Ethnobotanical, phytochemical, and pharmacological review of four medicinal plants used by various tribal communities in Bangladesh

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Review

Abstract

Background: The indigenous tribes of Bangladesh, whose plant based treatments have been conserved and passed down through the centuries, rely heavily on traditional medical knowledge for basic healthcare. Four commonly used medicinal plants - *Allium sativum, Colocasia esculenta, Datura metel,* and *Moringa oleifera* are examined in this review along with their phytochemical profiles and pharmacological characteristics.

Methods: About 180 published articles on indigenous knowledge of medicinal plants in the different regions, with a focus on scheduled tribe populations from electronic databases like Scopus, Google Scholar, Web of Science, PubMed, and Science Direct were used to gather secondary data. After manual removal of duplicates, screening done by reading abstract, full texts and data were collected. From the review and visual findings, all the tables were generated manually. For each plant, plant species, geographic region, tribal community, used part, ethnomedicinal properties, phytochemical constituents and pharmacological activities recorded.

Results: The literatures revealed that the selected plants contain diverse bioactive constituents, including organosulfur compounds, phenol, flavonoids, alkaloids, terpenoids, and glycosides, which are associated with antimicrobial, anticancer, antioxidant, hepatoprotective, antidiabetic, and neuropharmacological effects. Tribal communities use these plants to treat various diseases, and ritualistic ailments. The results showed the major classes of phytochemicals in our selected four medicinal plants from Bangladesh and their pharmacological roles, with emphasis on their applications in traditional and modern medicine.

Conclusions: The findings underscore the deep interconnection between biodiversity and indigenous cultural practices, of medicinal plants specially in Bangladesh and highlight the importance of documenting traditional knowledge for future drug discovery initiatives and sustainable healthcare strategies. Preservation, scientific validation, and responsible utilization of ethnomedicinal resources are essential to support both community health and modern pharmacological research.

Keywords: *Allium sativum, Colocasia esculenta*, *Datura metel,* Ethnobotany, *Moringa oleifera,* Bangladesh

Background

Medicinal plants have been used globally for their multiple uses in traditional medicine. Their biological properties and bioactive constituents have been explored through traditional bioassay guided drug discovery and modern reverse pharmacognosy approaches (Mariangela 2021). Plants play a significant role because they offer vital functions to ecosystems. Humans and other living things cannot exist as they ought to in the absence of plants. Medicinal herbs consistently served as a reliable source for ecosystems. Unquestionably, people have thought about medicinal plants since the beginning of time (Jamshidi *et al.* 2018). Humans have traditionally depended on plant derived resources to address various health needs, owing to their inherent therapeutic properties. Interactions among phytoconstituents can influence pharmacological activity producing synergistic, antagonistic, or modulatory effects that ultimately shape the plant's overall therapeutic potential (Rasool 2012, Jack 1997). Due to the relatively minimum side effects, traditional herbal treatment has been employed for several years in both developed and developing nations (Wichtl 2004). Limited access to modern healthcare has led rural women to rely on Ayurvedic remedies for gynecological conditions such as abortion, menstrual irregularities, infertility, and childbirth complications. These herbal treatments are affordable, accessible, and generally safer, yet much of this traditional knowledge remains undocumented. With modernization threatening its preservation, systematic documentation of this valuable Ayurvedic heritage is essential for advancing medical science (Ferdous & Hossain 2020). The use of medicinal plants evolved from empirical practices to evidence-based applications as their therapeutic mechanisms became understood. Before the rise of iatrochemistry in the 16th century, plants were primary sources of treatment and prevention. Many food crops also exhibit medicinal properties that are key to their therapeutic value. Studying these metabolites helps identify new drugs, understand plant toxicity, and preserve biological diversity (Hossain *et al*. 2013) In Bangladesh, the majority of tribal community use medicinal plants as Ayurvedic and Unani drugs. Most tribal people in Bangladesh seek treatment for their illnesses from traditional medical practitioners. In addition to using medicinal plants to cure patients, traditional healers are regarded as authorities in plant knowledge and formulations for curing illnesses (Alam *et al*. 2022). Medicinal plants used by various tribes throughout Bangladesh reported by various researchers in their documentations in recent years (Rahmatullah 2012). Tribal communities possess medicinal knowledge from generation to the next through their family serving as apprentices to the practitioner. Scientists and the general human beings can gain considerable information if adequate documentations of tribal medicinal practices are stored properly. In addition to indicating potential therapeutic benefits, adequate documentation of a plant species can give scientists a broad overview of the species so they can investigate it and isolate its bioactive components (Kabir *et al* 2014).

Ethnobotanical documentation is limited in Bangladesh, most of the studies covering only one plant species or one geographic region, and very few studies bringing the traditional use and phytochemical, pharmacological information together in the same context (Rahmatullah 2012; Alam et al. 2022). This disintegration hinders the use of traditional knowledge in the formulation regarding pharmacology. The present review fills this gap by choosing four medicinal plants - *Allium sativum*, *Colocasia esculenta, Datura metel* and *Moringa oleifera* - not at random but in compliance with the specific reasons necessary to make meaningful and useful comparisons in this integrative approach: (i) consistent and recurring documentation of traditional use across multiple tribal communities in Bangladesh - Chakma, Tripura, Marma and Santal; (ii) the presence of different phytochemical classes - organosulfur compounds, tropane alkaloids and the flavonoid rich profile - allowing traditional use and (iii) sufficient existing literature of phytochemistry and pharmacology to allow a correlation between traditional use and modern evidence. This review aims to recognise species where the traditional use of the tribal communities and the pharmacological evidence converge, to highlight any lack of documentation, and to pinpoint any areas where the tribal communities live, and using the species. The same rationale applies to the practical objective of the review work - establishing an evidence based approach for prioritizing future analytical, toxicological, and clinical studies of those species in Bangladesh.

