

Exploring the Ethnobotanical Resources of Indian Sundarbans: An Insight into Medicinal Plants

Goutam Biswas, Bhanumati Sarkar, Sarthak Ranjan Sarkar, Nidhi Sharma, Samima Sultana and Nithar Ranjan Madhu*

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Abstract:

The Indian Sundarbans, a unique ecosystem comprising mangrove forests and diverse habitats, harbors an extensive array of medicinal plants with profound healing properties. This chapter navigates through the rich source of indigenous medicinal plants of the Sundarbans like Hogla, Hetal, Goran, Bain, Sundari, etc. outlining their traditional uses and potential therapeutic applications. Focusing on the roles of these plants in local healthcare practices, we tried to combine traditional wisdom with current scientific insights that hold great potential for pharmaceutical advancements. Different bioactive compounds (alkaloids, flavonoids, tannins, terpenoids) produced by medicinal mangroves have antioxidant, anti-inflammatory, antibacterial, and anticancer activities and other health-care potentials. Threats of habitat degradation, climate change, and anthropogenic activities pose grave risks to the existence of these invaluable plants, warranting immediate attention to safeguard their biodiversity. In a world where consumers are increasingly seeking natural and sustainable alternatives to promote their health, using plants as a medicinal source is commercially and environmentally feasible.

Introduction:

The use of medicinal plants in India has a deep-rooted history dating back to ancient times, forming the basis of traditional systems of medicine like Ayurveda (Maiti et al., 2010, 2013;

Goutam Biswas

Department of Zoology, Acharya Prafulla Chandra College, New Barrackpore, West Bengal, India

E-mail:  biswas.goutam007@gmail.com; Orcid iD:  <https://orcid.org/0000-0002-2218-4467>

Bhanumati Sarkar

Department of Botany, Acharya Prafulla Chandra College, New Barrackpore, West Bengal, India

E-mail:  bsarkar328@gmail.com; Orcid iD:  <https://orcid.org/0000-0001-9410-9311>

Sarthak Ranjan Sarkar

Department of Zoology, Acharya Prafulla Chandra College, New Barrackpore, West Bengal, India

E-mail:  sarthak.kinjal@gmail.com; Orcid iD:  <https://orcid.org/0009-0007-7764-7012>

Nidhi Sharma

Department of Zoology, Acharya Prafulla Chandra College, New Barrackpore, West Bengal, India

E-mail:  ns9036027@gmail.com

Samima Sultana

Department of Zoology, Acharya Prafulla Chandra College, New Barrackpore, West Bengal, India

E-mail:  samimasultana108@gmail.com

Nithar Ranjan Madhu*

Department of Zoology, Acharya Prafulla Chandra College, New Barrackpore, West Bengal, India

E-mail:  nithar_1@yahoo.com; Orcid iD:  <https://orcid.org/0000-0003-4198-5048>

*Corresponding Author: nithar_1@yahoo.com

Erfani, 2021; Sarkar et al., 2021, 2022; Kar et al., 2022; Dhakar and Tare, 2023). Different regions of the Indian subcontinent possess unique medicinal flora with diverse traditional practices (Banerjee et al., 2014; Bose, 2018; Bhattacharjee, 2021; Basu et al., 2022; Bhowmik et al., 2022; Darro & Khan, 2023; De & Sharma, 2023; De et al., 2023). These practices reflect regional variation and highlight the cultural significance of traditional medicine in different parts of India (Shakya, 2016; Sarkar et al., 2016).

The Indian Sundarbans, a vast mangrove forest between India and Bangladesh shaped by the confluence of freshwater and saline tidal waters, constitute a rich and diversified ecoregion (Madhu et al., 2021; Das et al., 2022; Biswas et al., 2023). This unique mangrove, harbors a rich plant diversity, with numerous plant species known for their therapeutic properties (Neogi et al., 2016). Ethnobotanical practices in the Sundarbans are intrinsic to local communities, shaping their healthcare and cultural traditions. The indigenous people rely on the wealth of traditional knowledge, leveraging medicinal plants for various health issues like —treating skin conditions, digestive disorders, and injuries (Acharya et al., 2021, 2022, 2023). Beyond medicinal uses, these plants are interwoven into daily life, rituals, and economic activities. They hold cultural significance and serve as sources of livelihood, utilized in crafts, construction, and sustenance (Mondal & Das, 2023).

