REVIEW ARTICLE

A Comprehensive Review on Phytochemical Profile of *Acacia auriculiformis*

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Abstract

Acacia auriculiformis A. Cunn. Ex Benth is a globally distributed perennial shrub known for its wide-ranging medicinal properties and therapeutic uses, with a low toxicity profile. Traditionally, it has been used to treat conditions such as rashes, rheumatism, allergies, eye irritation, and pain. Its pharmacological activities include strong antimicrobial and antioxidant effects, which help combat infections and reduce oxidative stress. The plant has shown promising antimalarial and anti-filarial activities, making it useful for treating parasitic diseases like malaria and lymphatic filariasis. Additionally, *A. auriculiformis* exhibits cytocidal and antimutagenic properties, suggesting potential for cancer prevention and treatment. It also has spermicidal, wound healing, and hepatoprotective effects, further broadening its therapeutic applications. Of particular interest is its antidiabetic activity, demonstrating potential in managing blood sugar levels and improving insulin sensitivity. These pharmacological effects are attributed to the plant's bioactive compounds, such as flavonoids and tannins. This review highlights the plant's phytochemical composition, pharmacogenetic factors, and its broad spectrum of therapeutic activities, making *A. auriculiformis* a valuable resource for both traditional and modern medicine. Ongoing research is expected to further explore its potential for treating a variety of health conditions.

Highlights:

- The medicinal applications are broad, and the plant is used for treating irritation, rashes, rheumatism, allergies, and pain relief.
- It has extensive pharmacological effects, including antimicrobial, antioxidant, antimalarial, and antidiabetic properties.
- Its phytochemical profile is rich and contains bioactive compounds with significant therapeutic potential.
- The pharmacogenetic insights explore genetic influences on the plant's efficacy and safety.
- The plant demonstrates low toxicity and high effectiveness, with minimal adverse effects while providing therapeutic benefits.

Keywords: *Acacia auriculiformis*, Pharmacology, Phytochemicals, Nutritional value.

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Introduction

The Mimosaceae family includes the rapidly spreading *Acacia auriculiformis A. Cunn*, a deciduous or evergreen tree that may grow to a height of 30 meters. It has high concentrations of methyl glucuronic acid, glucuronic acid, galactose, arabinose, and rhamnose. Because of the tannins and triterpenoid saponins present, it is said to have spermicidal, filaricidal, and central nervous system depressant properties (Srivastava and Singh, 2024; Prayogo *et al.,* 2024; Thorat and Kadre, 2024).

The Fabaceae family includes *Acacia auriculiformis (A. auriculiformis) A.Cunn. ex Benth*., a medium-sized, straight, deciduous, or evergreen tree that may grow to a height of up to 30 meters. It is typically found in India's parks and roadside areas. Acacia's common name comes from the Greek word "akis," which means "spike" or "point." In contrast, the latin word "auricula" denotes a creature's outer ear and is a specific name, whereas the word "forma" denotes a frame, figure, or shape. The tree is originally from Australia and was brought to West Bengal, India, in 1946.

The primary aim of the study was to showcase the most recent pharmacological and phytochemical studies conducted on the *A. auriculiformis* plant to date. Using the keywords "*A. auriculiformis* phytochemistry," "*A. auriculiformis* pharmacology," and "*A. auriculiformis* patents" in the SciFinder, PubMed, Scopus, and Google Scholar databases, a comprehensive and relevant literature search was performed. Results from the literature search showed papers published. Following that, specific papers on pharmacology and phytochemistry were carefully screened, chosen, and examined without regard to the chronological order to compile the current manuscript (Ge *et al.,* 2015).

The current review delves into traditional, ethnobotanical, phytochemical, pharmacological, and nutraceutical knowledge. Modern pharmacological research and the presence of several important phytochemicals back up ethnobotanical and traditional assertions. The presence of essential proteins, vitamins, amino acids, and minerals demonstrates *A. auriculiformis* importance as a nutraceutical.

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Materials and Method

Comprehensive information related to *A. auriculiformis* was collected using the keywords, botanical name of *A. auriculiformis* and common name of *A. auriculiformis* in various electronic databases like Pubmed, google Scholar, and Science Direct. Additionally, some books were also referenced.

Taxonomy

Auriculiformis is formally referred to as *A. auriculiformis A.Cunn. ex Benth.* Additional informal designations for this plant encompass papuan wattle, dal moth, earleaf acacia, auri, earpod wattle, black wattle, tan wattle, northern black wattle, and darwin black wattle. In telugu, it is known as minnumaan, kondamanu, seema babul, and maha babul; in tamil as kaththi karuvel; in kannada as aurculis; in marathi as akashia; and in Australian babool.

