**ACANTHUS ILICIFOLIUS: A TRUE MANGROVE WITH BIOMEDICAL POTENTIAL**

Rutvi Patel, Nilay Patel, Krushil Patel, Meet Patel, Kunj Patel, Preeti Verma, Mamta Shah*

L. M. College of Pharmacy, Navrangpura, Ahmedabad 380009, Gujarat, India.

**ABSTRACT**

*Acanthus* (Family: Acanthaceae) is a genus of the major group of angiosperms comprising of more than 30 species of mangrove that are widely distributed in the tropical and subtropical regions of the world. Among all the species of true mangroves, *Acanthus ilicifolius* is commonly growing in India and has an enormous potential as an important plant of medicinal worth. All the parts of this plant have been used to cure a number of ailments in various traditional systems of medicine including Ayurveda. The traditional uses of this plant have been supported by the results of several pharmacological studies on extracts and/or pure compounds. Compounds recorded to be present in this species mainly include alkaloids, benzoxazinoides, phenylethanoides, lignans, flavanoids, megastigmanes, fatty acids and aliphatic alcohol glycosides. Thus main objective of this review is to offer thorough scientific information on biological and pharmacognostic characterization, ethnomedicinal uses, phytochemicals, pharmacological activities of *Acanthus ilicifolius* published till date. An attempt has been made to highlight this plant as a source of medicinally active compounds that are valuable for human welfare, thus providing a platform to help future studies on this true mangrove species of *Acanthus* genus.

**KEYWORDS:** *Acanthus ilicifolius*, Medicinal uses, Phytochemistry, True mangrove.

**INTRODUCTION**

The genus *Acanthus*, belonging to the family Acanthaceae, comprises of over 30 species, mostly shrubs or perennial herbs, native of tropics and subtropics, many of which are found from India to southern China, tropical Australia and the Western Pacific islands, throughout Southeast Asia.[1] In India, it is common in both east and west coast including...
Andaman Islands and Nicobar Islands. The name ‘Acanthus’ is derived from a Greek word meaning ‘spiny’ and the genus is also known as ‘Bear's Breeches’ due to the spiny nature of the plant. The genus comprises of mangrove species viz. *Acanthus ebracteatus* Vahl., *A. ilicifolius* L., *A. volubilis* Wall., *A. latisepalus*, *A. montanus* and *A. xiamenensis* that are known to sustain in the most hostile atmosphere making this genus a unique taxa among all true mangrove genera that represent both terrestrial and true mangrove species. Ambiguity regarding taxonomical identity of *A. xiamenensis*, *A. ilicifolius*, *A. ebracteatus* and *A. volubilis* has been reported in few studies. A. *xiamenensis* is endemic to China and all the other species are common in Indo-West Pacific region. However, in India only *A. ilicifolius* is known to occur in all mangrove habitats except Lakshadweep, whereas *A. ebracteatus* and *A. volubilis* have very restricted distribution. *Acanthus ilicifolius* is common in landward edges of mangroves just above the high tide mark, and also occurs in inner mangroves. In ancient times, *Acanthus* leaves were employed as a decorative motif in architecture of the Mediterranean countries. In the late 1960s, the founders of The Arts Society chose the *Acanthus* leaf as the Society's emblem. Out of all the species, *A. ilicifolius* has a long history of use as a folklore and traditional remedy for treating various diseases in Ayurveda as well as in Thai medicine and Traditional Chinese Medicine. Hence, this genus represents medicinally as well as economically important plants. In this review, the ecological importance and the medicinal qualities of one of the most useful species of true mangrove *viz.* *Acanthus ilicifolius* are highlighted along with its anatomy, chemical descriptions of compounds with medicinal properties and the pharmacological actions that validate its traditional uses.

**METHODS**

An extensive literature survey was conducted using the keywords ‘*Acanthus ilicifolius*’, ‘phytochemicals’ and ‘biological activities’ on electronic databases (Web of Science, PubMed, Scopus, Science Direct, Google scholar, Springer Links and ACS Publications) to gather appertaining documented literature and research works till August-2020. Moreover, bibliography of the referred articles was also delved to pull together the total data.