The extensive use of medicinal plants in these communities signifies the intimate relationship between humans and nature, emphasizing the reliance on natural resources for healthcare needs (Smith-Hall et al., 2012). This traditional wisdom, coupled with these medicinal mangrove plants' scientific validation and therapeutic properties, presents a promising avenue for integrating traditional medicine into modern healthcare practices (Mondal et al., 2012; Biswas, 2022). As modern-day consumers prioritize their health, there is a growing recognition of the potency and efficacy of plant-based remedies. Harnessing the healing properties of these plants offers a lucrative avenue in industries such as pharmaceuticals, wellness products, and herbal supplements. Thus, a combination of traditional wisdom and scientific exploration makes the study of medicinal plants in the Sundarbans an area of great interest (Patra et al., 2019).

Medicinal Plant Diversity and Traditional Uses:

Various medicinal plants are found within the Indian Sundarbans, and their traditional usage is for therapeutic purposes (Madhu & Sarkar, 2015; Ghosh et al., 2022; Mandal, 2022; Pal et al., 2022; Jyotirmayee et al., 2023). These indigenous trees, shrubs, herbs, and climbers revealed their potential for health-related issues (Pyne & Santra, 2017; Raha et al., 2022; Saha et al., 2022; Pimple et al., 2023). From bark to fruit, roots to leaves, each preparation serves a distinct medicinal purpose, addressing a spectrum of healing benefits that sheds light on the invaluable ethnobotanical wealth of the Sundarbans. Table 1 represents different medicinal plants along with their ethnobotanical practice (Bandaranayake, 1998; Chowdhury et al., 2014; Sanyal, 2022; Mukhopadhyay, 2018; Islam et al., 2022).

Table 1. List of various medicinal plants of the Sundarbans and their traditional uses

Sl.	Common Name	Scientific Name	Family	Parts Used	Traditional Usage	Types of Plants
1	Hogla	<i>Typha elephantina</i>	Typhaceae	Roots	Treats gastrointestinal issues and skin ailments, notably dysentery. Roots are anecdotally effective.	Herb
2	Goran	<i>Ceriops decandra</i>	Rhizophoraceae	Bark, Leaves	Alleviates skin diseases and digestive disorders.	Tree / Shrub
3	Hental	<i>Phoenix paludosa</i>	Arecaceae	Fruit Pulp	Treatment of skin maladies.	Palm
4	Sundari	<i>Heritiera fomes</i>	Malvaceae	Bark	Remedies ulcers, skin afflictions, and possesses astringent properties.	Tree
5	Kankra	<i>Bruguiera gymnorhiza</i>	Rhizophoraceae	Bark	Addresses diarrhea and dysentery.	Tree
6	Bain	<i>Avicennia officinalis</i>	Acanthaceae	Bark, Leaves	Manages rheumatic conditions and skin disorders.	Tree / Shrub
7	Ketaki	<i>Pandanus odoratissimus</i>	Pandanaceae	Flowers	Helps in diabetes management and exhibits anti-inflammatory properties.	Shrub
8	Golpata	<i>Nypa fruticans</i>	Arecaceae	Roots, Leaves	Utilized in traditional medicine for treating fever and potentially broader therapeutic benefits.	Shrub
9	Gewa	<i>Excoecaria agallocha</i>	Euphorbiaceae	Latex	Latex is applied externally to alleviate pain and swelling caused by various conditions.	Shrub / Tree
10	Garjan	<i>Rhizophora mucronata</i>	Rhizophoraceae	Bark, Leaves	Treats skin disorders like eczema and dermatitis, believed to aid gastrointestinal issues.	Tree

11	Khalsi	<i>Aegiceras corniculatum</i>	Primulaceae	Leaves, Bark	Used in traditional remedies for treating diarrhea, dysentery, and fever management.	Shrub / Tree
12	Keora	<i>Sonneratia apetala</i>	Lythraceae	Bark, Leaves	Reputed to have antimicrobial and anti-inflammatory properties; applied for wounds and skin infections.	Tree
13	Chak Keora	<i>Sonneratia caseolaris</i>	Lythraceae	Fruit	Edible fruit for local cuisine, fruit extract as an anthelmintic	Tree
14	Guava	<i>Psidium guajava</i>	Myrtaceae	Leaves	Leaves manage gastrointestinal issues, coughs, and colds.	Tree / Shrub
15	Hargoza	<i>Acanthus ilicifolius</i>	Acanthaceae	Root, Stem, Leaf	It is applied in treating conditions like leucorrhoea, paralysis, osteoblastic activity, asthma, and colds.	Herb
16	Kala Bain	<i>Avicennia officinalis</i>	Acanthaceae	Root, Stem, Leaf	Used as an anticancer, gastroprotective, astringent, diuretic, antiulcer, and for various conditions.	Tree / Shrub
17	Dhundul	<i>Xylocarpus granatum</i>	Meliaceae	Leaves, Fruits, Barks	Employed to treat viral infections, fever, cholera, dysentery, and fever.	Tree
18	Bawani lata	<i>Sarclobus globosus</i>	Apocynaceae	Stem, Seed	Used as an antiseptic, to prevent bleeding, wound healing, and skin injuries.	Climber / Shrub
19	Pasur	<i>Xylocarpus mekongensis</i>	Meliaceae	Bark	Treats dysentery, suitable for making furniture	Tree
20	Peyara Bain	<i>Avicennia marina</i>	Acanthaceae	Fruit	Used in a concoction for abortion	Tree

