefthimiou et al. (2017)
	- Pods	- Treats sore throats, conjunctivitis	Dwarakanath and Sharathchandra (2018)
	- Bark	- Astringent, softening	Duke (1985); Beckstrom-Sternberg and Duke (1996)
	- Bark, leaves	- Antimalarial	Garavito et al. (2006)
	- Leaves	- Healing agent, healing agent	Morton (1981); Dwarakanath and Sharathchandra (2018)
	- Roots	- Antispasmodic, antidiarrheal, antirheumatic, aphrodisiac, astringent, soothing, febrifuge, stimulant, relieves sore throats	Duke (1981)
Brazil	- Bark	- Astringent, softening	Duke (1981)
	- Roots	- Antidiarrheal, relieves sore throats	Duke (1981) and Morton (1981)
	- Leaves	- Healing	Morton (1981); Dwarakanath and Sharathchandra (2018)
	- Pods, seeds	- Treats sore throats, conjunctivitis	Dwarakanath and Sharathchandra (2018)

India	- Branches	- toothbrushes	Biradar and Bhagyashri (2013)
	- Roots	- Antispasmodic, antidiarrheal, antirheumatic, aphrodisiac, astringent, soothing, febrifuge, stimulant, relieves sore throats	Duke (1981)
	- Bark	- Against dysentery and gastric disorders	Bora et al. (2007) and Poongodi et al. (2011)
	- whole plant	- Antiulcer, antipyretic, against dental caries	Bora et al. (2007) and Poongodi et al. (2011)

3.5. Phytochemical composition

The studies reviewed on the composition of *A. farnesiana* demonstrate that the latter would essentially contain terpenes, phenolic acids, flavonoids, tannins, alkaloids, fatty acids from seed oils, polysaccharides, non-protein amino acids, and other phytochemicals.

a. Terpenes

Three compounds, cis-3-methyldec-3-en-1-ol acid, cis-3-methyldec-3en-1-oic acid and trans-3-methyldec-4-enoic acid play a role important in the smell of cassia oil. The essential oil of *A. farnesiana* would mainly contain: methyl salicylate (47.5%), anisaldehyde (17.3%), geraniol (9.8%), benzaldehyde (6%), geranyl acetate (3.3%), geranial (2.8%), 3-methyldec-3-en-1-ol (1.9%), (Z)-3-nonen-1-ol (0.7%), β-ionone (0.7 %), myrcene (0.5%), 3-methyldec-4en-1-ol (0.5%), benzyl alcohol (0.5%), linalool (0.4%), α-ionone (0. 4%) and some other components. Various non-volatile terpenes have also been isolated from the seeds such as the diterpene glycoside (Seigler, 2003; GlobinMed, 2016 and Papaefthimiou et al., 2017).

Four new diterpenes, namely Acasiane A, Acasiane B, Farnesirane A and Farnesirane B, as well as three known diterpenes and two triterpenes have been isolated from the roots (Lin et al., 2009; Sharmin and Mahazabin, 2018).

Three sterols were identified from the hexane and chloroform extracts of the pods: stigmasterol (51.08%), stigmastan-3,5-diene (37.42%) and 3-acetyl-cholest-5-en-22-ino. (11.50%). In addition, from the two extracts, three phytosterols were characterized: campesterol, stigmasterol and gamma-sitosterol; the compound (3β,22E)-stigmasta-5,22-dien-3-yl β-D-glucopyranoside has also been isolated (Hernández-García et al., 2019).

b. Phenolic acids

Detecting only in pods and seeds, gallic acid and its derivatives (ellagic acid, m-digallic acid, methyl gallate, ethyl gallate) are the main phenolic acids present in the plant (Lin et al., 2009; GlobinMed, 2016; Subhan et al., 2018 and Hernández-García et al., 2019).

c. Flavonoids

The flavonoids isolated from the hydroalcoholic extract of the pods of this species are naringin, naringenin, naringenin 7-O- (6″-galloylglucoside) and naringenin 7-O- (digalloylglucoside 4″, 6″) (Zarza-Albarran et al., 2020).

The leaves of *A. farnesiana* also contain various flavonoids (apigenin-6,8-bis (C-β-D-glucopyranoside), quercetin-3-O-rutinoside). Its seeds have also been reported to contain the flavone diosmetin and the flavone farnisin (e.g. 7,3′-dihydroxy-4′-methoxyflavone) (GlobinMed, 2016; Subhan et al., 2018). Finally, eight flavonoids were isolated from the roots of *A. farnesiana* (Lin et al., 2009; Sharmin and Mahazabin, 2018).

d. Tannins

In acacia species, hydrolysable and condensed tannins (proanthocyanidins) are the next most abundant compounds after flavonoids. They have been identified and isolated in different parts of some species (Subhan et al., 2018). The leaves, pods and bark of *A. farnesiana* contain significant amounts of tannins (GlobinMed, 2016).

