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ETHNOMEDICINAL USES, PHYTOCHEMISTRY AND PHARMACOLOGY OF *ACACIA FARNESIANA (L.)*

Ravi Kant[1], Ram Nath Khorwal[1]*

[1]Lords School of Sciences, Lords University, Alwar- Bhiwadi Highway, Chikani, Alwar 301028, Rajasthan

ABSTRACT

Acacia farnesiana (L.), belonging to the family Fabaceae, is a widely distributed medicinal plant with a long history of use in traditional systems of medicine across tropical and subtropical regions. The plant has been traditionally employed for the management of various ailments, including gastrointestinal disorders, infections, inflammation, diabetes, skin diseases, and parasitic infestations. The present review comprehensively compiles and critically evaluates available literature on the ethnomedicinal uses, phytochemical constituents, and pharmacological activities of *A. farnesiana*. Phytochemical investigations have revealed the presence of diverse bioactive compounds such as flavonoids, phenolic acids, tannins, terpenoids, fatty acids, and glycosides, which contribute to its broad spectrum of biological activities. Pharmacological studies have demonstrated antioxidant, antimicrobial, anti-inflammatory, antidiarrhoeal, antihyperglycaemic, anthelmintic, cytotoxic, and antiviral potentials through in vitro, in vivo, and in silico approaches. This review highlights the therapeutic relevance of *A. farnesiana* and emphasizes the need for further mechanistic, toxicological, and clinical investigations to support its development as a potential source of novel therapeutic agents.

Keywords: *Acacia farnesiana* (L.), ethonomedicina, pharmacology, phytochemistry, tec.

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INTRODUCTION

Medicinal plants have constituted the backbone of traditional healthcare systems since the dawn of human civilization and continue to represent a vital resource for contemporary medicine [1]. Long before the advent of synthetic pharmaceuticals, human societies relied on plants for the prevention and treatment of diseases, pain management, wound healing, and the maintenance of overall health [2]. Archaeological and historical records from ancient civilizations such as those of India, China, Egypt, Mesopotamia, and Greece provide compelling evidence of the systematic use of medicinal plants [3]. Classical texts including the *Charaka Samhita*, *Sushruta Samhita*, Traditional Chinese Materia Medica, and Greco-Roman pharmacopeias document hundreds of plant species used for therapeutic purposes [4]. Even in the modern era, plant-derived compounds remain indispensable to healthcare, either as crude herbal preparations or as purified molecules that serve as lead structures for drug development [5].

Medicinal plants have constituted the backbone of traditional healthcare systems since the dawn of human civilization and continue to represent a vital resource for contemporary medicine [6]. Long before the advent of synthetic pharmaceuticals, human societies relied on plants for the prevention and treatment of diseases, pain management, wound healing, and the maintenance of overall health [7].

According to estimates by the World Health Organization, nearly 80% of the global population relies on traditional medicine for primary healthcare needs, particularly in developing and low-income countries [8]. This reliance is driven by several factors, including cultural acceptability, accessibility, affordability, and the perceived safety of herbal remedies. In rural and tribal communities, traditional healers and indigenous knowledge systems play a crucial role in disease management, often serving as the first point of contact for healthcare [9]. Importantly, this vast reservoir of ethnomedicinal knowledge has been accumulated through centuries of empirical observation and intergenerational transmission, making it a valuable starting point for scientific exploration.

Ethnomedicinal research serves as a bridge between traditional knowledge and modern pharmacological science. By systematically documenting the traditional uses of plants and correlating them with phytochemical composition and biological activities, ethnomedicine provides rational leads for drug discovery [10]. Plants that are repeatedly used across different cultures for similar ailments are particularly attractive candidates for scientific validation, as such convergence often indicates genuine therapeutic efficacy. Moreover, ethnomedicinally guided research can significantly reduce the time, cost, and risk associated with the random screening of plant species, thereby increasing the success rate of identifying biologically active compounds [11].

