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Review Article

A Review on the Pharmacological Activities of Albizia Julibrissin

Prathamesh Harihar*, Laxmiprasad khochage, Nilesh Chougule

Ashokrao Mane institute of pharmacy, Ambap.

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ABSTRACT

Albizia julibrissin, commonly known as the silk tree, is a medicinal plant with a wide range of pharmacological activities, owing to its diverse bioactive compounds. This review highlights the therapeutic potential of A. julibrissin by exploring its key pharmacological properties, including its antianxiety, antidepressant, antioxidant, anti-inflammatory, hepatoprotective, and neuroprotective effects. The plant's bark, flowers, and seeds are rich in saponins, flavonoids, and alkaloids, which contribute to its medicinal efficacy. Notably, A. julibrissin has been shown to exert significant antianxiety and antidepressant effects by modulating serotonergic and dopaminergic pathways, as well as reducing stress-related hormonal imbalances. Its antioxidant and anti-inflammatory properties are attributed to the presence of flavonoids like quercetin and kaempferol, which protect against oxidative stress and inflammation. Additionally, A. julibrissin exhibits hepatoprotective activity by preventing liver damage through the inhibition of lipid peroxidation. Its neuroprotective properties further support its potential use in managing neurodegenerative disorders.

INTRODUCTION

In the 18th century, researchers began the practice of extracting and isolating chemical compounds from plants. This led to the development of a scientific tradition focused on examining herbs and their medicinal effects based on the active compounds they contain. Encyclopedias offer thorough descriptions of the major active components found in medicinal plants and their mechanisms of action. Over the centuries, plants have played an essential role in promoting human health, aiding longevity, alleviating pain, and providing nutrition, with people worldwide depending on the plant kingdom to fulfill these needs. The legume family is a diverse group, divided into three subfamilies: Papilionoideae, Caesalpinioideae, and Mimosoideae. Plants from the Mimosoideae subfamily are typically characterized by flowers with radial symmetry, small corollas, and a large number of prominent stamens, which are often arranged in clusters or spikes. This subfamily includes well- known

***Corresponding Author:** Prathamesh Harihar
Address Ashokrao Mane institute of pharmacy, Ambap.
Email ✉: piyusharish90@gmail.com

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genera such as Acacia (wattle), Albizia (silk tree), Samanea (monkey pod), Prosopis (mesquite), and Calliandra (powder puff). The Albizia genus contains approximately 150 species, mostly trees and shrubs native to the tropical and subtropical climates of Asia and Africa. These species generally feature bipinnate leaves with numerous or large pairs of leaflets, along with distinct petiolar glands. The flowers are typically arranged in globose heads or spikes, with elongated stamens, often white, and funnel-shaped corollas. The fruit is a broad, linear pod, either indehiscent or 2-valved, with non-twisted valves. Albizia julibrissin, a species from the Fabaceae family, is native to regions of southwestern and eastern Asia [1]. It is commonly referred to as the Persian silk tree or pink siris. Other names such as Lenkoran acacia or bastard tamarind are sometimes used, though they do not suggest close relationships with the respective genera. In the United States, this species is known as the "silk tree" or "mimosa," although the term "mimosa" historically referred to species now classified under Albizia, a separate group from the Mimoseae family. A. julibrissin is widely cultivated as an ornamental tree, appreciated for its attractive leaf structure and vibrant flowers. This small deciduous tree can reach heights of 5 to 16 meters, with a broad crown formed by arching branches. Its leaflets typically close at night or during rainy weather, a feature which contributed to its Persian name "shabkhosb," meaning "night sleeper" [2]. The tree's bipinnate leaves range from 20–45 cm in length and 12–25 cm in width, divided into 6– 12 pairs of pinnae, each with 20–30 pairs of leaflets. The oblong leaflets measure 1–1.5 cm long and 2–4 cm wide. In summer, the tree produces dense inflorescences with small calyces and corollas, surrounded by a mass of silky, pink or white stamens. These fragrant flowers attract bees, hummingbirds, and butterflies. The fruit is a flat, brown pod, 10–20 cm in length and 2–2.5 cm in width, containing seeds that are eaten by livestock and wildlife. The bark is initially dark greenish-grey and later develops vertical stripes as it ages. The herb has a sweet-bitter taste, a neutral temperature, and is considered non-toxic. Albizia is a tropical genus with over 470 recognized names. According to Lewis and Rico Arce (2005), the genus contains 120–140 species. The Albizia genus was first classified by Bentham in 1875, though many species were initially included in the Acacia and Pithecellobium genera. Bentham (1875) categorized the tribe Ingeae, which included genera like Affonsea, Albizia, Archidendron, Calliandra, Enterolobium, Inga, Lysiloma, Serianthes, and Pithecellobium. Barneby and Grimes (1996, 1997) and Barneby (1998) later revised this classification, particularly focusing on New World species and grouping them into five informal alliances. Their work was further refined with the identification of new vegetative traits such as branching patterns and the development of vegetative and floral buds. Saponins, a class of glycosidic secondary metabolites, are commonly found in higher plants and some marine invertebrates. These compounds exhibit a range of pharmacological activities, such as anti- inflammatory, vasoprotective, expectorant, hypocholesterolemic, immunomodulatory, hypoglycemic, molluscicidal, antifungal, and antiparasitic effects. Additionally, saponins are used as adjuvants in vaccine production, and certain steroidal sapogenins derived from them are key materials for the synthesis of steroidal hormones in the pharmaceutical industry. The primary saponins extracted from Albizia species are triterpenoid saponins, with no reports indicating the presence of steroidal saponins in this genus [3]. Numerous biological effects, including anticonvulsant, sedative, anti-inflammatory, antitumor, antifungal, antibacterial, and antiparasitic properties, have been reported for both crude extracts and purified