**BOTANICAL DESCRIPTION**

*Acanthus ilicifolius* Linn. (Figure 1)

**Synonyms**

Vernacular Names
Krishna Saraiyaka, Blue-flowered Katasaraiyaa (Ayurveda); Sea Holly, Holy Mangrove, Holy-leaved Acanthus (English); Hargoza, Harkukanta (Hindi); Harkuchakanta, Kentki (Bengali); Holechudi, Mulluchulli (Kannada); Payinachulli (Malayalam); Nivagur, Marandi, Mandli (Marathi); Moramdo (Konkani); Attumulli, Kaludaimulli (Siddha/Tamil); Alasyakampa, Alchi (Telugu); Harikusa, Sahachara(Sanskrit); Hargozza (Folk).[7,8,9]

Figure 1: Acanthus ilicifolius (A) Entire plant in its natural habitat and (B) a photograph of its flower.[10,11]

Taxonomical Classification
According to the botanical scheme of Engler, the plant is classified as follow.[6]

Kingdom: Plantae
Division: Tracheophyta
Subdivision: Angiospermae
Class: Dicotyledonae
Order: Magnoliopsida
Suborder: Lamiales
Family: Acanthaceae
Genus: Acanthus
Species: Acanthus ilicifolius L.

DISTRIBUTION AND ECOLOGY
It is true mangrove species distributed in tropical Asia and Africa. In India, it is reported from the east (the largest area of mangrove forest, the Sunderbans), the West seashore, Andamans and a North eastern state, Meghalaya (Figure 2). It is generally found on river banks or low marshland areas of mangrove forests and its surroundings above the high tide mark.[12]
PHARMACOGNOSTIC CHARACTERIZATION

Macroscopic characters
It is a shrub, up to 3 m high, with light green or purple, thick branched stem; roots rarely above ground; simple, opposite, lanceolate to broadly lanceolate leaf with spiny or dentate margin, varying in size, 7.5 to 15 cm in length and 5 to 6 cm in width, but smaller in flowering season and 0.5 to 2 cm long petiole, cauline, extipulate, flattened, pulvinous to sheathing base, surface glabrous, granular, pinnatified with strong, conspicuous veins, especially on the lower side, lateral veins 3 to 5 on each side terminating in a sharp 3 to 10 mm long spine at the toothed margin, spine longer in flowering season. Petioles are short, 5 to 6 mm in length, slightly winged with two sharp spines at the base, colour dark green when fresh, yellowish brown on drying, odour indistinct, taste bitter.\(^{[14]}\) Roots are generally shallow taproot, but occasionally stilt roots are conspicuous. Stem is greenish to purple in colour, outer surface is smooth; nodes with pair of spines present at the base of the petioles. Flowers are present in terminal spike, bisexual, typically zygomorphic, complete, erect, sessile, hypogynous, blue to purplish in colour and flowering usually occurs during February to May. Fruits are greenish capsules that dehisce along the dorsiventral line, with shiny, coriaceous outer surface, 1.4 cm in length, 1.05 cm in width and encompasses 3 to 4 kidney-shaped seeds that are 0.5 to 1.0 cm long.\(^{[4,14]}\)

Microscopic characters
Leaf can be characterized by important features like presence of salt glands with a unicellular stalk and multicellular head in adaxial side; median vein with numerous irregular collateral
vascular bundles; the lateral vein bundles somewhat near to median bundle with continuous layer of sclerenchyma sheath; the two layered palisade tissue being confined on abaxial side only; glandular trichomes and deeply sunken stomata intermittently seen in the abaxial region.[14] Stem shows single layered thick epidermis; outer cortex with collenchyma cells and inner cortex consisting of parenchyma with air cavities; solitary sclereids embedded in peripheral phloem cells; pith made up of small parenchymatous cells that contain numerous calcium oxalate crystals and water-storing large parenchymatous cells. The diagnostic features of powdered drug includes glandular trichomes with 2 to 10 celled salt secreting head either sessile or with 1 to 2-celled stalk; lower epidermis with plenty of diacytic stomata; transversely cut fragments of lamina exhibiting upper epidermis with sunken pits embedded with glandular trichomes; groups of long pericyclic fibres with thick pitted wall and narrow lumen; and pitted lignified parenchymatous cells.[7]