Within this broader context, the genus *Acacia* occupies a prominent position in traditional medicine and pharmacognosy. Belonging to the family Fabaceae, the genus comprises more than 1,300 species distributed across tropical and subtropical regions of the world [12]. Many *Acacia* species are known for their economic, ecological, and medicinal importance [13]. They are used as sources of timber, gum, tannins, fodder, and ornamental plants, in addition to their therapeutic applications. Several species of *Acacia* have been reported to exhibit antimicrobial, anti-inflammatory, antioxidant, antidiabetic, hepatoprotective, and anticancer activities, which are attributed to their rich content of secondary metabolites such as polyphenols, flavonoids, alkaloids, and terpenoids.

Acacia farnesiana (L.), commonly known as sweet acacia, cassie flower, or *Gandh babul*, is one of the most widely distributed and ethnomedicinally significant species of the genus [14]. The plant is a thorny shrub or small tree characterized by bipinnate leaves, fragrant yellow flowers arranged in globose heads, and elongated pods containing seeds. Native to the Americas, *A. farnesiana* has been extensively naturalized in many parts of the world, including India, Africa, Australia, and Southeast Asia [15]. Its remarkable adaptability to diverse climatic and soil conditions has contributed to its widespread distribution and availability.

Despite the growing body of scientific literature on *Acacia farnesiana*, the available information remains fragmented, with studies focusing on isolated aspects such as ethnomedicinal use, phytochemistry, or specific pharmacological activities. A comprehensive and integrated evaluation that systematically correlates traditional knowledge with chemical composition and biological effects is essential to fully understand the therapeutic potential of this plant.

Traditional uses of *Acacia farnesiana*

There are several implications for *Acacia farnesiana* in traditional medicine. Locals use it as a remedy for ailments like colds and coughs. Ayurveda has reportedly shown some potential for the treatment of skin conditions. Table 1 represent the traditional uses of *Acacia farnesiana* [16].

Table 1. Ethnomedicinal uses of different parts of *A. farnesiana*

S.no	Plant parts	Ethnomedicinal uses
1.	Bark	Used as astringent, demulcent for bleeding gums, cough suppressant, typhoid, swelling of neck glands, dysentery, stomach disorder, rheumatic pain, anthelminthic, antimalarial
2.	Flower	Used as emetic, stomach aches, antispasmodic, stimulant, headaches, dyspepsia, cassie perfume
3.	Root	Tuberculosis, throat infections, diarrhoea, snake bite venoms, fever, antispasmodic, aphrodisiac, febrifuge, diarrhoea, rheumatism, stimulant, stomach, cancer
4.	Pods	Ulcer, dental caries, dysentery, inflammation of skin and raucous membrane, diarrhoea, leucorrhoea, uterorrhagia, conjunctivitis, sore throat, muscle relaxant, cardiac depressant

5.	Aerial parts	Insanity, convulsions, delirium
6.	Leaves	Used for sores and ulcers, antimalarial, healing agent, treat gonorrhoea
7.	Fruit	Used as astringent, skin irritation, diarrhoea mucous membrane irritation

Taxonomical classification

Acacia farnesiana is classified as a member of the Kingdom Plantae and the Phylum Tracheophyte, which denotes the presence of vascular tissues in the plant. Its classification as a member of the Class Magnoliopsida indicates that it is a dicot flowering plant. It shares taxonomic relationships with leguminous plants and kindred families of the Order Fables. It belongs to the pea family of plants [16].