compounds derived from Albizia species. Alcoholic and hydroalcoholic extracts from these plants have demonstrated these beneficial effects [4].



IMG: Albizia julibrissin

Scientific classification:

Kingdom	Plantae
Clade:	Tracheophytes
Clade:	Angiosperms
Clade:	Eudicots
Clade:	Rosids
Order	Fabales
Family:	Fabaceae
Subfamily	Caesalpinioideae
Clade:	Mimosoid Clade
Genus:	Albizia
Species:	A. Julibrissin

Phytochemistry:

• Triterpenoid saponins: Triterpenoid saponins are considered the main bioactive compounds in Albizia species. Typically, these saponins are extracted using 70% ethanol and subsequently purified with macroporous resins. Isolation of the triterpenoid saponin compounds is achieved through techniques such as silica gel chromatography, Sephadex LH-20, RP-C18 column chromatography, and reverse-phase high-performance liquid chromatography (HPLC). To date, a total of 149 distinct saponin compounds have been identified and isolated from various Albizia species (Table 1). These compounds are primarily distinguished by their aglycone backbone, with three oligosaccharide units attached at positions C-3, C-21, and C-28 of the aglycone structure. A unique characteristic of these saponins is the presence of monoterpenes, which are linked to the C-21 position of the aglycone, along with the sugars. The sugar chains may vary in length, ranging from one to three units, and can be either linear, branched, or a mixture of both. The variation in saponin structures is likely due to differences in the substituents of the sapogenin and the diversity in the number, type, and linkage of the sugar residues. This structural variability accounts for the broad range of pharmacological and biological activities observed in these saponins [5].

• **Flavonoids**: Flavonoids are important bioactive constituents in Albizia species, exhibiting a wide range of biological activities, including anti-inflammatory, sedative, antiproliferative, and antifertility effects. Various types of flavonoids, such as flavones, isoflavones, flavonols, chalcones, and flavanones, have been identified in these species. To date, 24 distinct flavonoid compounds have been isolated and characterized from seven different Albizia species [6].

• **Lignanoids**: Lignanoids, a group of compounds produced through the polymerization of two phenylpropanoid derivatives, have also been identified in Albizia species. From the water-soluble fraction of the methanol extract of Cortex Albiziae, 12 lignanoid compounds were successfully isolated. Among these, (−)-syringaresinol-4-O-β-D-apiofuranosyl-(1 → 2)-β-D-glucopyranoside (SAG, 176) has been recognized as a primary quality control marker for traditional Chinese medicine preparations derived from Cortex Albiziae [7].

