

## Medicinal and economic potential of *B. acutangula*: A review

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### Abstract

*B. acutangula* is the species of Barringtonia from Bangladesh, India (Southern States), Sri Lanka up to Australia known by such names as freshwater mangrove and itchy tree. Herein, the present review attempts to synthesize and consolidate such information on *B. acutangula* with respect to its botanical description, ecological importance, phytochemical content, medicinal uses especially mentions in historical texts, wound-healing property as well economic potential of this species. It is known botanically for angular branches, elliptical leaves and white or pinkish flowers with an Odor of orange followed by spherical fruits. In ecological terms, it is critical to revegetate river banks, support biodiversity and help in salt environment adaptation of mangrove areas. Phytochemical investigation of different parts of the plant attributes antioxidant, anti-inflammatory and antimicrobial properties to bioactive phytoconstituents as saponins, flavonoids & alkaloids. *B. acutangula* has a great importance in traditional medicine systems employed to cure pain, inflammation as well digestive disorders. Its seeds also provide an oil that is used in soap making and its wood for construction. This review opens up with *B. acutangula*, a plant of immense significance on multiple fronts and subsequently discusses untapped areas for future endeavours along with its sustainable exploitation opportunities.

**Keywords:** *B. acutangular*; Indian oak; Freshwater mangrove; Botanical characteristics; Ecological significance; Phytochemistry; Medicinal uses; Economic applications; Saponins; Flavonoids

### 1. Introduction

Indian oak is one more example, it is a freshwater mangrove and its native only in Indian Subcontinent this shows the diversity of plants found throughout India over here. The tree is a member of the family Lecythidaceae, and as such it can be found in different types of habitat from riverbanks to mangrove swamps where its ecological importance linked with medicinal and economic use.

*B. acutangula* is known from its slender and angular stem, elliptic leaves with serrate margins, inflorescence features white to pale pink flowers turning into large globose fruits packed by numerous seeds; This ample adaptability to saline environments renders *R. mangle* as key player in the mangrove ecosystems by providing stabilization of coastal and riverine areas.

Phytochemical analyses have revealed a wide array of bioactive compounds in *B. acutangula* such as saponins, flavonoid alkaloids and tannis. Livestock, for example, will sometimes browse the tree to self-medicate with its leaf and bark extract against ailments such as inflammation pain, while traditional medicine in Africa often uses seeds from the neem given their documented antiparasitic action effects specific to gastrointestinal disorders & tropical diseases.

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In addition to its use in medicine, the seeds can be used to produce oil for making soap and lubricant, while also being a convenient source of fuel. These economic uses of the hormone cement its position as a renewable resource for small and local industries.

The objective of this review is to provide update information on *B. acutangula* including, botanical features, ecological value and diversity assessment; Phytochemistry with bioactivities; medicinal uses along with material medica accounts (Ayurveda uses) besides industrial mechanisms optimization creation phenomenon in economically significant traits exploiting biotechnological Applications. This review aims to discuss these aspects and recognizing the multidimensional value of *B. acutangula* as a potent lead in not only pharmaceutical but also sustainable materials, an absolute urge for unexploited areas toward eco-conservation will be highlighted raising vigorous investigation against its occurrence.

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## 2. Botanical Characteristics of *B. acutangula*

*B. acutangula*, the most popularly by its common name Indian oak (or just "oak") and freshwater mangrove, false-mango it is a flowering tree of family Lecythidaceae. Over the centuries, this species has evolved a number of distinctive botanical features that make it both environmentally robust and botanically interesting while also being used by humans in some unusual ways.

### 2.1. Morphology

*B. acutangula* normally grows from 10-15 meters tall but can achieve larger size if growing conditions are optimal It is recognisable by its wide-spreading crown and angular branches that lend an architectural character to the tree in a number of landscapes. When young, its smooth bark is light gray-brown becoming progressively darker and deeply furrowed with age.

### 2.2. Leaves

*B. acutangula* leaves are alternate, elliptic or lanceolate and 10-20 cm long Their saw-edged borders and shiny, dark green top surface contrast sharply with the leaf's lighter colored underpart. These features not only enhance photosynthetic efficiency, but also the ornamental value of these plants through variation in leaf arrangement and morphology.