Botanical Description

According to the microscopical and morphological descriptions of *Acacia farnesiana* and its parts (they are 2-4 m tall, evergreen, densely branched, thorny shrubs or small trees with rough bark and many branches, as well as branchlets with tiny lenticels that zigzag through the branchlets. 20 pairs of axillaries, linear-oblong, 2-6 mm, 1 to 1.5 mm, glabrous pinnae, each measuring 4 to 8 pairs, 1.5 to 3.5 cm in diameter. 2-7 cm long leaves; spine-like, 1-3 cm long stipules; small branchlets. There are 1 to 3 axillary heads with a diameter of 1-1.5 cm with bracts at or near the peduncle's tip. The blossoms are fragrant and golden,1.5 mm, 5-toothed calyx. 2.5 mm, corolla with five teeth. pubescent and cylindrical ovary. Legume is sub cylindric, straight or curved, and brown turgid, the seeds are separated from one another by a distinct pith that is 9-16 mm long, glabrous, and barely dehiscent [17].

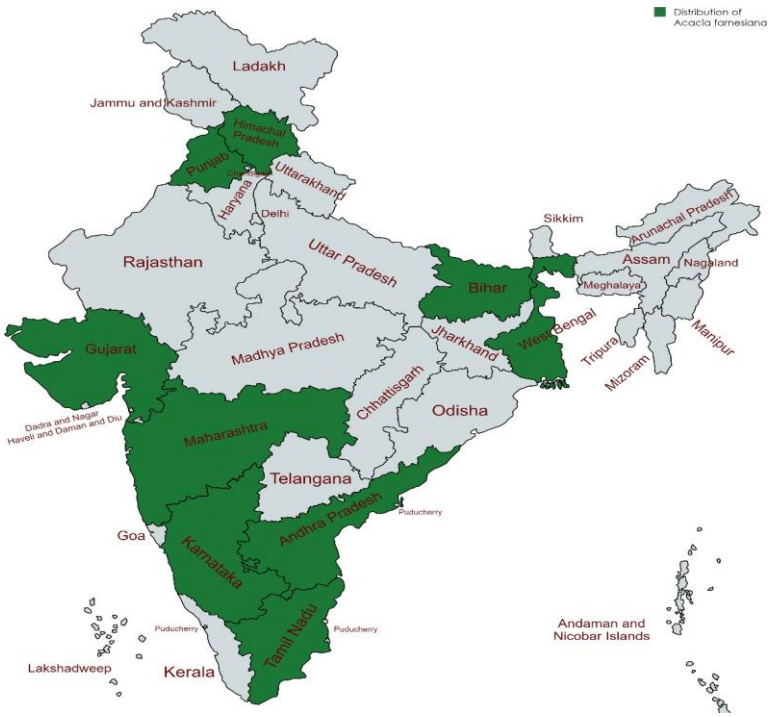

Figure 1. Geographical Distribution of *A. farnesiana* in India

Geographical Distribution

Acacia farnesiana, a thorny shrub also known by Vachellia farnesiana, is native to India and is widely distributed in Himachal Pradesh, Punjab, Gujarat, Maharashtra, Karnataka and Andra Pradesh, Bihar, West Bengal (Figure 1). The Acacia flourishes as a medicinal plant. It may also be found in the tropical regions of other nations, including Bangladesh, Sri Lanka, Pakistan, Myanmar, Andaman Islands, Nepal, and Maldives [17].

Phytochemistry

Within *Acacia farnesiana*, a captivating botanical narrative unfolds as various phytoconstituents take center stage across distinct plant parts. In the leaves and pods, a rich assembly of tannins graces the scene, encompassing compounds like caffeic acid, ferulic acid, Methyl gallate, tannic acid, pinitol, farnesol, taxifolin, ethyl gallate, m-Di gallic acid, ellagic acid and aromadendrin. Delving further, the realm of flavonoids flourishes within the fruits, pods, leaves, and bark. Genistein, rutin, (2S) naringenin 7-Oglucopyranoside (prunin, 5), Rhamnocitrin, apigenin, myricetin, quercetin, diosmetin, epicatechin, and galloyglucose intertwine to create a vibrant tapestry of chemical artistry. Across the spectrum of pods, fruits, leaves, and bark, the symphony of terpenes resonates. 4-isopropylbenzaldehyde, alpha-terpineol, benzaldehyde, geraniol, linalool, beta-ionone, alpha-ionone, Betulic acid, leucoxol, farnesirane B, leucophleol, and Acasiane A compose an olfactory masterpiece that enriches the plant's essence. The realm of amino acids finds its canvas in pods, fruits, and flowers, where isoleucine, lysine, leucine, phenylalanine, valine, glutamate, hydroxyproline, proline, serine, aspartic acid, threonine, methionine, arginine, glycine, histidine, tyrosine, and alanine come together in harmonious resonance. Roots, seeds, and pods are marked by the presence of Lipids are fats. Gamma-linolenic acid, oleic acid, palmitic acid, cis-heptadecenoic acid and cis-10 pentadecanoic acid. Classification of phytoconstituents of *Acacia farnesiana* is presented in Table 2 [17].