A. auriculiformis A. Cunn. Ex Benth, belonging to the family *fabaceae* (*Leguminosae*), is a prominent member of the plant kingdom. Classified under the domain Eukaryota and the kingdom Plantae, it falls within the subkingdom Viridiplantae and the infrakingdom streptophyta. This species is part of the phylum Spermatophyta, specifically the subphylum Angiospermae, and belongs to the class Magnoliopsida (Dicotyledonae). Within the subclass *Rosidae* and *Superorder Rosanae*, *A. auriculiformis* is situated in the order Fabales. It is categorized under the division *Tracheophyte* and subdivision *Spermatophytina*, and its genus is *Acacia Mill.*

A. auriculiformis Cunn.ex Benth., *orth. Var.*, *A. moniliformis Griseb*., and *Racosperma auriculiformae* (*A.Cunn. ex Benth*.), pedley are among the synonyms of *A. auriculiformis.*

Botanical Description

The duration of the season for flowers and fruiting for *A. auriculiformis* differs by region; in Australia, it spans from April to July. Seeds are ripe four to five months later, between August and October. Malaysia experiences floral blooms from February to may, and the harvesting season for mature produce seeds is from October to April. Java, Indonesia, experiences its flowering season from March to June, while Thailand observes the mature seed collection period from August to February. In India, *A. auriculiformis* blooms from December to January the year before and bears fruit from February to March. On the contrary, fruiting and flowering transpire in diverse regions of India between March and December, exhibiting a peak profusion during September and October. Bark, leaves, and fruits of *auriculiformis*—pods comprising seeds and funicles—are utilized in a wide range of biological processes.

In its natural habitat, *A. auriculiformis* attains a maximum height of 25 to 35 m at favorable locations, where a straight bole composes the majority of the tree's stature. Typically 8 to 20 meters in height, it is sporadically a 3 to 5 m tall shrub with a short bole that is densely branched. The bark of juvenile trees is smooth and gray or brown, with intermittent blackening at the base; as the tree matures, it becomes longitudinally fissured and rugged. Phallic-shaped, glabrous, greyish-green, and faintly textured phyllodes are observed. They lengthen to 8 to 20 cm and widen to 1.0 to 4.5 cm. In addition to minutes, densely packed secondary veins, and a specific duct located at the base of the phyllode, three prominent longitudinal veins are evident. These veins run in a parallel line towards the lower margin or in the central region, near the base. The inflorescence, which grows in pairs in the upper axils, is an axillary spike that is interrupted and can reach a maximum length of 8.5 cm.

The flowers are sessile, minute, fragrant, tubular, five-merous, and pale golden in hue. Numerous, approximately 0.3 cm long filaments adorn the corolla, which can reach a maximum length of 0.2 cm. The ovary is densely pubescent. Approximately, 0.1 cm in length, the calyx is succinctly lobed. The pods have an approximate length of 6.5 cm and a width of 1.5 cm. They are flat, flexible yet unyielding, closely curled into an open coil, glaucous, resinous to a certain degree, and veined transversely with undulating boundaries. They transform from their original straight or curved state to one of random coiling and twisting as they mature. The lustrous black seeds, which measure 0.4 to 0.6 cm in length and 0.3–0.4 cm in width, are arranged transversely within the pod. Each has an elongated, elliptical, or red, yellow, or orange funicle; the areole is substantial and nearly encased.

Botanical Features

In optimal conditions within its natural habitat, *A. auriculiformis* develops into a 25 to 35 m tall tree, with a straight bole encompassing the majority of the tree's height. It is usually an 8 to 20 m tree, although it is sometimes occasionally a 3 to 5 m shrub with a low bole and many branches. In young trees, the bark is smooth and gray or brown, with occasional blackening around the base; as the tree ages, it becomes rough and longitudinally fissured.

Inflorescences, Flowers and Fruits

The inflorescence, which grows in pairs in the upper axils, is an axillary spike that is interrupted and can reach a maximum length of 8.5 cm. The flowers are sessile, minute, fragrant, tubular, five-merous, and pale golden in hue. Numerous approximately 0.3 cm-long filaments adorn the corolla, which can reach a maximum length of 0.2 cm. The ovary is densely pubescent. Approximately 0.1 cm in length, the calyx is succinctly lobed. The pods are approximately measuring 6.5 cm in length and 1.5 cm in breadth. They are flat, flexible yet unyielding, closely curled into an open coil, glaucous, resinous to a certain degree, and veined transversely with undulating boundaries. They transform from their original straight or curved state to one of random coiling and twisting as they mature. The lustrous black seeds, which measure 0.4 to 0.6 cm in length and 0.3 to 0.4 cm in width, are arranged transversely within the pod. Each has an elongated, elliptical, or red, yellow, or orange funicle; the areole is substantial and nearly encased.

Leaves

The phyllodes are falcate, glabrous, greyish-green, and lightly textured. They lengthen to 8 to 20 cm and widen to 1.0 to 4.5 cm. In addition to several minutes, densely packed secondary veins, and a discernible duct located beneath the phyllode, three prominent longitudinal veins are apparent and run in a parallel direction towards the lower margin or in the central region, close to the base. (Ahmadu *et al.,* 2024)

Habitat and Ecology

A. auriculiformis is indigenous to Papua New Guinea, Indonesia and Australia, where it often lives on land. It is found in every state in India except for Arunachal Pradesh, Sikkim, and Jammu and Kashmir. This is due to its quick growth, drought resistance, seasonal tolerance of wet soils, and capacity to grow in poor soils.

Phytochemical Description

This section discusses the phytochemicals isolated from *A. auriculiformis* (Tables 1 and 2).