Traditional Medicinal Uses

*A. ilicifolius* is traditionally used for the treatment of skin diseases, small pox, ulcers, snake bite and rheumatism. A decoction of the plant with sugar candy and cumin is used in dyspepsia with acid eructation. Tea brewed from the leaves relieves pain and purifies the blood.[15] The plant is also considered to be a diuretic and is used as a cure for dropsy and bilious swellings.[6] The root is boiled in mustard oil and used in paralysis of limbs. The leaves, roots and other parts of *A. ilicifolius* are widely used as herbal medicine for human diseases in different countries (Table 1). In Malaysia, the leaf is used to treat rheumatism, neuralgia and poison arrow wounds. It is widely believed among mangrove dwellers that chewing the leaves will protect against snake bite. The pounded seeds are used to treat boils and the juice of leaves to prevent alopecia. In Ayurveda, the drug is also used as astringent and makes a good nerve tonic, expectorant and stimulant. The roots especially are used as expectorant and prescribed in cough and asthma. The root, boiled in milk, is largely used in leucorrhoea and general debility.[9] The tender shoots and leaves are used in India for treating snake and insect bites. In Goa, the leaves, abound in mucilage, are used as an emollient fomentation in rheumatism and neuralgia. The Siamese and Indo-Chinese also consider the roots to be useful in paralysis and asthma.[16]
Table 1: Traditional uses of Acanthus ilicifolius.

<table>
<thead>
<tr>
<th>Disease</th>
<th>Plant parts used</th>
<th>Country</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anti-rheumatic</td>
<td>Leaves, leaves abound in mucilage</td>
<td>Malaysia, India</td>
<td>[17, 18]</td>
</tr>
<tr>
<td>Neuralgia</td>
<td>Leaves, leaves abound in mucilage</td>
<td>Malaysia, India</td>
<td>[17]</td>
</tr>
<tr>
<td>Poison arrow wounds</td>
<td>Leaves</td>
<td>Malaysia, India</td>
<td>[17]</td>
</tr>
<tr>
<td>Alopecia</td>
<td>Leaves (juice)</td>
<td>Malaysia, India</td>
<td>[18]</td>
</tr>
<tr>
<td>Leucorrhoea</td>
<td>Leaf and roots boiled in milk</td>
<td>India</td>
<td>[15,16]</td>
</tr>
<tr>
<td>Paralysis and Asthma</td>
<td>Roots</td>
<td>Thailand, India and China</td>
<td>[15]</td>
</tr>
<tr>
<td>Snake bite</td>
<td>Tender shoots and leaves</td>
<td>India</td>
<td>[15,16,19]</td>
</tr>
<tr>
<td>Cold and Dermatitis</td>
<td>Water extract of the bark</td>
<td>Thailand, India</td>
<td>[15]</td>
</tr>
<tr>
<td>Astringent, Expectorant and stimulant</td>
<td>Whole plant</td>
<td>India</td>
<td>[12]</td>
</tr>
</tbody>
</table>

**Phytochemistry**

Through several phytochemical studies, A. ilicifolius has been explored for the presence of various classes of bioactive compounds namely alkaloids, benzoxazinoids, lignans, flavanoids, triterpenoids and steroids (Table 2).