Table 2. Phytoconstituents of *Acacia farnesiana* along with its method of detection

S.no	Chemical class	Phytoconstituent	Plant part	Method of detection
1.	Phenolic acids (Benzoic acids)	Gallic acid	Pods	HPLC, GC-MS, UV
		Methyl gallate	Bark and Pods	_
2.	Flavanones	Naringenin (40,5,7-Trihydroxy flavanone)	Pods	IR, NMR, UV

		Naringenin-7-diglucoside (Naringin)	–	–
		Naringenin-7-O-b-D-[60-Ogalloyl]-glucopyranoside	–	–
		Kaempferol	Pods	UV, MS, NMR
		Kaempferol-7-(60-galloylglucoside)	Flower	ESI-MS, NMR
		Kaempferol-7-diglucoside	Pods	HPLC, MS, NMR, UV
		Myricetin-7-O-b-(60-galloylglucopyranoside)	Pods	ESI-MS, NMR
		Quercetin-7-O-b-(60-galloylglucopyranoside)	Pods	ESI-MS, NMR
		Quercetin-3-O-rutinoside (Rutin)	Leaf	HPLC, NMR
		Vicenin [Apigenin-6,8-bis-C-b-Dglucopyranoside]	Aerial parts	PMR
		Aromadendrin	Pods	UV
3.	Fatty acids	Coronaric acid	_	_
		Linoleic acid	_	_
		Linolenic acid	Seed	IR

Reported Pharmacological Activities

Anti-cytotoxic activity

Lin et al., (2009) conducted an in-vitro study to assess the anti- cytotoxic activity of *Acacia farnesiana* on human cancer cell lines namely (Ca9-22, A549, MCF-7, MDA- MB-231, Hep 3B and Hep G2) using MTT method. It was found that four new diterpenes (Farnesirane B, Farnesirane A, Acasiane A and Acasiane B) were isolated from roots of *Acacia farnesiana* that displayed promising anti- cytotoxic effect against cancer cell lines. Flavonoids present in Acacia such as 3′,4′,5-trihydroxy-7- methoxyflavone and diosmetin mildly reduced mildly reduced the production of superoxide anion or the release of elastase by human neutrophils, suggesting modest anti-inflammatory effects [18].

Ramli et al., (2011): conducted a study to evaluate anti-bacterial and anti-oxidant activity of ethanolic extract of *Acacia farnesiana* leaves. The antioxidant activity was assessed based on

iron chelation, reducing power, and scavenging of DPPH radicals and nitric oxide. The ethanolic extract of A. farnesiana exhibited concentration-dependent responses in all antioxidant assays. Using a broth microdilution assay, the extract showed MIC values of 0.8 mg/mL against *Bacillus subtilis* and 2.5 mg/mL against *Saccharomyces cerevisiae*, with no cytotoxicity observed in the brine shrimp lethality test. Total phenolic content quantified by the Folin-Ciocalteu method was 209.78 ± 3.21 mg gallic acid/g extract. HPLC-PDA and LC/MS analyses identified flavonoid galloylglycosides and flavonoid glycosides, with quercetin deoxyhexoside tentatively identified as the major constituent. The extraction method likely influenced the constituents, contributing to the antioxidant and antibacterial activities observed [19].