Flavonoids

Several flavonoids have been documented in extracts of *A. auriculiformis*. In the early 1960s, a unique flavan-3,4-diol was extracted from the heartwood of *A. auriculiformis* using paper iontophoresis (Tiho *et al.,* 2024). Additionally, a novel flavan glucoside known as auriculoside (I, Glc=*β*-D-glucopyranosyl) or 7,3',5'-trihydroxy-4'-methoxyflavan 3'-glucoside, was isolated and demonstrated 80 % CNS depressive activity (Singh, 2024; Ogunniyi *et al.,* 2023). The bark of *A. auriculiformis* contains quercetin [2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxy-4*H*-chromen-4-one] and epicatechin [(2R,3R)-2-(3,4-

Table 1: Showing phytochemicals isolated from *A. auriculiformis* in *In-vitro* studies

S. No.	*Part used*	*Extract/Phytoconstituent*	*Dose tested*	*Reference*
1	Heartwood	Isolated compounds (3,4',7,8-tetrahydroxyflavanone, 4',7,8-trihydroxyflavanone, Teracacidin), methanol, diethyl ether, ethyl acetate, n-butanol extracts.	0.1, 1.0, and 10.0 mg/ml	(Rangra *et al.,* 2019)
2	Bark powder	Ethyl acetate, methanol, acetone, water extract/fractions, crude extract	10-150 µg/mL, 10-700 µg/ml, 1-100 µg/ml	(Singh *et al.,* 2007, Singh *et al.,* 2007, Singh *et al.,* 2007)
3	Leaves and flowers	Ethanolic extract	1 mL of 1 mg/mL	(Chew *et al.,* 2011)
4	Bark and empty pods	Petroleum ether and acetone extracts	0.1 mL of 1 mg/mL	(Sathya and Siddhuraju, 2013)
5	Leaves and bark	Ethyl acetate, methanol, and n-hexane extract	1.75, 7.80, 7.95 µg/mL	(Urmi *et al.,* 2013)
6	Bark	Ethanolic extract	900 µg/mL	(Sravanthi *et al.,* 2014)
7	Seed	Raw, dry heated and pressure cooked extracts	1 mg/mL	(Loganayaki *et al.,* 2011)
8	Fruit	Methanolic extracts	1 mg/mL	(Prakash *et al.,* 2011)
9	Leaves	Water, chloroform, petroleum ether, ethyl acetate and ethanolic extracts	25, 50, 75, 100, 125, 150 µg/mL	(Kumar *et al.,* 2017)

Table 2: Phytoconstituents found in *A. auriculiformis*

S. No.	*Part Used*	*Extract/Phytoconstituent*	*Dose Tested*	*Reference*
1	Heartwood	Isolated compounds (3,4',7,8-tetrahydroxyflavanone, 4',7,8-trihydroxyflavanone, Teracacidin), methanol, diethyl ether, ethyl acetate, n-butanol extracts.	0.1, 1.0, and 10.0 mg/ml	(Samanta *et al.,* 2019)
2	Bark powder	Ethyl acetate, methanol, acetone, water extract/fractions, crude extract	10-150 µg/mL, 10-700 µg/ml, 1-100 µg/ml	(Singh *et al.,* 2007)
3	Leaves and flowers	Ethanolic extract	1 mL of 1 mg/mL	(Chew *et al.,* 2011)
4	Bark and empty pods	Petroleum ether and acetone extracts	0.1 mL of 1 mg/mL	(Sathya and Siddhuraju, 2012)
5	Leaves and bark	Ethyl acetate, methanol, and n-hexane extract	1.75, 7.80, 7.95 µg/mL	(Urmi *et al.,* 2013)
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7	Seed	Raw, dry heated and pressure cooked extracts	1 mg/mL	(Loganayaki *et al.,* 2011)
8	Fruit	Methanolic extracts	1 mg/mL	(Prakash *et al.,* 2011)
9	Leaves	Water, chloroform, petroleum ether, ethyl acetate and ethanolic extracts	25, 50, 75, 100, 125, 150 µg/mL	(Kumar *et al.,* 2017)

dihydroxyphenyl)-3,4-dihydro-2*H*-chromene-3,5,7-triol] (Kaur *et al.,* 2014). Furthermore, two novel glycosides, proacaciaside I and proacaciaside II, with anti-filarial properties, were identified in the fruits of *A. auriculiformis* (Sharma *et al.,* 2024).

Saponins

A. auriculiformis contains a variety of saponins with notable biological activities. A novel triterpenoid trisaccharide, acacic acid lactone-3-*o*-*β*-D-glucopyranosyl (1→6)- [*α*-L-arabinopyranosyl (1→2)]-*β*-D-glucopyranoside, was identified in its extracts. Additionally, acaciaside A and acaciaside B, both featuring the aglycon acacic acid lactone, were found to have sperm-immobilizing activity (Risnasari *et al*., 2024). The aqueous ethyl alcohol extract of the legumes revealed another novel triterpenoid saponin, 3-*o*- [*β*-D-xylopyranosyl (1→3)-*β*-D-xylopyranosyl (1→4)-*α*-L-rhamnopyranosyl (1→2)]-[*α*-L-rhamnopyranosyl (1→4)]-*β*-D-glucopyranosyl}-3,16,21-trihydroxyolean-12-en-28-oic acid (Hagaggi *et al*., 2024). From the fruits, new saponins like proacaciaside-I, proacaciaside-II, and acaciaside C were isolated and shown to have anti-filarial activity (GC, 2024). Additionally, a novel triterpenoid saponin and corosolic acid were extracted from the stem (Asati & Yadava, 2014; Chute *et al.,* 2024).