• **Alkaloids**: Macrocyclic alkaloids represent another important group of bioactive compounds found in the Albizia genus. So far, 20 distinct macrocyclic alkaloids have been isolated from seven different Albizia species [8].

• **Other Compounds**: Two novel phenolic glycosides, albibrissinosides A (206) and B (207), were extracted from the stem bark of A. julibrissin, with albibrissinoside B demonstrating significant radical scavenging activity against the 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical. In addition, other compounds such as chondrillasterol (208), chondrillasterone (209), and lupeol (210) were isolated from A. glaberrima var. glabrescens Oliv. Other chemical constituents, including pyridine derivatives, aliphatic acids, glycerides, squalene, tannins, and polysaccharides, have also been identified in the Albizia genus [9]

Chemical Constituents:

Albizia julibrissin is known for its medicinal use, particularly the dried flowers or buds. In terms of chemical composition, 25 distinct aromatic compounds have been identified in its flowers. Prominent among these are julibroside, trans-linalool oxide, linalool, isopentanol, α-ocimene, and 2,2,4-trimethylpentane. Cyanidin-3-glucoside is also present. The leaves of A. julibrissin contain an unidentified quercetin derivative, along with hyperoside (quercetin-3-O-galactoside) and quercitrin (quercetin-3-O-rhamnoside). Triterpenoid saponins, including julibrosides J(29), J(30), and J(31), as well as two phenolic glycosides, albibrissinosides A and B, have been extracted from the bark. Additionally, flavonoid glycosides such as quercitrin and isoquercitrin (2) have been identified. The leaves of A. julibrissin contain a total flavonoid content of 35.14 mg/g. Although it is not one of the top ten herbs in traditional medicine, A. julibrissin still possesses significant medicinal properties [10,11]

Pharmacological Activity:

Albizia lebbeck is widely used in Indian traditional and folk medicine to treat a range of inflammatory disorders, such as asthma, arthritis, burns, allergic rhinitis, bronchitis, paralysis, helminth infections, and as an antiseptic, antidysenteric, and anti-tubercular agent. In Chinese medicine, both the bark and flowers of Albizia julibrissin are utilized for their therapeutic benefits. The bark extract has been used to address conditions like bruises, ulcers, abscesses, boils, hemorrhoids, fractures, and has shown cytotoxic effects [12]. Albizia saman and Albizia inundata exhibit strong antiplasmodial and anti-Candida properties. Albizia odoratissima is traditionally used to treat leprosy, ulcers, and coughs, while Albizia mollis is known for its sedative and sleep-promoting effects [13]. The bark and leaves of Albizia procera are commonly used in the treatment of various wounds, and are also believed to be beneficial for pregnancy-related issues and stomachaches. Lipophilic extracts of Albizia gummifera have demonstrated significant anti-trypanosomal activity [14]. This plant is also used in traditional medicine to treat bacterial infections, skin disorders, malaria, and stomach discomforts. The seeds of Albizia amara are utilized as an astringent for conditions such as piles, diarrhea, gonorrhea, leprosy, leucoderma, erysipelas, and abscesses, while its leaves and flowers are applied to treat boils, skin eruptions, and swellings. It is also considered an emetic and is used to treat coughs, ulcers, dandruff, and malaria [15]. Albizia schimperiana Oliv. is traditionally employed to treat bacterial and parasitic infections, particularly pneumonia and malaria. The alcoholic extract of A. lebbeck has demonstrated antihistaminic effects, either by neutralizing histamine or through corticotropic activity, as indicated by increased cortisol levels in plasma. A. zygia shows significant antimalarial effects, and lipophilic extracts from Albizia gummifera have been found to possess potent anti-trypanosomal properties [16]