**Leaf**

**Alkaloids:** Acanthifoline, a 1-methyl-1,2,3,4-tetrahydro-5-methoxy-2,7-napthyridin-3-one[20]; trigonellin[21]; 2-benzoxazolinone[22,23]; acanthiline A (pyrido[1,2-a]indole); 4-hydroxybenzoxazole-2-one[24]; indole alkaloids like 1H-indole-3-carboxylic acid, 1H-indole-3-carboxaldehyde and 1H-indole-3-acetic acid[25]; betaine.[26]

**Benzoxazinoids:** Benzoazin-3-one, benzoxazinoidglucosides[27], 4-benzoxazin-3(4H)-one, megastigmane 2-benzoxazolinone, 5,5’-bis-benzoxazoline, 2,2’-dione.[7]

**Lignans:** A coumaric acid derivative called acancifoliuside[28], acteoside[29], isoacteoside[30], acanthaminoside[31], (+)-syringaresinol-3α-O-β-D-glucopyranoside, (+)-lyoniresinol-3α-O-β-D-glucopyranoside[32], (-)-lyoniresinol[33] are isolated from the methanolic extract of leaf; (+)-lyoniresinol 3α-O-β-D-galactopyranosyl-(1→6)-β-D-glucopyranoside and (+)-lyoniresinol 2α-O-β-D-galactopyranosyl-3α-O-β-D-glucopyranoside have been reported from aerial parts[34]; (Z)-4-coumaric acid glycosides like (Z)-4-coumaric aci-4-O-β-D-glucopyranoside and (Z)-4-coumaric acid-4-O-β-D-apiofuranosyl-(1’→2’)-O-β-D-glucopyranoside[1], phenylethyl-O-β-D-glucopyranosyl-(1→2)-β-D-glucopyranoside, phenylethyl-O-β-D-glucopyranoside, benzyl-O-β-D-glucopyranoside and vanillic acid[26]; 411-
epoxymegastigmane glucoside and megastigmane glucosides [(6S, 9S)-roseoside)] have also been reported from A. ilicifolius growing in China\(^1\); the phenylethanoids reported in the plant are blepharin, acteoside, isooverbascoside\(^{35}\); martynoside and crenatoside.\(^{36}\)

**Flavanoids:** Quercetin, quercetin-3-O-β-D-glucopyranoside\(^{21}\), apigenin-7-O-β-D-glucuronide, vitexin\(^{37}\), luteolin 7-O-β-D-glucuronide, apigenin-7-O-β-D-glucuronide, methylapigenin-7-O-β-D-glucuronate\(^{38}\), catechin/epicatechin, galatechin/epicatechin and amphicin/epigalin.\(^{39}\)

**Aliphatic glycosides:** Ilifolioside B\(^{1}\) and ilicifolioside C.\(^{40}\)

**Triterpenoids:** Pentacyclic triterpenes, β-amyrin, α-amyrin\(^{41}\), lupeol, oleanolic acid and ursolic acid.\(^{21,22,42,43}\)

**Steroids:** β-Sitosterol\(^{21,43}\), cholesterol, campesterol, stigmasterol\(^{44}\), stigmast-7-en-3-β-ol, octacosyl alcohol, stigmasteryl β-D-glucopyranoside\(^{27}\), daucosterol and 3-O-β-D-glucopyranosyl-stigmasterol.\(^{35}\)

**Hydrocarbons:** 24-Methylene cycloartenol, cycloartenol, 19-Norlanost-5-en-3-ol, 24-methyleneelanost-9-en-3β-ol, 4-methyl-cholesta-7-ene-3β-ol, phytol, octadecanone, tetracosanol and octacosanol.\(^{43,44}\)

**Fatty acid derivatives:** Palmitic acid and octadecanoic acid.\(^{44}\)

**Others:** Amino acids like glutamic and aspartic acids and organic acids like malic, citric, oxalic glycolic and succinic acids\(^{45}\), uridine and uracil.\(^{38}\)