Carbohydrates

Carbohydrates such as methyl glucuronic acid, glucuronic acid, galactose, L-rhamnose, and arabinose are present on the *A. auriculiformis* tree. Hydrolysis of an acidic polysaccharide extracted from defatted *A. auriculiformis* seeds yielded the following compounds: D-arabinose, D-xylose, D-galactose, D-glucose, and D-glucuronic acid.

Tannins

About 12 to 16% tannins were found in the bark of *A auriculoformis*. Content is found to be higher in younger tries.

Anthocyanidins

Leucodelphinidins and leucocyanidins, presence in the bark of *A. auriculiformis,* exhibit a crimson pigmentation upon light exposure (Telrandhe *et al.,* 2023).

Pharmacological Profile

Antioxidant activity

The antioxidant activity of *Acacia mangium* and *A. auriculiformis* was assessed using the DPPH radical scavenging method, revealing similar antioxidant potentials (Mihara *et al.,* 2005). In *A. auriculiformis* bark extracts, the ethyl acetate water fraction exhibited significant inhibition in DPPH scavenging (71.2%), chelating power (73.66%), lipid peroxidation (83.37%), and deoxyribose scavenging (75.63%) at 10 to 150 µg/mL. The acetone extract showed up to 91.7% inhibition in the deoxyribose assay and significant activity in other tests at concentrations of 10 to 700 µg/mL. Fractionation improved scavenging activity compared to the crude extracts. The ethyl acetate and water fractions showed better results in the DPPH test (72.0%) and hydroxyl radical scavenging (site-specific 88.0%, non-site-specific 93.6%) at 1 to 100 µg/mL (Singh *et al.,* 2007). Phenolics from *A. auriculiformis* bark and empty pods also demonstrated potential for antioxidant and nutraceutical applications (Sathya & Siddhuraju, 2013).

Antifungal

Acacisides A and B, acylated bisglycoside saponins isolated from the funicles of *A. auriculiformis*, have shown antifungal activity against *Aspergillus Ochraceous* and *Curvularia lunata* at concentrations of 300 µg/mL or less (Mandal *et al.,* 2005). A comparative study of heartwood extracts revealed that *A. auriculiformis* exhibited superior antifungal activity compared to *A. mangium*. Both species contain 3,4′,7,8-tetrahydroxyflavanone and teracacidin, but *A. auriculiformis* has 3.5-fold higher 3,4′,7,8-tetrahydroxyflavanone and 43-fold higher teracacidin levels. This higher flavonoid content may contribute to better heartrot resistance. Additionally, *A. auriculiformis* demonstrated increased DPPH radical scavenging activity and laccase inhibition, suggesting that its antifungal properties may involve neutralizing free radicals produced by fungal laccase (Mihara *et al.,* 2005).

Antimicrobial

Acacisides A and B, acylated bis glycoside saponins from *A. auriculiformis* funicles, exhibited moderate antibacterial activity, inhibiting *Bacillus megaterium*, *Salmonella typhimurium*, and *Pseudomonas aeruginosa* at concentrations of 700 µg/mL or higher. Ethanolic extracts of *A. auriculiformis* flowers and leaves showed moderate antimicrobial activity against eight bacterial species, including four gram-negative (e.g., *E. coli, Klebsiella pneumoniae*) and four gram-positive bacteria (e.g., *Bacillus cereus*, *S. aureus*). The extracts were more effective against gram-positive bacteria, likely due to the outer membrane barrier in gram-negative bacteria (Chew *et al.,* 2011).

Significant antibacterial activity was noted in ethanolic bark extracts against *S. aureus*, *P. aeruginosa*, and *Bacillus subtilis*, with the highest activity against *P. aeruginosa* (19.54 ± 0.40 mm) and antifungal activity against *Aspergillus niger* (20.62 ± 0.17 mm) at 100 mg/mL (Sravanthi *et al*., 2014). Methanolic leaf extracts were effective against both Gram-positive (*S. aureus, Streptococcus pyogenes*) and Gram-negative bacteria (*E. coli*) at 2 and 6 mg/mL (Pennacchio *et al.,* 2005).

Hydroalcoholic root and bark extracts demonstrated growth inhibition of *B. subtilis* and *Proteus mirabilis* at 5 to 10 mg/mL, with *S. aureus* showing the most significant antimicrobial activity at 1 to 1.40 mg/mL. However, *E. coli* and fungal strains were not inhibited (Ogunbite *et al.,* 2023). The minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) of 3.13 and 6.25 mg/mL, respectively, were required to inhibit and eliminate Xoo cells.