e. Alkaloids

Alkaloids have been isolated from the pods and seeds of *A. farnesiana* (Sharmin and Mahazabin, 2018). Identification of the essential oil made it possible to isolate nonadecane (GlobinMed, 2016).

f. Fatty acids

Eighteen methylated fatty acids were identified from hexane and chloroform extracts of the pods of *A. farnesiana*. Both extracts had abundant linoleic acid (C18: 2, Δ9c, 12c; 39.94–40.50%), oleic acid (C18: 1, Δ9c; 30.09–30.73%), palmitic acid (C16: 0; 13.15–13.05%) and stearic acid (18: 0; 8.16–8.01%). From 19 fatty acids characterized in the two extracts, six have already been reported in seeds of *A. farnesiana* (acids: myristic, palmitic, stearic, oleic, linoleic and arachidic) and 13 were first reported in *A. farnesiana* (acids: lauric, pentadecanoic, cis-10-pentadecenoic, palmitoleic, heptadecanoic, cis- 10-heptadecenoic, linolelaid, γ-linolenic, α-linolenic, cis-11-eicosenoic, behenic, cis-8, 11, 14 eicosatrienoic and lignoceric) (Hernández-García et al., 2019).

g. Polysaccharides

Acacia gums are non-starch, highly branched, neutral or slightly acidic polysaccharides. The structures of natural gummies vary widely, but many have a skeleton of 1→3 Dgalactopyranose units made up of four sugars: L-arabinose, L-rhamnose, D-galactose, and D-glucuronic acid (Subhan et al., 2018). It has been reported that the mucilage of the pods of *A. farnesiana* contained polysaccharides (arabinose, xylose, galactose, glucose and mannose) (GlobinMed, 2016).

h. Non-protein amino acids

Non-protein amino acids are commonly found in the leaves and seeds of the subfamily Mimosoideae species. N-acetyldjenkolic acid (11) systematically present in the genus *Acacia* was isolated for the first time in *A. farnesiana* (Seigler, 2003 and Hernández-García et al., 2019).

i. Other phytochemicals

Cyclitols

The identification of methanolic extracts from the fruits of *A. farnesiana* was used to isolate pinitol (Hernández-García et al., 2019)

Cyanogens

It has been reported that the dried foliage of *A. farnesiana* contained cyanogens (eg, linamarin and lotaustralin) (GlobinMed, 2016).

Protein

AFAL is a chitin-binding protein purified from the albumin fraction of soluble seed extracts of *A. farnesiana*. Complete amino acid sequencing obtained by tandem mass spectrometry confirms its similarity to PHA-like lectins (Santi-Gadelha et al., 2008 and Hernández-García et al., 2019).

Saponins

Saponin was isolated from pods and seeds of *A. farnesiana* (Sharmin and Mahazabin, 2018). As other phytochemicals, saturated hydrocarbons (tricosane, nonadecane and heneicosane) characterized the chemical analysis of essential oils and absolutes of *A. farnesiana*, while hexadecanoic acid and α-amyrin were important constituents of some absolutes (Papaefthimiou et al., 2017). Malic acid, coumaric acid and citric acid were identified from the methanolic and aqueous extracts of the pods of *A. farnesiana* (Hernández-García et al., 2019).

3.6. Biological activities

a. Antioxidant activity

Various studies have shown that *A. farnesiana* has a definite antioxidant power. Indeed, the studies conducted by Delgadillo et al. (2015, 2018, 2019) confirmed the antioxidant activity of the bean extracts of *A. farnesiana*. Recently, Hasib et al. (2020) demonstrated that the acetate-soluble fractions of *A. farnesiana* have antioxidant properties.

These antioxidant properties attributed to this species possibly indicate the presence of biologically important phytoconstituents including the presence of phenols, tannins which could be responsible for the antioxidant activities observed (Delgadillo-Puga et al., 2019 and Hasib et al., 2020). This is because gallic acid has a membrane-binding property thus preventing tissue damage (Konwar and Das, 2015).

It has also been identified that saponins and quercitin play an important role in alleviating oxidative stress. The other phytochemical alkaloids and terpenoids present in the plant may also have some contribution as an antioxidant (Delgadillo-Puga et al., 2018).

b. Anti-inflammatory activity

The results of the evaluation of the anti-inflammatory properties of organic and aqueous extracts of the pods of *A. farnesiana* performed by Delgadillo-Puga et al. (2018) demonstrated that these extracts can be effective as topical anti-inflammatory agents. Indeed, the presence of certain bioactive compounds with a powerful antioxidant activity recognized as gallic acid, catechin and epicatechin are very linked to the response of the anti-inflammatory activity by decreasing the production of inflammatory cytokines.

Thus, the triterpenes found in the chloroform and hexane extract help exert their anti-inflammatory activity by reducing cytokines such as TNF-α and IL-1β. Flavonoids are also responsible for these anti-inflammatory actions and constrain the expression and activation of pro-inflammatory cytokines, TNF-α and COX.