**Roots:** Triterpenoids\(^{22}\), 2-benzoxazolinone (acanthosides A-D).\(^{46}\)

**Pods:** 1,4-Benzoxazinone.\(^{1}\)

**Stem:** Homologous series of 15 saturated odd and even fatty acids\(^{47}\); lignan and cycloligan glycoside\(^{34,48}\), phenylethanoid glycoside (ilicifolioside A), an aliphatic alcohol glycoside-ilicifolioside B\(^{28}\), lignin glucosides, (+)-lyoniresinol-3α-[2-(3,5-dimethoxy-4-hydroxy)-benzoyl]-O-β-glucopyranoside and dihydroxymethyl-bis(3,5-dimethoxy-4-hydroxyphenyl)tetrahydrofuran-9(or 9')-O-β-glucopyranoside; and benzoxazinoidglucosides.\(^{7,20}\)
### Table 2: Phytochemicals isolated from *Acanthus ilicifolius.*

<table>
<thead>
<tr>
<th>Class of compound</th>
<th>Name of the compound</th>
<th>Compound structure</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Alkaloids</strong></td>
<td></td>
<td></td>
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<tr>
<td>Acanthicifoline</td>
<td><img src="image" alt="Acanthicifoline" /></td>
<td>[20]</td>
<td></td>
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<tr>
<td>Trigonellin</td>
<td><img src="image" alt="Trigonellin" /></td>
<td>[21]</td>
<td></td>
</tr>
<tr>
<td>2-Benzoxazolinone</td>
<td><img src="image" alt="2-Benzoxazolinone" /></td>
<td>[22]</td>
<td></td>
</tr>
<tr>
<td>Benzoxazin-3-one</td>
<td><img src="image" alt="Benzoxazin-3-one" /></td>
<td>[27]</td>
<td></td>
</tr>
<tr>
<td>5,5’-Bis-benzoxazoline-2,2’-dione</td>
<td><img src="image" alt="5,5’-Bis-benzoxazoline-2,2’-dione" /></td>
<td>[7]</td>
<td></td>
</tr>
<tr>
<td><strong>Flavanoids</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Quercetin-3-O-β-D-glucopyranoside</td>
<td><img src="image" alt="Quercetin-3-O-β-D-glucopyranoside" /></td>
<td>[21]</td>
<td></td>
</tr>
<tr>
<td><strong>Pharmaceutical Active Principles</strong></td>
<td><strong>Chemical Structure</strong></td>
<td><strong>Reference</strong></td>
<td></td>
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<tr>
<td>-----------------------------------</td>
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<tr>
<td><strong>Vitexin</strong></td>
<td>![Vitexin Structure]</td>
<td>[37]</td>
<td></td>
</tr>
<tr>
<td><strong>Cholesterol</strong></td>
<td>![Cholesterol Structure]</td>
<td>[27]</td>
<td></td>
</tr>
<tr>
<td><strong>Campesterol</strong></td>
<td>![Campesterol Structure]</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Stigmasterol</strong></td>
<td>![Stigmasterol Structure]</td>
<td>[21]</td>
<td></td>
</tr>
<tr>
<td><strong>β-Sitosterol</strong></td>
<td>![β-Sitosterol Structure]</td>
<td>[21]</td>
<td></td>
</tr>
<tr>
<td><strong>Stigmast-7-en-3-β -ol</strong></td>
<td>![Stigmast-7-en-3-β -ol Structure]</td>
<td>[27]</td>
<td></td>
</tr>
<tr>
<td><strong>Stigmasteryl-β-D-glucopyanoside</strong></td>
<td>![Stigmasteryl-β-D-glucopyanoside Structure]</td>
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<td></td>
</tr>
<tr>
<td><strong>Octacosyl alcohol</strong></td>
<td>![Octacosyl alcohol Structure]</td>
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</tbody>
</table>

**PHARMACOLOGICAL ACTIVITIES**

**Anti-cancer activity**

Benzoazolinone-type alkaloids, acanthosides A-D yielded from the root of *A. ilicifolius* are reported to possess significant cytotoxicity against the HepG2, HeLa, and A-549 cancer cell lines.
lines with IC$_{50}$ 7.8 to 26.6 µM, due to the presence of substituted benzoyl moiety in their structures.\[46\]