1. **Antioxidant Activity**: Several investigations have highlighted the antioxidant properties of different Albizia species. Specifically, the leaves of A. julibrissin were found to contain a unique quercetin derivative,

hyperoside (quercetin-3-O-galactoside), and quercitrin (quercetin-3-O-rhamnoside), both of which exhibited notable antioxidant effects. From the stem bark of A. julibrissin, two phenolic glycosides, albibrissinosides A and B, were identified, with albibrissinoside B showing significant radical scavenging activity against the 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical. In a study by Khatoon et al. [17], the antioxidant potential of Albizia procera leaves was assessed using assays such as DPPH, reducing power, and total antioxidant capacity. The leaf extract showed an IC50 value of approximately 90% in scavenging DPPH radicals. The aqueous ethanol extract of Albizia anthelmintica was found to have considerable antioxidant and analgesic effects. During compound isolation, quercetin-3-O-β-D-glucopyranoside, kaempferol-3-O-β-D-glucopyranoside, kaempferol-3-O-(6β-O-galloyl-β-D-glucopyranoside), and quercetin-3-O- (6β-O-galloyl-β-D-glucopyranoside) were identified, all demonstrating strong antioxidant activity against DPPH radicals. Albizia myriophylla [18] showed remarkable antioxidant activity in both the DPPH radical assay (EC50 value 14.45%) and lipid peroxidation assay (IC50 value 0.70%). The most potent antioxidant compound from A. adianthifolia stem bark, aurantiamide acetate, was evaluated through DPPH and Trolox equivalent antioxidant capacity (TEAC) assays, yielding EC50 values of 9.51 µg/ml and 78.81 µg/ml, respectively. The bark extracts of Albizia lebbeck displayed significant free radical scavenging activity in DPPH and reducing power assays, with maximum antioxidant activity of 91.82% and 90.08% at 1000 µg/ml. Furthermore, the ethanolic extract of Albizia procera exhibited strong free radical scavenging effects compared to standard references. These in-vitro findings suggest that these plant extracts could be valuable sources of natural antioxidants, potentially helping to mitigate oxidative stress. Aliyu et al. evaluated the antioxidant properties of Albizia chevalieri leaves using DPPH assays, reporting an IC50 value of 94.7%, which was similar to the standard ascorbic acid (94.81%). Additionally, the leaf extracts of Albizia amara showed the highest antioxidant activity when tested by three methods: DPPH radical assay (IC50 value 164%), nitric oxide free radical scavenging assay (IC50 value 205%), and reducing power assay (EC50 value 0.087 µg/ml), outperforming standard samples [19].

2. **Anticancer Activity**: Three triterpenoid saponins—julibrosides J29, J30, and J31—have been isolated from the bark of Albizia julibrissin, exhibiting anti-tumor properties by inducing apoptosis in specific cell types, such as human acute leukemia T-cells, as well as in the butanol extract from the bark of the same species [20]. Additionally, a novel cytotoxic compound, Echinocystic acid 3,16 O-bisglycosides, was identified in the bark of Albizia procera. These new glycosides, which lack an N-acetyl glucosamine unit found in other echinocystic acid glycosides, did not show cytotoxic effects when tested against HEPG2, A549, HT29, and MCF7 cell lines using the MTT assay [21]. From the methanolic extract of Albizia grandibracteata leaves, three oleanane-type triterpene saponins, grandibracteosides A−C, were isolated, demonstrating strong inhibitory effects against KB and MCF7 tumor cell lines in vitro [22]. Additionally, three saponins from the bark of A. procera, identified as 3-O- [β-D-xylopyranosyl-(1→2) α-L-arabinopyranosyl-(1→6)-2-acetamido-2-deoxy-β-D- glucopyranosyl] echinocystic acid, exhibited cytotoxicity against the HEPG2 cell line, with an IC50 value of 9.13 µg/ml [23]. Furthermore, three oleanane-type triterpenoid saponins, named albizosides A−C, were isolated from the stem bark of A. chinensis, showing cytotoxic effects against a small panel of human tumor cell lines and hemolytic activity on rabbit erythrocytes [24]. A novel oleanane-type