21	Akash Bel	<i>Casytha filiformis</i>	Lauraceae	Fruit	Treats sexually transmitted diseases and erectile dysfunction	Parasite
22	Mat-Garan	<i>Ceriops tagal</i>	Rhizophoraceae	Bark	Stops hemorrhages, useful for ailments resembling peptic ulcers	Shrub
23	Hudo	<i>Acrostichum aurium</i>	Pteridaceae	Rhizome	Treats boils and carbuncles	Shrub/Understory
24	Bon-Jui	<i>Clerodendrum inerme</i>	Lamiaceae	Leaves	Contains bitter extract used as a febrifuge	shrub
25	Chuliakan ta	<i>Derris trifoliata</i>	Fabaceae	Root	Treats chronic alcoholism, useful as a stimulant and antispasmodic	.Climber
26	Gorshingia	<i>Dolichandron spathaceae</i>	Bignoniaceae	Seed	Antiseptic properties, used in enteric spasms	Shrub
27	Panlota	<i>Finlaysonia obovata</i>	Rubiaceae	Leaf	Remedy for dysentery	Climber
28	Nona Hatisur	<i>Heliotropium curassavicum</i>	Boraginaceae	Root	Dried root powder used for treating wounds, cuts, and external ulcers	Herb
29	Bhola	<i>Hibiscus tiliaceus</i>	Malvaceae	Leaf, Bark,	Leaf extract used as a laxative, Bark mucilage for dysentery-like symptoms	Herb
30	Goria	<i>Kandelia candel</i>	Rhizophoraceae	Leaf	Treats problems related to frequent urination	Shrub
31	Kripal	<i>Lumnitzera racemosa</i>	Combretaceae	Stem	Stem fluid is used to treat skin rashes and itches	Shrub
32	Dudhilata	<i>Pentatropis capensis</i>	Apocynaceae	Latex	Latex is used to heal minor burns	Climber
33	Tagri Bani	<i>Scyphiphora hydrophyllaceae</i>	Rubiaceae	Shoot	Shoot extract used for enteric diseases and liver problems	Shrub

34	Ora	<i>Sonneretia griffithii</i>	Lythraceae	Fruit	Fruit is used as spice and for adding flavor in cooking	Tree
35	Antomul	<i>Tylophora tenuis</i>	Apocynaceae	Stem, Leaves	Decoction is used for bile/liver problems and perspiration	Herb
36	Sultan Champa	<i>Calophyllum inophyllum</i>	Calophyllaceae	Seed	Skin problems, rheumatism, swellings, ulcers, scabies, ringworm	Tree
37	Nagchampa	<i>Mesua ferrea</i>	Clusiaceae	Leaves, flowers	Used as an antiseptic and blood purifier, it treats skin problems, colds, fever and rheumatism.	Tree

Bioactive Compounds of the Medicinal Plants and their functions:

Investigating the botanical wealth of the Indian Sundarbans reveals a wide variety of bioactive compounds in various plant species responsible for healing properties. These substances, such as alkaloids, flavonoids, glycosides, phenolic compounds, and tannins, have anti-inflammatory, antioxidant, antimicrobial, and therapeutic potentials (Das, 2021). Thus offering significant medicinal implications for potential drug development and other health benefits.