**Antidiabetic activity**
A single oral dose of 200 and 400 mg/kg of ethanolic extract of root is shown to significantly decrease blood glucose levels in alloxan-induced diabetic rats after 5 h and 3 h respectively in an acute study and on first day in a sub-acute study. It is reported to improve regeneration of $\beta$-cells of pancreas.\[49\]

**Anti-inflammatory activity**
The methanolic fraction of leaf extract is reported to produce significant inhibition of rat paw oedema, when administered both prior to and after carrageenan administration, in a manner similar to BW755C, a synthetic cyclooxygenase (COX) and lipoxygenase (LOX) inhibitor. The extract is shown to decrease protein exudation and leukocyte migration in the peritoneal fluid, thereby indicating its effectiveness towards inhibiting peritoneal inflammation and also significant inhibition of COX (1 and 2) and 5-LOX activity. Moreover, pre-incubation of the extract is shown to inhibit the production of proinflammatory cytokines (TNF-$\alpha$ and IL-6) in lipopolysaccharide (LPS)-stimulated peripheral blood mononuclear cells (PBMCs). It is also reported to possess significant free radical (DPPH, ABTS, superoxide and hydroxyl radical) scavenging activity.\[50\]

**Anti-leishmanial activity**
2-Benzoxazolinone (BOA) isolated from the leaf (40 µg/ml) is shown to have anti-leishmanial activity against *Leishmania donovani* when compared with pentamine in *in vitro* experiments. BOA (i.p.) in the doses ranging from 0.25 to 1 g/kg is shown to be safe in mice.\[51,52\]

**Antimicrobial activity**
The *n*-hexane, alcoholic and chloroform extracts of leaves exhibit strong inhibitory action against *B. subtilis, S. aureus, C. albicans, A. fumigatus, A. niger* and moderate inhibitory action against *P. aeruginosa and P. vulgaris*.\[53,54\] The chloroform extract of *A. ilicifolius* leaf has been shown to exert maximum activity against *S. aureus, P. aeruginosa, P. vulgaris, C. albicans, B. subtilis, A. fumigates* and *A. niger* as compared to methanol and hexane extracts of leaf and root.\[55\] Another study reported the crude chloroform extract to be highly active against *V. cholerae* and *A. niger*, while the aqueous extract is shown to be active against
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Pseudomonas sp. and C. albicans.\textsuperscript{[56]} The methanol extract of A. ilicifolius is shown to have potential activity against the Methicillin-resistant Staphylococcus aureus.\textsuperscript{[57]} Furthermore, it is shown to possess maximum antimicrobial activity against both the bacterial and fungal phytopathogens.\textsuperscript{[58]} The antibacterial activity of the extracts is reported to be exhibited due to the presence of 6-hydroxy- benzoxazolinone, lignin glucosides, (Z)-4-coumaric acid-4-O-β-D-glucopyranoside and 3,5-dimethoxy-4-hydroxy methyl benzoate.\textsuperscript{[59,60]}

**Antinociceptive activity**

The methanolic extract of A. ilicifolius is reported to exhibit antinociceptive effects, due to its flavanoids and tannins, and is mediated by inhibition of lipoxygenase and/or cyclooxygenase in peripheral tissues induced by acetic acid, thereby reducing PGE2 synthesis and interfering with the mechanism of transduction in primary afferent nociceptor.\textsuperscript{[61,62]}

**Antioxidant and cytotoxic activity**

The methanolic extract of flowers, amongst the five extracts tested (acetone, methanol, acetone 70%, methanol 80% and water), is reported to possess the highest antiradical efficiency against DPPH radicals and the highest cytotoxicity (LC\textsubscript{50} 22 µg/mL) against brine shrimp nauplii due to the presence of terpenoids, phenolic compounds and alkaloid.\textsuperscript{[63]} Polysaccharides, flavanoids and phenolic compounds of A. ilicifolius displayed good antioxidant activity in various \textit{in vitro} and \textit{in vivo} models.\textsuperscript{[64,65]}