Other studies, such as those by Abrantes et al. (2013) and Leal et al. (2016) investigated the anti-inflammatory abilities of the lectin-like protein of *A. farnesiana* (AFAL). Lectins can reduce the effects of inflammation caused by phlogistic agents, such as carrageenan (CGN).

c. Antimicrobial activity

Ramli et al. (2011) evaluated the ability of the ethanolic extract of the leaves of *A. farnesiana* to inhibit the growth of bacterial and fungal strains. Quercetin and its morin isomer have been reported to be active antimicrobial agents.

Additionally, Santi-Gadelha et al. (2012) showed that lectin-like protein (AFAL) has bacterioestatic effects against *Xanthomonas axonopodis* pv. *passiflorae* (Gram-negative) and *Clavibacter michiganensis michiganensis* (Gram-positive). The antibacterial effect of flavonoids (rutin, quercetin and morin) was also observed using low concentrations against the two bacterial strains.

Sanchez et al. (2013) demonstrated that methyl gallate isolated from *A. farnesiana* exhibited antimicrobial properties by damaging membrane integrity, causing physiological changes leading to a significant reduction in pH, affecting membrane potential, and decreasing cellular

ATP levels. Indeed, extracts from the pods have demonstrated antimicrobial activity for the treatment of tuberculosis and dysentery (Hernández-García et al. 2019).

d. Antidiabetic activity

The extracts from *A. farnesiana* have demonstrated antidiabetic activity by stimulating the release of one or more known or unknown factor(s) from the gastrointestinal tract, which may block glucose uptake/transport directly or indirectly in the intestinal tract (Kingsley et al., 2014). This was also confirmed by the study conducted by Konwar and Das (2015). Indeed, in addition to the increase in the level of insulin found during treatment with extracts of *A. farnesiana*, they demonstrated a decrease in the intestinal absorption of glucose due to the antidiabetic action which can be attributed to the flavonoids, saponins, polyphenols and tannins contained in this plant.

e. Antinociceptive activity

The study conducted by Leal et al. (2016) confirmed that the seed proteins of *A. farnesiana* possess antinociceptive properties associated with the inhibition of cell migration and release of inflammatory mediators.

f. Analgesic activity

A. farnesiana extract showed dose-dependent pain inhibition in both central and peripheral secondary mouse models (Hasib et al., 2020).

g. Antidiarrheal activity

In the study by Hasib et al. (2020), the extract from *A. farnesiana* has a statistically significant anti-diarrheal effect only at high doses.

h. Cytotoxic activity

The study conducted by Ramli et al. (2011) on the cytotoxic activity of the ethanolic extract of the leaves of *A. farnesiana* indicates that it may not be suitable for development as an anticancer, but cytotoxicity testing suggested the safety of the extract rich in flavonoid compounds.

i. Membrane stabilization activity

The study conducted by Sharmin and Mahazabin (2018) showed that the membrane stabilizing activity can be attributed to the anti-inflammatory properties of phytoconstituents isolated from the seeds of *A. farnesiana*.

j. Pest control activity

Recent studies by Olmedo-Juárez et al. (2020) and Zarza-Albarrán et al. (2020) demonstrated that galloylated flavonoids from the pods of *A. farnesiana* possess potent deworming activity against the eggs and infective larvae of the parasitic sheep nematode *Haemonchus contortus.*

The main compounds found were identified as galloyl and flavanone derivatives, including gallic acid, methyl gallate, ethyl gallate, naringin, naringenin 7-O-(4″,6″digalloylglucoside), naringenin 7-0-(6″-galloylglucoside) and naringenin. Similarly, ESEM and CLSM images showed that the compounds evaluated adhered to the eggshell and the outer cuticle of the larvae. These results indicate that the pods contain nematicidal compounds and may be natural anthelmintic agents against *H. contortus.*

k. Thrombolytic activity

The extracts from *A. farnesiana* demonstrated thrombolytic activity. Moreover, new thrombolytic agents can be developed from the bark of this plant, which may be a new observation in the field of cardiovascular diseases (Sharmin and Mahazabin, 2018).

4. Conclusion

The synthesis of work carried out on *Acacia farenesiana* on an international scale has shown that it is a species that grows everywhere in the world, partly due to its rapid growth, the flexibility of its ecological requirements, and ease of adaptation to extreme temperatures. Widely used in the perfume industry, to restore and rehabilitate degraded environments, it has great ecological and economic value in its original distribution area and is also used in traditional medicine. It is a significant producer of secondary metabolites and has several medicinal properties. That said, this species is described as invasive and problematic outside its natural range. Although it has been recorded in Algeria in two specific geographically distant areas, it would be a priority to implement a preventive management strategy to limit its spread, which will certainly harm local biodiversity and ecosystem services, and to carry out pharmacological and ecological studies with a view to the socio-economic valorization of this invasive species.

Conflict of interest

No potential conflict of interest was reported by the authors.

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