### 2.3. Flowers

*B. acutangula* is one of the most distinctive okra flowers that pollinates seasonally in Bangladesh The flowers are usually white or pink and appear in large, showy clusters at the branch ends. It has five-petaled flowers with multiple stamens which make it an attractive flower and ecosystem-inhabitant for pollinators.

### 2.4. Fruits

*B. acutangula* bears globose many-seeded fruits about 5-7 cm in diameter following flowering. In its immature state, the fruits are green and fleshy to begin with but later turn brown and woody as they grow in size. They have a pulp and the fruit produces several seeds, to be eaten by wildlife which aid in dispersing this species across regions it is native to.

### 2.5. Ecological Adaptations

*B. acutangula* shows unique habitat flexibility, as it occurs in a wide array of ecological niches spanning from freshwater sites such river banks and shorelines of lakes to saline habitats founds the mangrove swamps Draft Trout finish sandophile, can withstand annual fluctuations in water levels; and deserts to semi-desert tropical areas of the environment that such ecological resilience, biodiversity is preserved nature gemeinsame Konstruieren."

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## 3. Cultural and Landscape Uses

Besides its ecological and botanical significance, *B. acutangula* has cultural value in every traditional medicine practiced across the state\_ranges which makes it important to pharmacopoeia of India -- where this plant grows wild. The bark, leaves and seeds of different parts of the tree are used for various medicinal purposes to provide relief from inflammation, gastrointestinal disorders as well as skin conditions. Moreover, its leaves and flowers are appealing which is why it is a sought after ornamental plant in tropical as well as subtropical regions.

To conclude, in addition to interesting botanical characters it exhibits ecological adaptability, cultural importance and have a wide scope of economic applications prominent *B. acutangula* from India.

## 4. *B. acutangula*

### 4.1. Ecological Significance

*B. acutangula*, also known as Indian oak or freshwater mangrove and distributes in the natural habitat among ecosystems often found overuse across its native range from the India subcontinent to Southeast Asia. The botanical and ecological importance of a plant is based on its endemism, vegetative adaptations or microhabitat preference, the crucial relationship between pollinators to pollen dispersal, niche representation for nectary provisioning bee species etc.

### 4.2. Habitat and Distribution

*B. acutangula* preferentially grows in freshwater habitat like riverbanks, lakeshores and marshy areas etc. It is also found to adapt in saline conditions within mangrove ecosystem showing its capability of tolerating water levels and soil salinity converse. Thus, *B. acutangula* occupies any diverse ecological niches due to its broad habitat tolerance which a major characteristic that enables for wide geographical distribution in all regions of the world and as an indicator concerning about vegetation influence over seed production or diversity.

### 4.3. Soil Erosion and Habitat Stabilization

Erosion control and habitat stabilization in riverbanks, coastal area are highlighted under notable ecological roles of *B. acutangula*. The tree provides a large network of roots that holds the soil which help reduce erosion brought by water currents and tidal current. This is extremely important for stabilizing in such type of environmental disturbance mostly occur due to natural hazards like flood and cyclone, where *B. acutangula* acts as soil binder that may be helpful against any kind of soil erosion or land degradation.

### 4.4. Biodiversity Support

It also acts as a keystone species in both freshwater and mangrove ecosystems, supporting various other flora and fauna. The tree canopy provides shade and cover over the water, hiding many of the animals found in this ecosystem from view-such as fish, amphibians and crustaceans. The flowers of *B. acutangula* Petals are edged in pink and the vibrant style is also dark tipped, possibly to attract pollinators such as bees or butterflies which further enhance local biodiversity along with aiding reproduction of other plant species within the ecosystem. Further, the wildlife species also migrate to consume the fruits of *B. acutangula* and thus address their dietary requirements also aiding in seed dispersal throughout the landscape as well.

### 4.5. Adaptation to Climate Change

In the face of an ever-changing climate, *B. acutangula* can be said to adapt in different environmental conditions making it a species of ecological importance that help build climate resilience and adaptation needs. The researchers observed that its tolerance of the saline environments prevalent in mangrove swamps might confer some resilience to rising seas and shifting coastal dynamics. In addition, the biomass and soil stabilizing functions of *B. acutangula* further point to its key role in climate change mitigation measures including carbon sequestration.

### 4.6. Conservation and Management

As it is ecologically important and widely distributed, conservation of *B. acutangula* must be imperative for protection from loss its habitats as well as genetic diversity. To protect against loss of habitat, overexploitation and invasion by other species, the species can be managed in a sustainable way - with practices such as restoration of habitats and protection to natural populations.