According to the MIC index (Table 3), AAEA had bactericidal and bacteriostatic actions on Xoo. The color appearance of the well contents determined the inhibition of Xoo in the microdilution procedure. It was caused by the color shifts caused by the TTC solution. In contrast to the absence of color change in wells lacking viable bacterial cells, those containing such cells produced red formazan (Emmanuel *et al.,* 2014).

The quantification of botanical constituents present in both Acacia extracts in varying amounts was achieved via GC-MS analysis of the active chemical constituents AAEA and AMMH. Leaf extracts of AAEA contained a greater quantity

Table 3: M-I-C, M-B-C and M-I-C index of Acacia spp. leaves extracts against X. oryzae pv. Oryzae

Extracts	*Concentrations (mg/mL) Index*		*Index*
	M-I-C	M-B-C	M-I-C
AAEA	3.13	6.25	2

AAEA = *A. auriculiformis* ethyl acetate leaf extract

of compounds than those of AMMH. This may be the result of the polarity characteristics that each Acacia leaf extract acquires during the extraction procedure. It has been observed that methanol extracts only polar compounds, resulting in the destruction of fewer plants than ethyl acetate. The leaf preparations of both AAEA and AMMH contained an assortment of active chemicals that have been identified and documented in other plant extracts. These chemical constituents may have supplemented the antibacterial activity of both leaf extracts against Xoo.

Cestocidal

Auriculiformis funicles extracted with ethanol demonstrated cestocidal activity. A single cysticercoid of *Hymenolepis diminuta* was given orally to two groups of ten rodents each. On the twentieth day, one group received 250 mg/kg/day of saponins, and the other received 300 mg/kg/day of ethanolic extract. The mature worms were expelled after 5 days of ethanolic extract treatment and 3 days of saponin treatment (Tiwari *et al.,* 2023).

Antifilarial

Triterpenoidal saponins acaciaside A and B, derived from the funicles of *A. auriculiformis*, demonstrated an *in-vitro* lethality of 97 % for microfilaria of Setaria cervi within a time span of 100 min at a concentration of 4 mg/ml. Furthermore, adults were eradicated in 35 min. Following the preliminary stage of treatment, adult rats that were intraperitoneally implanted with *Setaria cervi* exhibited a 1.5-fold increase in blood microfilaria count following ten days of 100 mg/kg of the medication should be administered orally. Following the completion of the third phase of treatment, there was an observed reduction in microfilaria density exceeding 80%. The administration of saponins to rodents resulted in no adverse effects. The increased microfilaria counts suggested that the medication caused substantial physiological stress in the fully developed worms, which led to an increased rate of microfilaria expulsion before they ultimately perished. Upon inspection, no adult nematodes were detected.

Spermicidal

In-vitro studies demonstrated that the isolated triterpenoidal saponins, acaciasides A and B, derived from *A. auriculiformis*, effectively immobilize sperm at a concentration of 0.35 mg/mL, surpassing the efficacy of the standard Triton X-100 (Ochoa-Negrete *et al.,* 2024). A fraction enriched with acaciaside B from *A. auriculiformis* seeds exhibited sperm immobilization activity at a minimum effective concentration (MEC) of 120 µg/mL and had an EC_{50} value of 35.20 µg/mL. The fraction did not induce mutagenic effects in vaginal microbiota, primarily consisting of *Lactobacillus acidophilus*, even at 10MEC. Ames tests on Salmonella typhimurium strains TA 97a, 98, 100, and 102 showed no carcinogenic potential, indicating a lack of mutagenic effects (Pal *et al.,* 2009).

Wound healing

An ointment made from ethanolic and aqueous bark extracts of *A. auriculiformis* demonstrated wound healing benefits in Swiss albino rats with excision and incision wound models. Histopathological and hydroxyproline content analyses revealed that the ethanolic bark extract ointment was more effective than the aqueous extract. It notably reduced the epithelialization period, enhanced wound contraction rate, and improved hydroxyproline content, tensile strength, granulation tissue, and fiber formation. The healing activity was attributed to the presence of phytoconstituents such as flavonoids, tannins, and phenolic compounds (Singh & Sharma, 2014).

Hepatoprotective

The hepatoprotective properties of bark and pod extracts of *A. auriculiformis* were evaluated concerning paracetamol-induced liver injury. Biochemical indicators of liver function, such as total bilirubin, total protein, alanine transaminase, and aspartate aminotransferase, were measured in the serum of the experimental animals. A comparison was made between the evaluation parameters of the examined extract and those of the standard medication, silymarin. Bark and pod extracts of *A. auriculiformis* were found to be viable treatment options for liver damage, according to the findings (Sathya and Siddhuraju, 2012).

Antidiabetic

Previous studies have demonstrated that phenolic compounds obtained from the empty pods and bark of *A. auriculiformis* exhibit antioxidant, bimolecular protective, and antidiabetic characteristics. Bark and empty pods may both be suitable for the formulation of antioxidant/nutraceutical supplements and antidiabetic agents, according to the findings (Sathya and Siddhuraju, 2012). It was discovered that extracts of the bark and empty pods of *A. auriculiformis* exhibited a protective effect against type II diabetes induced by alloxan. This suggests that these extracts may possess therapeutic potential for diabetes.