Anti-hyperglycemic activity

Kingsley et al., (2014): conducted a study on Wistar rats to evaluate the anti- hyperglycaemic activity of various extracts of *Acacia farnesiana* using a glucose tolerance test as well as isolate an active fraction (AF) from the effective extract through alcohol precipitation and delve into the mechanism of action of the active fraction of the plant. It was discovered that water extract of aerial parts of the plant at a dose of 50 mg/kg demonstrated significant glucose- lowering activity at 30 and 90 minutes after glucose loading in normal fed rats. In contrast, the alcohol and hexane extracts showed minimal activity. The alcohol precipitation of the water extract yielded approximately 48% precipitate and 52% soluble fractions. The soluble fraction exhibited significant glucose-lowering activity in normal glucose-loaded rats at a dose of 25 mg/kg, while the precipitate fraction showed no such activity Under tissue culture conditions, AF treatment at a concentration of 40 µg/ml increased glucose uptake in the isolated rat hemidiaphragm. In this in-vitro setup, insulin (0.1 IU/ml) also enhanced glucose uptake by the hemidiaphragm. When both the herbal drug (20 µg/ml) and insulin (0.1 IU/ml) were administered together, the effect of insulin on glucose uptake was largely observed [20].

Puga et al., (2015): conducted a study to assess the antioxidant activity as well as protection against oxidative-induced damage of crude extract from the pods of *Acacia farnesiana*. For evaluation of the above activity the pod extract was challenged against hydrogen peroxide utilizing kidney cells (in-vitro) and Mongolian Gerbils (*Meriones Unguiculatus*) were employed to observe the extract's radical scavenging ability. The pod extract exhibited significant protective effects on radical scavenging capacity against DPPH+ and ABTS•+ and inhibited TBARS formation in vitro. The vegetal pod extract did not produce any pro-oxidative effect when introduced to kidney cells in DMEM. Cell damage in DMEM with added $H_2 O_2$ was significantly higher than in samples with vegetal pod extracts at 50 ppm (P

< 0.05) or 200 ppm (P < 0.001) respectively. Plasma scavenging properties showed a notable dose-dependent positive effect in the groups administered with Acacia pod extract [21].

Anti- inflammatory and Analgesic activity

Lael et al., (2016): conducted a study on Wistar rats and Swiss mice to evaluate anti-inflammatory as well as analgesic activities of proteins extracted from seeds of *Acacia farnesiana.* Five different protein fractions namely prolamin, albumin, globulin, acidic as well as basic glutelins were isolated and analysed for their protein profiles, as well as hemagglutinating and proteolytic activities. The globulin fraction (GLB) was specifically tested for its anti-inflammatory and analgesic properties. Globulins significantly reduced carrageenan-induced paw edema in a dose-dependent manner, accompanied by a decrease in myeloperoxidase activity ($p < 0.05$). Additionally, GLB decreased carrageenan-induced neutrophil peritoneal migration. However, GLB was ineffective in inhibiting dextran-induced edema. Pre-treatment with globulins significantly reduced acetic acid-induced abdominal constrictions and decreased the paw licking time in the first phase of the formalin test by 69.1%. However, GLB did not exhibit a significant antinociceptive effect in the hot plate test (55-56 °C). Heat treatment of GLB (at 100 °C for 30 minutes) eliminated its anti-edematogenic and hemagglutinating activities. These findings suggested that seeds from A. farnesiana are a potential source of proteins with anti-inflammatory and analgesic properties [22].