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## 5. Phytochemistry of *B. acutangula*

*B. acutangula*, commonly known as Indian oak or freshwater mangrove, possesses a rich phytochemical profile that contributes to its medicinal properties and potential applications in various industries. This section explores the bioactive compounds identified in different parts of *B. acutangula* and their pharmacological significance.

### 5.1. Major Phytochemical Classes

**Table 1** Major Phytochemical Classes Found in *B. acutangula* with Molecular Formula

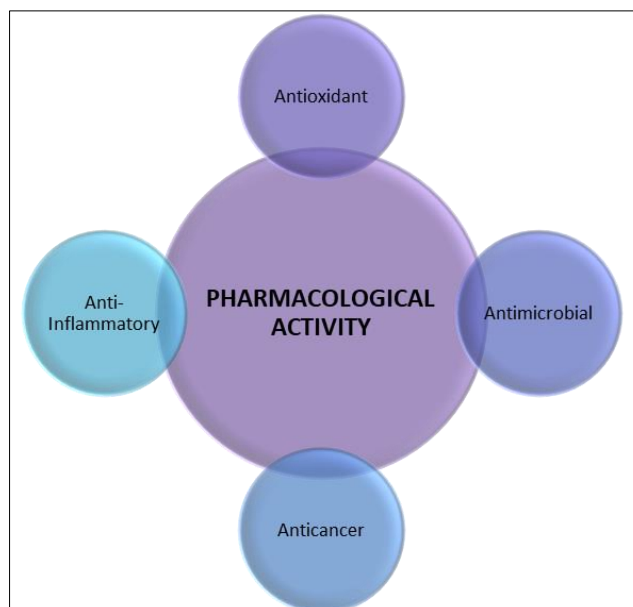
S.No.	Phytochemical	Molecular Formula
1	Saponins	C <sub>55</sub> H <sub>86</sub> O <sub>24</sub>
2	Flavonoids	C <sub>15</sub> H <sub>10</sub> O <sub>2</sub>
3	Alkaloids	C <sub>18</sub> H <sub>25</sub> N <sub>O5</sub>
4	Tannic	C <sub>76</sub> H <sub>52</sub> O <sub>46</sub>

- Saponins *B. acutangula* contain saponin which are glycosides with soap-like properties.; Other potential properties associated with saponins: Saponins have been investigated as non-ionic/surfactants, and they also display biological activity, such anti-inflammatory property antimicrobial etc. These compounds are frequently found in the bark and seeds of *B. acutangula*.
- Flavonoids: are secondary metabolites that have antioxidant properties. Flavonoids like quercetin, kaempferol and rutin present in *B. acutangula* are responsible for its antioxidant as well as anti-inflammatory activities. *B. acutangula* contains flavonoids which are mostly present in the leaves and flowers of bitter melons
- Alkaloids: Alkaloid is a nitrogenous compounds and possesses complex pharmacological activity. Bioactive : contains alkaloids, reported in *B. acutangula*, however; detailed reports and bioactivities need to be further investigated. The seeds and the bark of *B. acutangula* have been reported to contain alkaloids.
- Tannins: Tannin is a general term for polyphenolic compounds with the ability to precipitate proteins, specifically those with an affinity towards prorien. This medicinal property of *B. acutangula* is associated with the presence of tannins in it which are used to heal wounds and for treatment against diarrhoea [9]. Tannins are mainly present in *B. acutangula* bark and seeds.

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### 6. Pharmacological Activities

- *B. acutangula* shows antioxidant activity due to the flavonoids and other phenolic compounds it contains. This helps neutralize free radicals and is believed to help provide part of the potential health-promoting effects associated with protection from oxidative stress-related diseases due to their antioxidant actions on dietary antioxidants.
- Saponins and flavonoids present in *B. acutangula* show anti-inflammatory activity by inhibiting inflammatory mediators and pathways, respectively; This property is particularly useful for the healing of inflammatory conditions such as arthritis and skin inflammation.
- Antimicrobial Activity: Saponins and tannins in *B. acutangula* have demonstrated activity against a variety of bacteria, fungi. The antimicrobial power that they have to offer is useful in taste/cure of diseases and very helpful in maintaining the food for long hours.
- Anticancer Potential: In vivo and in vitro studies indicate that the anticraycans an von gular extracts, because of its effectiveness to inhibit tumor cell growth or induce apoptosis. These findings suggest yet uncovered potential and led to concluding that further researches could be carried out in order to determine bioactive compound(s) responsible for the anticancer effects.