**Anti-ulcer activity**

The anti-ulcer activity of methanolic extracts of the leaf (at 100 to 200 mg/kg) produces significant inhibition of gastric lesions induced by pylorus ligation and ethanol-induced gastric ulcers in Wistar albino rats. The extract is shown to cause significant reduction in the gastric volume, free acidity and ulcer index as compared to control, probably due to anti-secretary action.\textsuperscript{[66]}

**Antiviral activity**

The ethanol extracts (50\%) of the leaf, flower and root have been shown to possess \textit{in vitro} antiviral activity against Tobacco Mosaic Virus.\textsuperscript{[52,66]} Blepharin, acteoside, isoverbascoside, daucosterol and 3-O-β-D-glucopyranosyl-stigmasterol isolated from the leaf when investigated for anti-influenza virus activities by measuring the neuraminidase activity of influenza virus, the phenylethanoids (blepharin, acteoside, isoverbascoside) exhibited significant antiviral activities.\textsuperscript{[35]}
Hepatoprotective activity
The alcoholic extract (250 and 500 mg/kg, p.o.) has shown significant hepatoprotective activity in rats in carbon tetrachloride-induced hepatotoxicity model, that was comparable with curcumin (100 mg/kg, p.o.), as evaluated from the serum and tissue activity of marker enzymes.\[29]\n
Osteoblastic activity
Acancifoliuside, a coumaric acid derivative isolated from the methanolic extract of the leaf, when tested for its effects on the functions of osteoblastic MC3T3-E1 cells, significantly increased the growth and differentiation of osteoblasts, indicating that *A. ilicifolius* leaf may help to prevent osteoporosis.\[41]\n
Other significant potential
Intragastric administration of *A. ilicifolius* ethanol extract in rat plasma has shown potential hepatoprotective, antioxidant and anti-inflammatory activities due to the presence of phenylethanoid glycosides namely acteoside, isoacteoside, martynoside, and crenatoside.\[36]\nCondensed tannins (catechin/epicatechin, galatechin/epicatechin, and amphicin/epigalin) isolated from the leaf are shown to have anti-tyrosinase activities and antioxidant activities on mushroom tyrosinase with the IC\(_{50}\) 19.7 ± 0.13 µg/mL.\[39]\n
Toxicity studies
The ethanolic extract of *A. ilicifolius* leaf is reported to be non-toxic at single dose oral administration with the LD\(_{50}\) greater than 5000 mg/kg. In acute toxicity studies performed on mice, it practically did not show any harmful effect to vital organs at doses of 1000 mg/kg and 2000 mg/kg. However at higher doses (5000 mg/kg), administration of the extract is shown to cause changes in some vital organs.\[67]\n
CONCLUSION
*Acanthus ilicifolius* is a true mangrove plant widely distributed in the tropical and subtropical regions of the world. The botanical studies on *Acanthus ilicifolius* provide scientific information on morphological and anatomical characteristics. The phytochemical studies revealed different bioactive compounds from the various parts of *A. ilicifolius*. Numerous pharmacological studies done using different types of extracts of plant are antimicrobial, anti-inflammatory, antiviral, antidiabetic, antioxidant, cytotoxic and anticancer activities, antinociceptive, hepatoprotective, leishmanicidal and osteoblastic activity which contributed
to the use of *Acanthus ilicifolius* in ethnomedicine. Furthermore, acute toxicity reports of ethanolic extract of plant on the animal model are presently available, which suggests that the extract is practically non-toxic at single dose oral administration. The data documented in our article would be useful in future planning of proper utility of this plant in the healthcare system.

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**CONFLICTS OF INTEREST**

The authors declare no conflict of interests with the publication of this review article.

**REFERENCES**


**GRAPHICAL ABSTRACT**

- Antioxidant
- Acteoside
- Acanthus ilicifolius
- Anticancer
- Anti-inflammatory