Antioxidant Properties:

Mangrove species like *Rhizophora* spp. and *Avicennia* spp. are recognized for their rich content of diverse bioactive compounds with potent antioxidant properties. These compounds encompass tannins, flavonoids, phenolic compounds, carotenoids, xanthenes, and quinones, collectively contributing to their anti-oxidative potential. Tannins, widely present in these species, possess robust antioxidant capabilities, neutralizing free radicals and preventing cellular damage caused by oxidative stress (Dahibhate et al., 2020). Flavonoids, another prevalent compound, offer similar protective effects, aiding in the body's defense against oxidative damage and reducing inflammation. Phenolic compounds such as gallic acid, caffeic acid, and ferulic acid act as strong antioxidants, playing a crucial role in protecting cells from oxidative stress-induced damage. Carotenoids, renowned for their pigment qualities, also act as antioxidants, contributing to the body's overall scavenging of free radicals (Saranraj et al., 2016; Eswaraiah et al., 2020).

Antimicrobial Potential:

Rhizophora mucronata, *Sonneratia alba*, and *Avicennia marina* are recognized for their antimicrobial qualities and contain a wide range of bioactive substances, such as flavonoids,

alkaloids, saponins, and phenolic compounds. These compounds have been studied for their potential to combat a wide spectrum of pathogens, showcasing promising abilities to fight microbial infections (Mitra et al., 2021). Flavonoids, prevalent in these mangroves, possess antimicrobial properties, effectively inhibiting the growth and spread of various bacteria, fungi, and viruses. Alkaloids, another significant group of compounds, contribute to their antimicrobial efficacy by displaying inhibitory effects against pathogenic microorganisms (Dahibhate et al., 2019). Saponins in these mangroves exhibit detergent-like properties, disrupting microbial cell membranes and inhibiting their growth. Phenolic compounds, known for their antioxidative abilities, also demonstrate antimicrobial effects, aiding in combating microbial infections (Nabeelah Bibi et al., 2019).