Anti-tubercular and anti-dysentery activity

Garcia et al., (2019): conducted a study to identify various compounds from chloroformic, methanolic as well as hexanic extracts obtained from fruits of *Acacia farnesiana* in order to test the activity of these extracts against dysentery and *Mycobacterium tuberculosis* bacteria. It was discovered that compounds such as (3β,22E)-estigmasta-5,22-dien-3-yl β-D-glucopyranoside and tetracosanoic acid(2S)-2,3- dihydroxypropyl ester were isolated as well as characterized from both chloroform and hexane extract. Methanolic extract revealed compounds such as gallic acid, methyl gallate, (3β,22E)-estigmasta-5,22-dien-3-yl β-D-glucopyranoside, (2S) naringenin 7-O- βglucopyranoside (prunin), sucrose and pinitol respectively. These extracts demonstrated antidysentery and antitubercular effects at MIC 100-200 µg/mL respectively. Methyl gallate and its acetylated derivative demonstrated activity against the M. tuberculosis H37Rv strain, with MIC values of 50 and 25 µg/mL, respectively. The flavanone prunin was effective against multidrug-resistant M. tuberculosis G122 with an MIC of 50 µg/mL. Additionally, methyl gallate, gallic acid, and prunin exhibited activity against C. jejuni, each with an MIC of 50 µg/mL [23].

Anti-diarrhoeal activity

Hasib et al., (2020) conducted a study to evaluate anti-diarrhoeal, anti- oxidative and analgesic activity of methanolic extract of *Acacia farnesiana*. The different fractionalities of the extract were subjected to in-vitro assay for assessing its TPC values and antioxidant capacity. The ethyl acetate soluble fraction (EASF) demonstrated the highest free radical scavenging capacity, with an IC50 value of 21.49 ± 1.04 µg/ml, compared to the standard butylated hydroxytoluene (BHT), which had an IC50 value of 20.41 ± 0.05 µg/ml. This notable antioxidative potential was further supported by a phenolic content of 39.26 ± 0.85 mg of gallic acid equivalent per gram of extract. At a dose of 400 mg/kg body weight, the plant extract significantly reduced castor oil-induced diarrhoea in a mouse model by 47.62% ($p < 0.05$), while the standard loperamide achieved a 66.67% reduction in diarrheal feces. The central and peripheral analgesic activities of the crude methanol extract of V. farnesiana (MEVF) were assessed using the tail flick and acetic acid-induced writhing methods, respectively, in Swiss albino mice. In the tail flick method, oral administration of MEVF at doses of 200 and 400 mg/kg body weight resulted in a 221.09% and 237.09% increase in pain response time, respectively, after 90 minutes, whereas the standard morphine induced a 518.34% increase within the same period. Additionally, these doses of the extract produced 63.27% and 69.39% reductions, respectively, in acetic acid-induced abdominal constrictions in mice. Compared to the standard acetylsalicylic acid, which showed a 75.51% inhibition, the extract's peripheral analgesic activity was also statistically significant ($p < 0.05$). These findings suggest that the methanol extract of V. farnesiana has anti-diarrhoeal, anti- oxidative as well as analgesic properties [24].

Anti-helminthic activity

Olmedo et al., (2020) conducted an in-vivo study to isolate and identify the chemical compounds from an organic fraction (EtOAc-F) of hydroalcoholic extract of *Acacia farnesiana* pods to assess its anthelmintic activity against infective larvae and eggs of parasite *Haemonchus contortus*. Twenty-one crossbred female lambs, known as "Katahdin," with body weights of 21.9 ± 0.39 kg and an age range of three to four months, were utilised. H. contortus (L3) was given to the animals orally at a single administration of 350 L3/kg BW. It was discovered that EtOAc-F caused a total reduction (67.7%) of faecal egg count (FEC) of the parasite as compared to Albendazole that was used as standard treatment. The phytochemical investigation identified flavonoids and derivatives of galloyl as the main constituents. The pods of A. farnesiana may act as an effective anthelmintic to suppress H. contortus and possibly other parasites that are significant to veterinarians [25].