CNS depressant

The butanol extract fraction of aerial portions of *A. auriculiformis* demonstrated CNS depressing effects in a barbiturate potentiation test on mice. The butanol fraction was then separated into soluble and insoluble ethyl acetate fractions. The soluble part of ethyl acetate contained a phytoconstituent known as auriculoside, which was responsible for 80% of the CNS depressive effect (Malavika and Thenmozhi, 2023).

Larvicidal

The larvicidal activity of *A. auriculiformis* leaf extracts was tested in various solvents, including water, chloroform, petroleum ether, ethyl acetate, and ethanol, against *Aedes albopictus* and *Culex quinquefasciatus*. The ethanolic extract showed a dose-dependent inhibitory effect on both larval species. The LC_{50} values were 6.1 µg/mL for *C. quinquefasciatus* and 4.2 µg/mL for *A. albopictus*. The LC_{90} values were 8.5 µg/mL for *C. quinquefasciatus* and 9.42 µg/mL for *A. albopictus* (Kumar *et al.*, 2017) (Table 4).

Table 4: Biologically active compounds found in *A. auriculiformis* ethyl acetate leaf extract

Extracts	*Compounds*	*Biological activities*	*References*
AAEA (A. auriculiformis ethyl acetate)	Propanoic acid, ethyl ester	Antimicrobial & antifungal	(Bukvicki et al., 2014, Rujjanawate et al., 2016)
	2,3-Butanediol	Induce plant defenses; growth promotion, salt tolerance, drought tolerance, enhance disease resistance & induced systemic resistance	(Yi et al., 2016, Kanchiswamy et al., 2015)
	1,2-Ethanediol, monoacetate	Stimulant, antiseptic, carminative, Dysentery & digestive	(Petrovska, 2012)
	1-Acetoxy-2-propanol	Antimicrobial	(Aldunate et al., 2015)
	1,2-Ethanediol, diacetate	Antimicrobial & antibacterial	(Samanta et al., 2019, Ge et al., 2015)
	Benzyl alcohol	Antimicrobial & free radical scavenging	(Shanmugam et al., 2016)
	1,2,3-Propanetriol, 1-acetate	Antibacterial & antimicrobial	(Haroun et al., 2014, Song et al., 2017)
	1-Tridecene	Antibacterial, free radical scavenging & antimicrobial	(Jerbi et al., 2016, Granados-Chinchilla et al., 2016)
	Ketone, methyl 2-methyl-1,3-oxothiolan-2-yl	Antifungal	(Salem et al., 2016)
	Resorcinol	Antimicrobial; antioxidant, Antibacterial & anticancer	(Tamura et al., 2013, Kantar et al., 2015)
	n-Pentadecanol	Antibacterial & antibiofilm	(Muthuraj et al., 2015, Everlyne et al., 2016)
	Phenol, 2,4-bis(1,1-dimethylethyl)	Inhibit quorum sensing; antifungal	(Padmavathi et al., 2014, Rangel-Sanchez et al., 2014)
	3-Buten-2-one, 4-(4-hydroxy2,2,6-trimethyl-7-oxabicyclo[4.1.0]hept-1-yl)-	Antimicrobial, anticancer, Antioxidant & antibacterial	(Ahamath and Sirajudeen, 2014, Madkour et al., 2017)
	Pentadecanal	Antimicrobial; antibacterial, & antioxidant	(Owolabi et al., 2013, Lauk et al., 2015)
	Octacosanol	Antimicrobial & anti-inflammation	(Zeng et al., 2016, Guo et al., 2017)
	2-Cyclohexen-1-one, 4-hydroxy3,5,5-trimethyl-4-(3-oxo-1-butenyl)	Antifungal & antibiofilm	(Kanagarajan et al., 2016, Jain et al., 2017)
	Neophytadiene	Antimicrobial & antibacterial	(Ceyhan-Guvensen and Keskin, 2016, Wei et al., 2016)
	Palmitic acid	Antibacterial; antioxidant, Anticholinesterase & antimicrobial	(Ertas et al., 2016, Ivanova et al., 2017)
	Phytol isomer	Antibacterial & trematocidal	(Devi et al., 2016, Agarwal et al., 2017)
	E,E,Z-1,3,12-Nonadecatriene5,14-diol	Antifungal & antibacterial	(Zhang et al., 2016, Parveen et al., 2017)
	Phthalic acid, di(6-methylhept-2-yl) ester	Antioxidant	(Sharma and Cannoo, 2016)
	Supraene	Antioxidant, antibacterial, antitumor, pesticide & immunostimulent	(Nivetha and Prasanna, 2016)