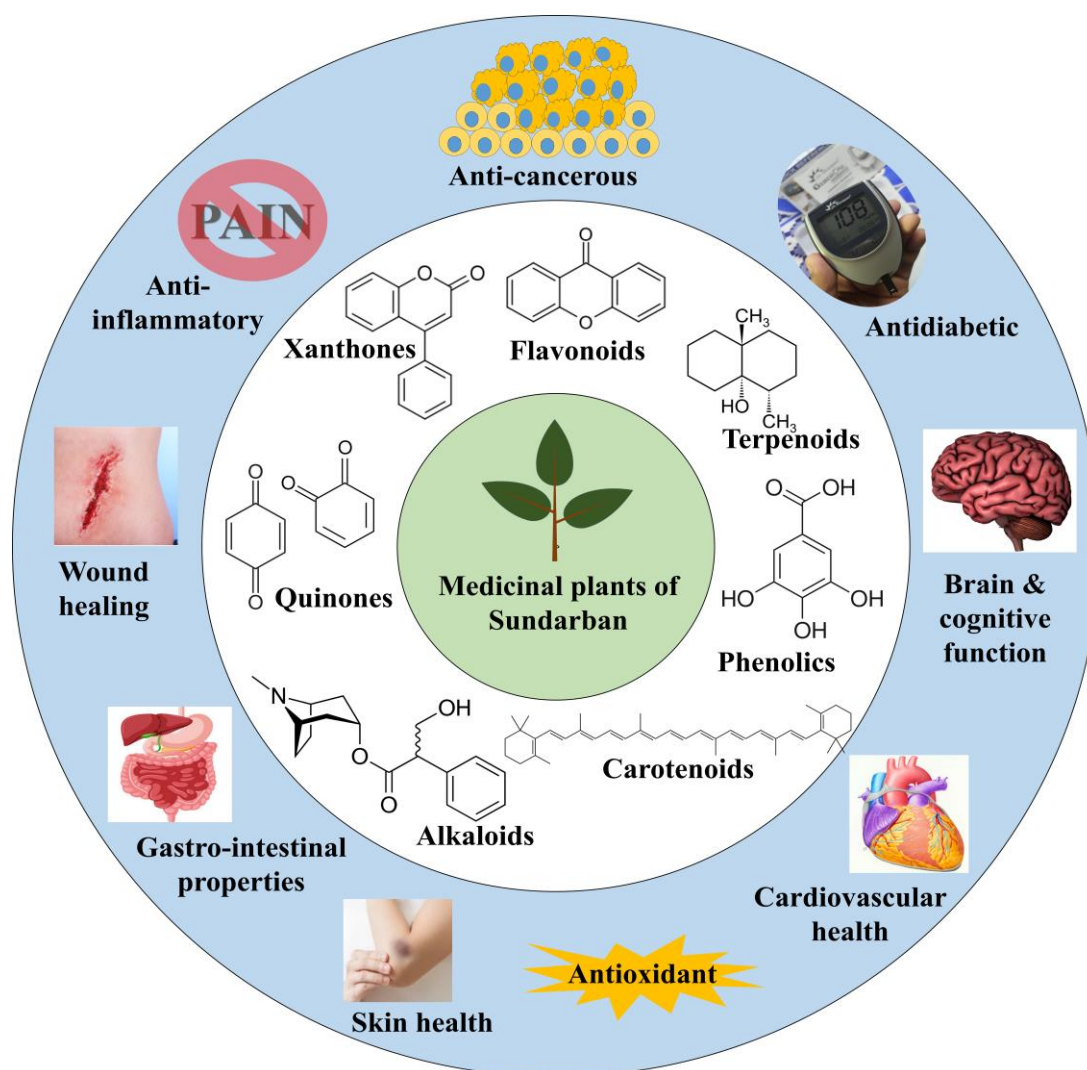


Figure 1. Some bioactive compounds and their health implications (Figure concept adapted from Wani et al., 2020)

Anti-inflammatory Effects:

Avicennia spp., *Ceriops decandra*, and *Avicennia officinalis* contain an impressive combination of flavonoids, terpenoids, and phenolic compounds. These compounds exhibited the potential to alleviate inflammation by modulating key pathways involved in the inflammatory process. Flavonoids, well-known for their antioxidative and anti-inflammatory effects, work synergistically with terpenoids, which display robust anti-inflammatory actions. Phenolic compounds further contribute by suppressing inflammatory mediators. The collective presence of these bioactive compounds in these mangrove species signifies their promising therapeutic potential in managing inflammatory conditions (Sithranga Boopathy & Kathiresan, 2010; Sohaib et al., 2022).

Wound Healing Abilities:

Tannins and phenolic compounds found in *Rhizophora* spp., *Ceriops zippeliana*, and *Avicennia integra* play pivotal roles in fostering wound healing. These compounds are believed to expedite wound closure, facilitate tissue repair, and potentially exhibit antimicrobial properties, thereby promoting accelerated healing processes. Known for their astringent qualities, tannins assist in contracting tissues, reducing bleeding, and aiding in wound closure. With their antioxidative and antimicrobial attributes, Phenolic compounds contribute to tissue regeneration and may prevent infection, collectively fostering a conducive environment for faster and more efficient wound healing in these mangrove species (Vinoth et al., 2019; Fernandez et al., 2002).

Cardiovascular and Gastrointestinal Health:

The phenolic compounds in *Sonneratia apetala* and *Acanthus ebracteatus*, along with the xanthenes in *Mesua ferrea*, have potential cardiovascular and gastrointestinal wellness advantages. These compounds likely possess antioxidant properties, shielding cells from oxidative stress, and may exhibit anti-inflammatory effects, potentially alleviating inflammation within these systems. Their combined antioxidative and anti-inflammatory attributes suggest promising implications for promoting cardiovascular and gastrointestinal health within these mangrove species (Lalitha et al., 2019; Sasidhar, 2020; Kshirsagar et al., 2020).

Skin Health and Diabetes Management:

Carotenoids and xanthenes present in *Avicennia lanata*, *Calophyllum inophyllum* signify potential advantages for skin health. Carotenoids, known for their antioxidant properties, may support skin integrity (Sumadri et al., 2018). Glycosides in *Lumnitzera racemosa* and *Aegiceras corniculatum* suggest potential antidiabetic effects. These compounds could assist in managing diabetes, potentially regulating blood sugar levels. Together, these bioactive compounds in these mangroves hint at beneficial prospects for skin wellness and diabetes management, promising natural support for these health aspects (Kumar & Pola, 2023).

Potential for Antitumor Activity and Cancer Treatment:

Excoecaria agallocha and *Xylocarpus* spp. contains flavonoids and alkaloids, demonstrating promising potential in impeding tumor growth. These compounds exhibit cytotoxic effects specifically targeted at cancerous cells, suggesting a role in inhibiting tumor progression. Their identified bioactivity indicates a possible avenue for developing novel cancer treatments, leveraging these natural compounds' abilities to selectively combat and hinder tumor cell proliferation, fostering hope for future therapeutic interventions in oncology. *Xylocarpus granatum*, *Rhizophora stylosa* holds phenolic compounds, lignans, terpenoids, and xanthenes, showing promising potential in fighting cancer. These bioactive compounds possess cytotoxic properties that may selectively target and inhibit the growth of cancerous cells. Recognized for their anticancer effects, these compounds suggest a potential avenue for developing treatments that aim to impede cancer cell proliferation within these mangrove species (Audah, 2018).