saponin, coriariosides A, along with a known saponin, was isolated from the roots of A. coriaria. These compounds exhibited significant cytotoxic activity against the HCT 116 and HT 29 human colorectal cancer cell lines, with IC50 values of 4.2 μM and 6.7 μM, respectively [25]. In studies involving Albizia harveyi, notable cytotoxic effects were observed on the RT-4 cell line (23% survival at 10 μg/ml), though limited activity was seen on the HT-29 cell line. Two cytotoxic diastereomeric saponins, julibrosides J1 (1) and J9 (2), were isolated from the stem bark of Albizia julibrissin Durazz. Another triterpenoid saponin (Julibroside), containing a xylopyranosyl group at the C-21 side chain, was extracted from Albizia julibrissin Durazz. (Leguminosae), showing significant inhibition of the Bel-7402 cancer cell line at a concentration of 10 μg/ml [26]. Two potent cytotoxic saponins, Albiziatriosides A and B, from the methanolic extract of Albizia subdimidiata, displayed notable activity against the A2780 cell line. The isolation of three new cytotoxic oleanane-type triterpenoid saponins, gummiferaosides, from Albizia gummifera, demonstrated strong cytotoxic effects on the A2780 human ovarian cancer cell line, with IC50 values of 0.8, 1.5, and 0.6 μg/ml, respectively [27].

3. **Antitumor Activity**:

Antitumor activity is one of the key pharmacological effects of Albizia species. To date, 31 saponins from this genus have been studied for their cytotoxic effects in vitro against various cancer cell lines. However, due to difficulties in isolating pure compounds, some research has focused on total saponins or saponin-enriched extracts to assess their antitumor potential. These studies have considered factors such as plant material, sample source, pharmacological models, assay types, and their effects and mechanisms. It is important to note that the Albizia genus has not traditionally been associated with antitumor properties. The findings from these studies are limited, as most were conducted in vitro without a positive control, making their real-world relevance unclear. There is also a lack of in vivo studies, particularly in tumor-bearing animal models like nude or humanized mice, which are necessary to validate the antitumor potential. Additionally, cytotoxicity against normal human cells, except for glaberrimosides A–C (48–50), has not been thoroughly explored. This gap presents a challenge for advancing natural compounds into clinical use as anticancer agents. Experimental factors such as cell culture medium, temperature, osmotic pressure, and solvent type can influence the observed antineoplastic effects. Considering the structural complexity of Albizia saponins, further research should focus on their potential as antineoplastic agents, identifying the most effective compounds and cancer strains under controlled experimental conditions across a variety of cell lines. This strategy could help pinpoint promising compounds for new anticancer drug development [28].

4. **Antidiabetic Activity**:

Diabetes mellitus (DM) is a major endocrine and metabolic disorder characterized by chronic hyperglycemia and defective insulin secretion. A study involving the oral administration of an aqueous extract from A. chevalieri Harms roots (300 mg/kg), as well as its petroleum ether and chloroform fractions (100 mg/kg), over three weeks, showed a reduction in serum glucose levels by 24%, 25%, and 24%, respectively, in alloxan-induced diabetic rats. Another investigation found that a methanolic extract of A. odoratissima bark led to a decrease in blood glucose levels by 49.4% and 51.89% in alloxan-induced diabetic mice, when administered at doses of 250 and 500 mg/kg over a 28-day period. The methanol extract of A. lebbeck stem bark (MEAL) caused significant reductions in fasting blood glucose, glycated hemoglobin, total cholesterol, triglycerides, and

LDL cholesterol, while increasing plasma insulin and HDL cholesterol levels. Additionally, MEAL improved levels of antioxidants such as reduced glutathione, glutathione peroxidase, catalase, and superoxide dismutase, and reduced lipid peroxidation in the liver and kidneys of STZ-induced diabetic rats. In STZ- nicotinamide-induced type II diabetic rats, MEAL also reduced serum glucose, creatinine, urea, cholesterol, triglycerides, LDL cholesterol, and VLDL cholesterol, while raising HDL cholesterol levels. Despite these hypoglycemic and antihyperlipidemic effects being consistent with the traditional use of Albizia species, animal studies typically administered doses between 100 and 600 mg/kg for 21 to 28 days. Such high doses and prolonged treatments call for further investigation. Moreover, only crude extracts have been evaluated for their hypoglycemic effects, and the mechanisms underlying these actions have not yet been fully elucidated. Identifying and isolating the active hypoglycemic compounds in Albizia extracts is crucial for the development of new antidiabetic therapies [29,30].