Solanesol	Anti-inflammation, anti-ulcer, antioxidant & antibacterial	(Hu et al., 2016)
2,6,10,14,18,22-Tetracosahexaene, 2,6,10,15,19,23-hexamethyl	Antibacterial; antioxidant, & antiinflammatory	(Channabasava et al., 2015, Peng et al., 2017)
Triacontyl acetate .gamma.-Tocopherol	Antioxidant, antibacterial; anticancer, anti-inflammatory & cardioprotective	(Padey and Gupta, 2014, Pandey et al., 2014)
Farnesyl bromide	Anti-malarial & antimicrobial	(Kraus et al., 2013, Eaton et al., 2016)
Vitamin E	Antioxidant, antimicrobial & antiinflammatory	(Compoccia et al., 2014)
Stigmasta-7,16-dien-3-ol, (3.beta.,5.alpha.)-	Insecticidal	(Jung et al., 2016)
beta.-Amyrin	Antioxidant, antibacterial; Antimicrobial & antimutagenicity	(Verma and Gupta, 2015, Lima et al., 2016)
Lup-20(29)-en-3-one	Therapeutic agent for Hypopigmentation & antifungal	(Villareal et al., 2013), Rodriguez et al., 2015)
Methyl commate b	Antimicrobial, anti-inflammatory & antifungal	(Freires et al., 2016, Fatima et al., 2017)
dl-.alpha.-Tocopherol	Antioxidant; radical scavenger & anti-tumor	(Narayanan et al., 2016, Sivakumar and Gayathri, 2015)

Table 5: Ayurvedic formulations of the plant with their uses

Formulation	*Uses*
Dasanakanti churnam	For the purpose of fortifying the gums and teeth, this herbal dental powder is utilized.
Trayodashang guggulu	A lock jaw, sciatica, low back pain, and arthritis are all treated with this ayurvedic tablet.
Pepcer capsule	Peptic ulcer, gastritis, and heartburn are conditions that can be treated with this capsule.
Khadiradi gutika	A decoction derived from the bark of the babbula plant is employed to bind the granules utilized in the formulation of khadiradi tablets, a respiratory remedy.

Table 6: Physiochemical analysis of *A. auriculiformis*

Parameters	*Results*
Specific gravity @20°C	1.02 gm/cm^3
pH (direct) @20°C	4.8
Solubility in water	SOLUBLE
Solubility in alcohol	NLT 70% Conforms
Dry residue	NMT – 0.1 %
Active content	Presences of tannins Conforms
Physical appearance	Liquid Solution like water Conforms
Colour	Brownish Conforms
Solubility	Soluble in alcohol. Insoluble in fixed oils.
Heavy metal tests, mg/dm^3	
Lead-Pb	-
Cadmium-CD	-
Copper- Cu	-
Arsenic-As	-
Mercury- Hg	-
Microbiological tests	
Total heterotrophic germs, mould &fungi content	<100 nCfu/gm
Pathogeneous & germs of: Staphylococcus	-
Aureus; Pseudomonas, Aeruginosa, E. Coli	-

Ayurvedic formulations

A. auriculiformis has been widely used in Ayurveda since ancient times and many formulations are available in the market given in table 5.

Physiochemical profile

Pharmacological examinations were done on liquid extract of *A. auriculoformis* by super critical fluid extraction method. The following findings were recorded in table 6.

Ethnobotany

The Aboriginal people of Australia employ the *Auriculiformis* tree as a traditional remedy for an extensive array of ailments. An infusion of the bark is said to remedy rheumatism, while a decoction of the root is utilized to soothe painful eyes, according to an Australian aboriginal custom (Girijashankar,

2011). Furthermore, the tree's seeds are used in the treatment of dermatological conditions like pruritus, dermatitis, and allergies. The Ibibio people, who inhabit the Niger Delta region of Nigeria, utilize this specific plant for medicinal purposes against malaria (Okokon, 2010). Phytoconstituents and plant extracts of *A. auriculiformis* have demonstrated therapeutic properties against a range of conditions, including rheumatism, pain, conjunctivitis, anthelmintic effects, HIV infection, and microbiological infections (Shafiei *et al*., 2017).

Teracacidin was isolated from the methanol extract of *A. auriculiformis* due to its significantly higher concentration compared to the extract of *Acacia mangium*. After undergoing dissolution in a separatory funnel containing 300 ml of ethyl acetate, 3 g of fraction A-A was extracted using 3,200 mL of water.

An analysis of contrastive antifungal power. Antifungal activity was significantly observed in the methanol extracts obtained from *A. auriculiformis* when compared to the growth of *P. noxius* and *P. badius*. *P. badius* growth was marginally inhibited by *A. mangium* extracts, in contrast to *A. auriculiformis*, whereas *P. noxius* growth remained unaffected.

Clinical and pharmacological studies done on M. esculenta

A technique for *in-vitro* brine shrimp lethality test for MEAA. *In-vitro* anthelmintic activity against Tubifex, the worm. The worms (*Tubifex tubifex*) were obtained from a Chittagong-based aquarium retailer. Their average length was 2.5 to 25%. MEAA was introduced into the experimental groups in increments of 5, 8, and 10 mg/mL. In contrast to the control group, which was administered distilled water, the standard group was treated with levamisole at a 1-mg/mL concentration. A total of five groups were allocated to five petri dishes, and ten worms were arbitrarily selected for each dish. A volume of 3 mL of the solution was introduced into each allocated group. Following this, the nematodes' "time of immobilization" and "time of mortality" were meticulously monitored and documented. A stage during which the worms remained immobile but continued to convulse violently was referred to as the "time of paralysis," while a stage during which they completely ceased all movement was termed the "time of death." Three experiments were performed (Adnan *et al.,* 2019).