Threats and Conservation:

The traditional use of these medicinal plants has been a cornerstone of local healthcare practices in the Sundarbans. While these plants have shown promising therapeutic potential, further scientific exploration and validation are imperative to ascertain their efficacy, safety, and mechanisms of action. However, these medicinal mangrove plants face severe threats like habitat destruction from logging and urbanization, climate change impacts like rising sea levels, cyclonic disruption, pollution from industrial waste, and unregulated commercial harvesting (Sharma et al., 2021).

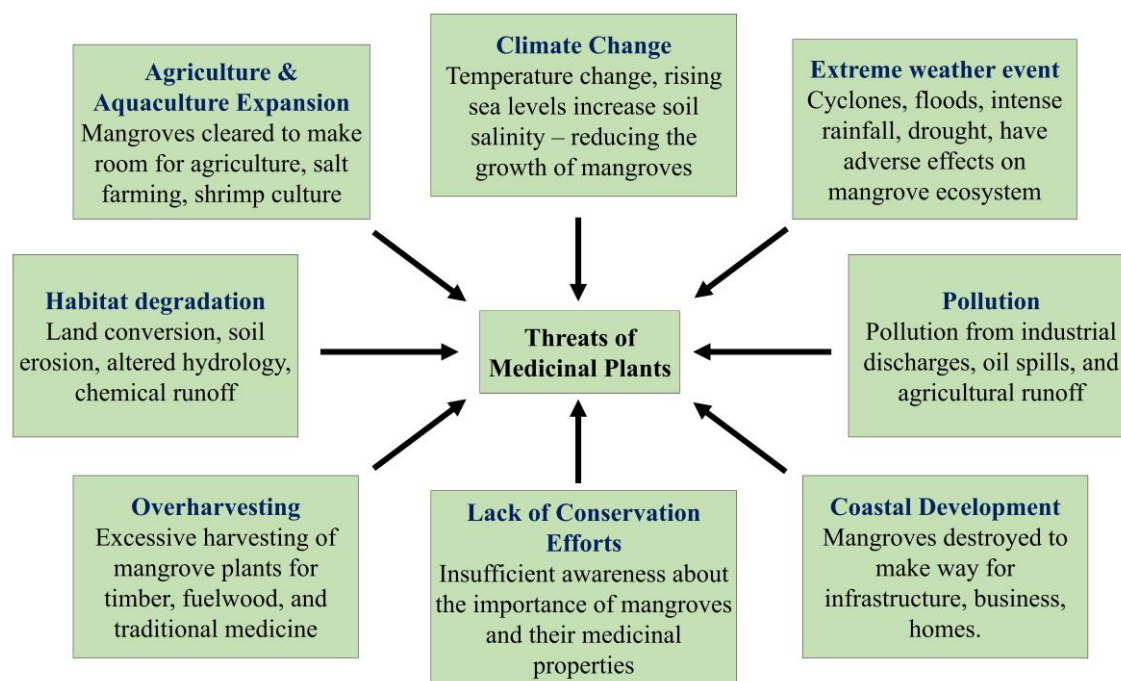


Figure 2. Some potential threats to the medicinal plants.

Urgent conservation efforts focusing on habitat protection, climate resilience, pollution control, and sustainable harvesting are necessary to safeguard these medicinal plants in the Sundarbans. Empowering local communities through education and eco-friendly practices can conserve this invaluable heritage, ensuring the preservation of the biodiversity of Sundarban and traditional knowledge. Efforts to protect these practices maintain cultural identity and offer insights into sustainable living and traditional healthcare systems. Conservation efforts should prioritize protecting habitats, engaging local communities, conducting research, enforcing policies against illegal harvesting, and fostering international collaboration to safeguard medicinal mangrove plants in the Sundarbans (Chowdhury et al., 2016).

Conclusion:

In conclusion, the diverse array of medicinal plants thriving in the Indian Sundarbans represents an invaluable resource for the local communities and the broader field of medicine. The preservation and scientific exploration of this botanical wealth stand to offer significant contributions to humanity's quest for novel therapeutic interventions and holistic healthcare practices. Integrating traditional knowledge with modern scientific research holds the promise of uncovering novel medicinal compounds and treatments, potentially enriching the global pharmacopeia.

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