Saleema et al., (2022): conducted an in-vitro study to access the anti-microbial activity of *Acacia farnesiana* ethanolic crude extract. It was discovered that two compounds namely O-

galloyl-D-glucopyranose as well as 5, 6, 3', 5' tetrahydroxy 7,8, 4' trimethoxy flavones were isolated and identified with the help of bioassay-guided fractionation of ethanolic extract. These compounds were tested against both Gram-positive (*Staphylococcus aureus* and *Bacillus cereus*) as well as Gram-negative bacteria (*E-coli*) and showed anti-microbial activity against most of the strains, especially with Gram- negative bacteria being more resistant. Acacia farnesiana extract inhibited the growth of B. cereus, S. aureus, and E. coli at a concentration of 125 µg/mL, producing inhibition zones of 10.5 mm, 7.2 mm, and 12.8 mm, respectively. These findings suggest that Acacia farnesiana could serve as effective natural alternatives for controlling food poisoning bacteria and as sources of food preservatives [26].

Anti-viral activity

Chandrashekar et al., (2022) conducted an *in-silico* study to evaluate the effect of *Acacia farnesiana* phytochemicals on coronavirus spike protein. Twelve Acacia farnesiana phytochemicals have been chosen as small molecules for this study based on their ACEI and anti-inflammatory properties. The purpose of the selection process is to assess the molecular interaction between the human complex molecule and the spike protein of SARSCoV2. The following natural compounds from A. farnesiana were selected as effective against COVID-19: Quercetin, Caffeic acid, Diosmetin, myricetin, ferulic acid, ellagic acid, apigenin, naringenin, Rhamnocitrin, kaempferol, methyl gallate and gallic acid. Additional ADME analysis was performed. The outcome showed that the bound structure of ACE2 and spike protein becomes unstable because A. farnesiana contains ACEIs and anti-inflammatory phytochemicals. It is therefore possible for these natural substances to exhibit antiviral activity through the disruption of spike protein binding to the ACE2 receptor in humans [27].

Anti-oxidative activity

Deka et al., (2024): conducted an in-vitro anti-oxidant assay on ethyl acetate extract of *Acacia farnesiana* bark that revealed the anti-oxidant potential of the extract by exhibiting radical scavenging and high TPC and TFC values of 0.15 GAE/g and 0.21 GAE/G respectively. The extract at concentrations of 50, 100 as well as 150 mg/ml exhibited appreciable stabilization effects on human RBC membranes confirming its anti-inflammatory activity. The level of protection was expressed as a percentage, was significantly higher at a concentration of 150 mg/mL compared to lower concentrations. However, protection diminished at concentrations above this level [28].

CONCLUSION

Acacia farnesiana (L.) represents an important ethnomedicinal plant with significant therapeutic potential, supported by both traditional knowledge and modern scientific investigations. The

plant has been extensively used in folk and traditional medicine for treating a wide range of disorders, including infections, inflammation, gastrointestinal disturbances, metabolic disorders, and parasitic diseases. Phytochemical studies reveal a rich diversity of secondary metabolites, particularly flavonoids, phenolic compounds, tannins, terpenoids, and fatty acids, which are responsible for its multiple pharmacological effects. Experimental evidence from in vitro, in vivo, and in silico studies validates its antioxidant, antimicrobial, anti-inflammatory, antidiarrhoeal, antihyperglycaemic, anthelmintic, cytotoxic, and antiviral activities. However, despite promising preclinical findings, gaps remain regarding standardization, safety profiling, mechanism-based studies, and clinical validation. Future research should focus on isolation of lead compounds, elucidation of molecular mechanisms, toxicological assessment, and well-designed clinical studies to fully harness the medicinal potential of A. farnesiana as a safe and effective therapeutic agent.

Authors contribution

The authors confirm contribution to the paper as follows: writing original and editing: RK; writing original and editing; RNK: Supervision. All authors reviewed the results and approved the final version of the manuscript.

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***Correspondence Author:** Ram Nath Khorwal, Lords School of Sciences, Lords University, Alwar- Bhiwadi Highway, Chikani, Alwar 301028, Rajasthan