**Figure 1** Figure of Pharmacological Activity of *B. Acutangula*

### 6.1. Traditional and Modern Uses

Different parts (bark, leaves and seeds) of *B. acutangula* have been used mentioned in the traditional medicine systems such as Ayurveda and Traditional Chinese Medicines, for the treatment of various ailments including diarrhoea, skin diseases, inflammatory conditions etc. The modern pharmacological investigations acknowledge a few traditional utilities and establish several novel therapeutic arenas that might be surprised under the phytochemical armamentarium of *B. acutangula*.

### 6.2. Therapeutics of *B. acutangula*

Indian oak, freshwater mangrove (*B. acutangula*) is a medicinal plant that has been used in traditional medicine throughout the Indian subcontinent as well Southeast Asia. The bark, leaves seeds and roots of the plant tree have medicinal value that is used to treat many diseases. In this section, we have covered the traditional and current medicinal uses of *B. acutangula*.

#### 6.2.1. Anti-inflammatory Properties

**Medicinal Uses :**The bark and leaves extract of *B. acutangula* are used in traditional medicines to cure inflammation as well against inflammatory disorders. Externally used as poultices, extracts against arthritis or joint pain and skin inflammations

Phytochemical studies in modern times revealed the presence of flavonoids and saponins as bio-active compounds which have anti-inflammatory activity through inhibiting inflammatory mediators..

#### 6.2.2. Gastrointestinal Disorders

It is called bavachi in Gujarat (Malpai name ) Traditional Uses: The Seeds and Bark of *B. acutangula* are utilized by conventional restorative frameworks to fix stomach issues like the runs, intestinal sicknesses similarly as genuine colics etc. Decoctions or extracts are taken orally to treat diarrhea and spasm.

**Pharmacognostical View:** *B. acutangula* contain tannins along with other astringent compounds which helps in reducing irritation, inflammation of gut and various GIT disorders also. These actions make it a staple ingredient for the treatment of digestive complaints.

#### 6.2.3. Wound Healing

They are used traditionally to treat wounds cuts, etc... on the skin and have been applied as an infusion/ fomentation. The astringent and antimicrobial properties of the plant help clean wounds, can speed up healing.

Recently, tannins and flavonoids present in *B. acutangula* fruit have been reported to accelerate wound healing activity through the antimicrobial effect as well as improvement of tissue reformation. These properties substantiate its anecdotal use as a topical agent for skin injuries.

#### 6.2.4. Antimicrobial Activity

**Traditional Use:** Different parts of *B. acutangula*, seeds and bark are used in traditional medicine against antimicrobial effects. It is also used on bacterial and fungi infections by extracts.

**Latest Knowledge:** Phytochemical investigations have shown the presence of antimicrobial compounds like saponins and tannines in *B. acutangula* now at present understanding level, but so far no information is available on actual chemical structure elucidation. These metabolites inhibit the growth of pathogens and bolster its use to alleviate microbial infections.

#### 6.2.5. Antidiabetic Potential

**Historical Use:** Leaves extracts of *B. acutangula* have been recognised from ancient times for its anti-diabetic property in traditional medicine practices. The seeds have been shown to possess hypoglycemic effects.

**Current Belief:** Early studies suggest that the extracts from these plants could be potentially used as antidiabetic agents by enhancing insulin sensitivity and glucose homeostasis. The mechanisms underlying this will need to be clarified by more research.

#### 6.2.6. Other Traditional Uses

**Common Cold:** The leaves and bark of *B. acutangula* are also used once in a while to treat flu, but you should consult with your doctor first before using it if you have asthma or seasonal allergies such as hay fever;

**Purgative:** The seeds from *B. acutangula* have been used traditionally as a purgative to treat constipation

### 6.3. Economic Applications of *B. acutangula*

Indian oak, or *B. acutangula* (L.) Gaerth., popularly known as fresh water mangrove, provides multifaceted commercial hopes with the variety of services such from pharmaceuticals to cosmetics and agriculture. In this article of the review series we present an overview of economic significance for *B. acutangula* in terms of its important components and corresponding applications.