A *Xanthomonas oryzae* pv. *oryzae* (Xoo) isolate was cultured for 48 hours at 30°C on peptone sucrose agar (PSA) (Beric *et al.,* 2012). By employing two-fold dilution procedures, the necessary solvents were used to dilute a stock solution of the extracted substance. Separate solutions of 50, 25, 100, and 200 mg/mL were prepared and subsequently stored in screw-cap containers bearing immaculate labels. Using a glass rod, the Xoo culture that had been aged for two days was separated from the PSA by vortexing in 10 mL of sterile distilled water (SDW). For typical Xoo solutions, the optical density (OD) value was established at 0.1 O. D600 utilizing a microplate spectrophotometer. At 40 °C (Wanhkangwan *et al.,* 2009), 35.0 L of Xoo suspensions were transferred to 0.7% soft agar (SA) using a pipette., which was subsequently positioned on top of 15 min of Mueller-Hinton agar (MHA) that had solidified. A total of six cork borer-drilled wells, each measuring 6 mm in diameter, were employed for agar extraction. In order to supplement each well, 50 L of a particular concentration of extract was added. The wells were then supplemented with the positive control (0.2 mg/mL streptomycin sulfate) and negative control (corresponding solvents). Plates were incubated at a temperature of 30°C for two days subsequent to being exposed to laminar flow for 30 minutes.

A measurement was taken of the diameter of the inhibitory zone (DIZ) that surrounded the control and treatment wells. Utilizing a ruler, the diameter in millimeters (mm) of the inhibitory zones was ascertained. In total, each experiment was conducted three times and consisted of three replications. Utilizing SAS software, a one-way ANOVA and Tukey's Honestly significant difference post hoc test was implemented to analyze the DIZ mean statistically. A comparison was made between the mean DIZ of the controls and the identical concentration in both instances.

When comparing methanol leaf extracts of *A. auriculiformis* to (AAEA) leaf extracts, it was observed that the latter exhibited the highest DIZ values at concentrations of 50, 200, and 25 mg/mL, respectively, measuring 9.89, 18.898, 28.89, and 33.33 mm. The leaf extracts of *A. auriculiformis* methanol (AAMH) demonstrated inhibition of Xoo at a concentration of 50 mg/mL. DIZ, at a concentration of 25 mg/mL, was undetectable by AAMH. Consequently, it was deduced that AAEA exhibited greater efficacy in comparison to AAMH, given that Xoo could be impeded by AAEA at a minimal concentration of 25 mg/mL (Sarah *et al.,* 2017).

The vertical expansion of the DIZ zone, produced by the combination of ethyl acetate, methanol, and Acacia extracts, was directly proportional to the extract concentration. DIZ values of 9.89, 18.898, 28.89, and 33.33 mm were observed for *A. auriculiformis* ethyl acetate (AAEA) leaf extracts at concentrations of 25, 50, 100, and 200 mg/mL, respectively, when compared to methanol leaf extracts. Xoo was inhibited by leaf extracts of *A. auriculiformis* methanol (AAMH) at a concentration of 50 mg/mL. AAMH did not detect DIZ at a concentration of 25 mg/mL. Consequently, the determination was made that AAEA exhibited greater efficacy in comparison to AAMH, given that AAEA could impede Xoo at a minimal concentration of 25 mg/mL.

Conclusion

A. auriculiformis, a multipurpose shrub widely distributed across Asia, has been historically utilized in conventional medicine due to its broad therapeutic potential. The plant's bioactivity, combined with the low toxicity of its phytoconstituents, has made it valuable for treating a wide range of medical conditions. Traditional applications of *A. auriculiformis* include remedies for skin disorders, rheumatism, pain, inflammation, and parasitic diseases. Its use in folk medicine underscores the importance of the plant's pharmacological potential. The present study highlights the importance of further exploring *A. auriculiformis* as a source of medicinal compounds for modern therapeutic applications. While research has confirmed its medicinal value, there remains a need to isolate novel phytochemicals from the plant and investigate their specific mechanisms of action. Such studies will enable a deeper understanding of how these compounds contribute to the plant's traditional uses. This is particularly important since the scope of current research is limited in its ability to fully explain the plant's medicinal

properties. However, despite the progress made in understanding its pharmacological potential, there are challenges in translating traditional knowledge into modern clinical practice. Clinical investigations are necessary to determine the safety, efficacy, and pharmacological impacts of isolated bioactive compounds from *A. auriculiformis*. These studies are essential for validating the therapeutic claims associated with the plant, but they often face limitations, including the need for rigorous methodologies, larger sample sizes, and long-term studies. Nonetheless, clinical research plays a critical role in advancing the discovery and development of new medicines from *A. auriculiformis*. By thoroughly investigating its bioactive compounds, researchers can unlock new opportunities for its use in treating modern diseases, ensuring that this plant remains a valuable source of medicinal agents for future generations.

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Author Contribution

Ruchi Dobariya and Vaibhavi Savalia are involved in the complete writing of the article. Krishna Raninga and Pravin Tirgar were involved in the overall formatting and editing. Jigar Savaliya and Anjali Parmar were involved in the critical revision of tables and graphs and the improvement of the article.

Conflict of Interest

None.

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