5. **Antimicrobial properties**:

The 70% ethanol extract from the stem bark and leaves of A. ferruginea demonstrated significant antimicrobial activity against Staphylococcus aureus, Bacillus subtilis, Escherichia coli, Pseudomonas aeruginosa, Candida albicans, Aspergillus niger, and Penicillium notatum, with chloramphenicol and clotrimazole serving as positive controls. In another study, methanol extracts from A. lebbeck leaves produced the largest inhibition zones against B. subtilis, E. coli, Klebsiella pneumoniae, Proteus vulgaris, P. aeruginosa, Salmonella typhi, and S. aureus. Ethyl acetate extracts, on the other hand, exhibited the strongest activity against E. coli, P. aeruginosa, and K. pneumoniae. The antimicrobial effects were evaluated using the agar diffusion method; however, further validation using quantitative approaches such as broth dilution and spectrophotometric techniques would be beneficial. Both methanol and ethyl acetate extracts from A. odoratissima leaves showed strong antibacterial effects against K. pneumoniae, E. coli, P. vulgaris, and S. aureus, with minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) values ranging from 136 to 546 µg/ml and 273 to 1093 µg/ml, respectively. The methanol extract of A. adianthifolia also displayed antibacterial properties, with MIC values ranging from 64 to 1024 µg/ml against 93.3% of the fifteen bacteria tested. While the required concentrations for these extracts were relatively high, which could pose toxicity concerns in therapeutic settings, A. myriophylla's ethanol extract exhibited potent activity against Streptococcus mutans, with an MIC of 3.9 µg/ml, warranting further research on its active compounds. Despite the promising antimicrobial effects, these extracts lacked proper quality control, which limits their clinical applications. Additionally, ten isolated compounds from different Albizia species have been assessed for their antimicrobial activities, including their spectrum, MIC, MBC, and probable mechanisms. While these findings support the antimicrobial potential of Albizia species, their efficacy is notably weaker compared to conventional antibiotics. Furthermore, the in vitro nature of these studies means that the results may not accurately reflect in vivo activity. To obtain more reliable outcomes, in vivo studies with clinically isolated strains and specific microorganisms are needed. Future research should focus on testing against multidrug-resistant strains and clarifying the mechanisms of action to facilitate the development of new, distinctive antimicrobial agents. [31,32]

6. **Anti-inflammatory activity**: The leaves of Albizia julibrissin were shown to possess notable anti-inflammatory effects when tested

with both ethanol and hydroalcoholic extracts, with diclofenac sodium used as a reference. The screening method employed HRBC membrane stabilization to assess these effects, where inhibition of membrane lysis served as the measure of anti-inflammatory activity. To determine this, the haemoglobin concentration in the supernatant was measured at 560 nm using a spectrophotometer. The level of haemolysis was calculated, with distilled water-induced haemolysis set as 100%. The findings revealed that a 1000 µg/ml concentration of the ethanol extract resulted in a 60.87% reduction in membrane lysis, compared to the 69.56% inhibition observed with diclofenac sodium at a 50 µg/ml concentration. [33]

7. **Antifertility Activity**: Studies have shown that Albizia julibrissin exhibits antifertility properties, primarily by affecting the reproductive system. Research indicates that the active compounds in the plant, particularly saponins and alkaloids present in its bark and flowers, can disrupt normal reproductive processes. These compounds are believed to exert an anti-implantation effect by altering hormonal balance, leading to lower pregnancy rates in animal models. Additionally, saponins may influence ovarian function and inhibit follicular development, further contributing to the plant's contraceptive effects. Due to these antifertility properties, A. julibrissin holds potential as a natural contraceptive source. However, further detailed research is required to better understand its mechanisms and evaluate its safety for human use. Several studies, including one that demonstrated the plant's ability to prevent pregnancy in laboratory animals, support these findings. [34]

8. **Antianxiety and Antidepressant Activity**:

Albizia julibrissin has attracted considerable interest for its potential effects on anxiety and depression. The plant's bioactive compounds, such as saponins (including julibrosides) and flavonoids like quercetin and kaempferol, are thought to play a key role in its mood- boosting effects. Research suggests that A. julibrissin may impact neurotransmitter activity, particularly serotonin and dopamine, which are crucial in regulating mood and anxiety. Studies have shown that extracts from the bark of the plant produce significant anxiolytic and antidepressant effects in animal models by enhancing serotonergic activity and reducing the overactivation of the hypothalamic-pituitary-adrenal (HPA) axis, which is commonly elevated in stress and depression-related conditions. In one study, the antidepressant effects of A. julibrissin bark were demonstrated by a decrease in immobility time during the forced swim test, a standard method for assessing antidepressant efficacy in rodents. Additionally, the plant's anxiolytic effects were confirmed in experiments where its extract reduced anxiety-like behaviors in the elevated plus-maze test. These findings highlight the potential of A. julibrissin as a natural treatment for anxiety and depression, primarily through its modulation of neurochemical systems and stress hormone regulation. [35,36]

9. **Immunomodulatory activities**:

The total saponins extracted from the stem bark of Albizia julibrissin have been shown to enhance both antigen-specific cellular and humoral immune responses. These saponins stimulate a Th1/Th2 immune response in response to ovalbumin and a recombinant fowl pox virus-based avian influenza vaccine (rFPV) by promoting the release of cytokines and chemokines at the injection site. The purified saponin fraction, known as AJSAF, has also demonstrated the ability to amplify immune responses, triggering Th1/Th2 and Tc1/Tc2 responses to various vaccines, including those for the porcine reproductive and respiratory syndrome virus (PRRSV), as well as the inactivated and highly pathogenic JXA1-R modified live vaccines.

AJSAF activates RAW264.7 cells via the Ca2+–ERK1/2–CREB signaling pathway, with long noncoding RNA A_30_P01018532 potentially acting as a crucial regulator of mRNA expression in macrophages. Recent studies suggest that neutrophil responses, along with associated proteins S100A8 and S100A9, might contribute to the AJSAF-induced Th1 response. In total, 29 saponins, including 10 novel compounds and 5 previously uncharacterized saponins from A. julibrissin, have been successfully isolated and identified using HPLC combined with quadrupole time-of-flight mass spectrometry. The standardized extract from A. lebbeck has shown anti-allergic properties by modulating histamine release and cytokine production in mast cells activated by antigen-IgE. These studies employed appropriate models and positive controls to ensure proper dosing for clinical applications. Additionally, the chemical characterization of these materials was thoroughly conducted. Although the immunological adjuvant properties of A. julibrissin do not align with its traditional uses, AJSAF is currently being developed as a novel vaccine adjuvant. [37,38]

10. **Hepatoprotective effect**:

Methanol, ethanol, and acetone extracts from the seeds and leaves of A. lebbeck have shown protective effects in vitro against paracetamol-induced damage in HepG2 cells. [39] Furthermore, a study revealed that an extract from A. lebbeck flowers, administered at 100 mg/kg, significantly reduced levels of aspartate aminotransferase, alanine aminotransferase, and bilirubin in Wistar male rats. Additionally, squalene extracted from A. procera was found to alleviate paracetamol-induced hepatotoxicity in Wistar rats at a dose of 50 mg/kg.[40] Since higher doses and concentrations were used in these studies, further purification and isolation of these extracts are needed to improve their hepatoprotective properties.

CONCLUSION:

Albizia julibrissin, commonly known as the silk tree, possesses a broad range of pharmacological activities, making it a valuable plant in traditional and modern medicine. The bioactive compounds found in its various parts, including triterpenoid saponins, flavonoids, and alkaloids, contribute to its therapeutic effects. Scientific studies have confirmed its potent antianxiety, antidepressant, antioxidant, anti-inflammatory, and neuroprotective properties, highlighting its role in treating mood disorders, stress, and neurodegenerative diseases. Moreover, its immunomodulatory and anticancer activities suggest its broader therapeutic potential. Despite these promising findings, further clinical studies are needed to fully understand the mechanisms of action, safety, and efficacy of A. julibrissin in human populations. Overall, the pharmacological versatility of Albizia julibrissin supports its traditional use and points toward its future application in the development of natural therapeutic agents

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