#### 6.3.1. Pharmaceutical Industry

**Healing Properties:** *B. acutangula* is rich in bioactive compounds such as saponins, flavonoids, alkaloids and tannins which provides pharmaceutical activities (like antioxidant properties), anti-inflammatory and antimicrobial nature) also possibly potent anticancer characteristics. **Bioactives & Derivatives:** Phytocomponents can be used in pharmaceutical formulations including anti-inflammatory, gastrointestinal and wound healing products along with add on as antimicrobial agents from *B. acutangula*.

#### 6.3.2. Cosmetics and Personal Care

**The Seed Oil:** The seeds of *B. acutangula* contain oil rich in fatty acids and has the emollient effect. This oil is included in cosmetic formulations like the moisturizers, lotions and hair products.

**Applications:** *B. acutangula* seed oil is popularly used to hydrate and condition the skin and hair, thereby it is an ideal ingredient for natural & organically sourced cosmetics too.

#### 6.3.3. Agriculture and Agroforestry

**Wood and timber:** Wood of *B. acutangula* is durable and resistant to pest, besides immune from all stages of fungal as well as insect attacks [8]. It is employed in building furniture, handles of tools and agricultural implements.

**WOOD FUEL:** in some areas the wood is treated as fuelwood for domestic cooking and suitability processes which provides immunity of local energy requirements.

#### 6.3.4. Soap and Oil Industry

Seed Oil for Lubricant: This seed oil of *B. acutangula* has industrial as well beyond cosmetics and personal care applications i.e., it is indicating the potential use in machinery equipment as lubricants (Mahajan & Khouri, 2014).

Soap Production: The natural surfactants derived from *B. acutangula* known as saponins are used in the production of soaps (Agnew and Steele, 1981). These materials are useful in the soap and detergent industry as they can create lather for better cleaning action.

#### 6.3.5. Ornamental and Landscaping

Beauty: Bitter gourd is mainly imported into the decorative economy; very beautiful leaves and quite exuberant for such small flowers It is usually grown in gardens, parks and other private or semi-private places due to aesthetic reasons.

#### 6.3.6. Sustainable Utilization and Conservation

Conservation of *B. acutangula* populations and habitats: Sustainable management practices required at all sites which helps in conservation of higher Biodiversity and improve ecosystem services through habitat protection

Direct Economic Value: *B. acutangula* is likewise of economic consequence as it employs or provides a means to acquire capital for many regional livelihood activities (e.g., collection and production).

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## 7. Conclusion

*B. acutangula*, also known as Freshwater Mangrove and Indian Oak have been described for its diverse bioactive compounds thus got considerable ecological significance and medicinal value has been important to the life of people in India sub-continent up to South- Western Pacific Zone. This review has established the diverse features of *B. acutangula* from botanical characters, ecological importance to phytochemical constituents or bioactive compounds and its therapeutic potential along with other economic uses as comprehensive snapshot.

Ecological Importance: It helps in the stability of ecosystems and conservation of biodiversity. This ecological robustness is exemplified by its ability to inhabit anything from freshwater riverbanks, all the way out to saline mangrove swamps. Diverse root system for avoiding soil loss, and habitat needs to maintain aquatic and coastal integrity.

Traditional knowledge and modern research has disclosed the medicinal potentials of *B. acutangula*. Different parts of the tree, such as bark, leaves and roots have been employed in traditional medicine systems for resolving inflammatory disorders including labor/gynecological cramps, gastrointestinal ailments (diarrhoea/dysentery), wounds/upset stomach/bloody diarrhoea from sore throat with burning pain; orifice infections. Phytochemical studies have revealed bioactive secondary metabolites justify the ethno biological uses of plants and a hope for pharmaceutical development.

Phytochemistry: *B. acutangula* is abundant in saponins, flavonoids, alkaloids and tannins which play a major role for its pharmacological actions. The molecules exhibited antioxidant, anti-inflammatory and antimicrobial effects - all of which could be important for helping cells respond to stress activation as well also show potential in health care products.

Economic aspects: *B. acutangula* has ample economic potential for many industries The seed yields oil used in cosmetics, the wood is prized for construction and furniture making, saponins originating from this botanical are applied to soap-making. These economic uses support local economies, sustainable livelihoods and industrial diversity.

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## Compliance with ethical standards

### Disclosure of conflict of interest

No conflict of interest to be disclosed.

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