Materials and Methods

Data Sources and Search Strategy

Relevant publications were retrieved from the databases: PubMed, ScienceDirect, Scopus, Web of Science, and Google Scholar for the year (1990-2025). Searches included combinations of the terms - ethnomedicine, ethnobotany, traditional use, tribal communities, indigenous knowledge, *Allium sativum*, *Colocasia esculenta*, *Datura metel*, *Moringa oleifera*, phytochemistry, pharmacology, toxicity information, medicinal plants. No primary surveys or fieldwork were performed; all information was collected from previously published literature.

Review Design

This study was conducted as an integrative narrative review, synthesizing ethnomedicinal, phytochemical, and pharmacological information on four medicinal plants used by indigenous communities in Bangladesh (*Allium sativum*, *Colocasia esculenta*, *Datura metel*, and *Moringa oleifera*). Following PRISMA framework, after manual removal of duplicate articles from relevant database searches, a total 180 were identified, by reading abstract and full texts, 100 duplicate records were removed before screening based on (same article appearing in more than one database) by comparing titles, authors, and publication years. Applying the eligibility criteria to titles, abstracts, and full texts, 50 records were excluded, and 30 records that met all eligibility criteria and provided comprehensive ethnobotanical, phytochemical, pharmacological data of the four plants, with specific relevance to indigenous use in Bangladesh were included in the qualitative narrative synthesis.

Eligibility Criteria

Inclusion criteria

Peer reviewed articles, theses, books, and ethnobotanical reports, Studies reporting tribal medicinal uses of the selected plants, Studies describing phytochemistry and pharmacology of the plants, Publications in English, 1990-2025.

Exclusion criteria

Studies unrelated to ethnomedicine, phytochemistry, or pharmacology, non-English papers, conference abstracts without full text, and articles with insufficient methodological clarity.

Quality Considerations

Because this is a literature based review, quality appraisal focused on: peer review status of the source, clarity and reliability of ethnobotanical documentation, experimental rigor of phytochemical and pharmacological studies. Only sources considered methodologically credible were included.

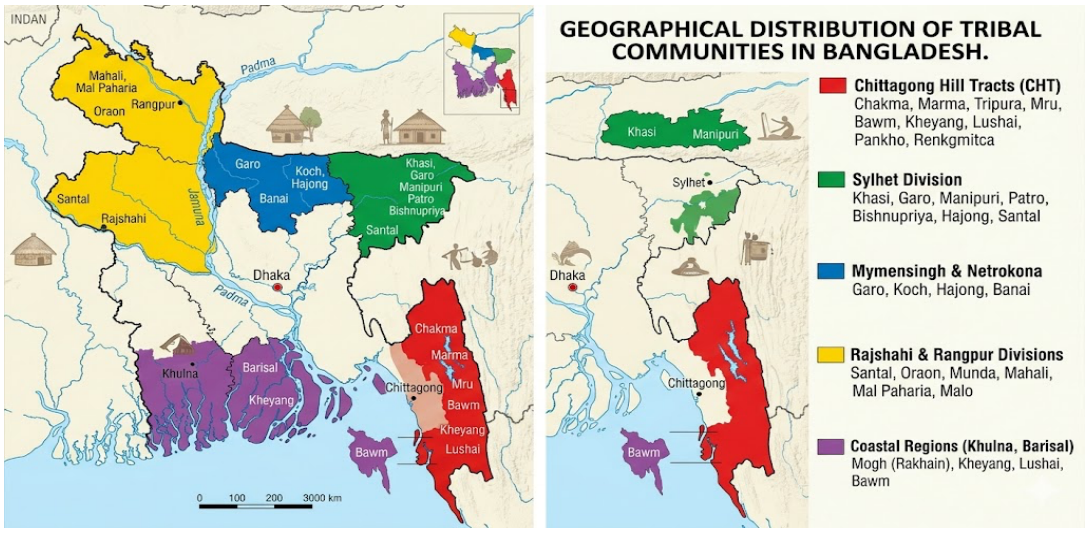


Figure 1. Geographical distribution of indigenous communities in Bangladesh

***Alliu sativum* L.**

Allium sativum L., commonly known as garlic**,** is a well-known medicinal plant, the member of the family Amaryllidaceae. It has been used in traditional medicine due to its rich phytoconstituents. All parts of the plants, including bulbs, leaves, cloves, and flowers, are utilized for their efficacy in the treatment of a variety of diseases (Tudu *et al* 2022).

Taxonomic description of *Allium sativum*

A. sativum belongs to the kingdom Plantae, within the angiosperm clade, and is classified among the monocots. It is placed in the order Asparagales, family Amaryllidaceae, subfamily Allioideae, tribe Allieae, genus Allium. Native is central Asia to Iran. It is a bulbous geophyte, and cultivated in Bangladesh, India, China. (POWO 2023; WFO 2023).

Phytochemical constituents

A. sativum is rich in organosulfur compounds**,** flavonoids**,** enzymes**,** and phenolics which are responsible for wide range of pharmacological effects (Choudhary *et al*. 2022).

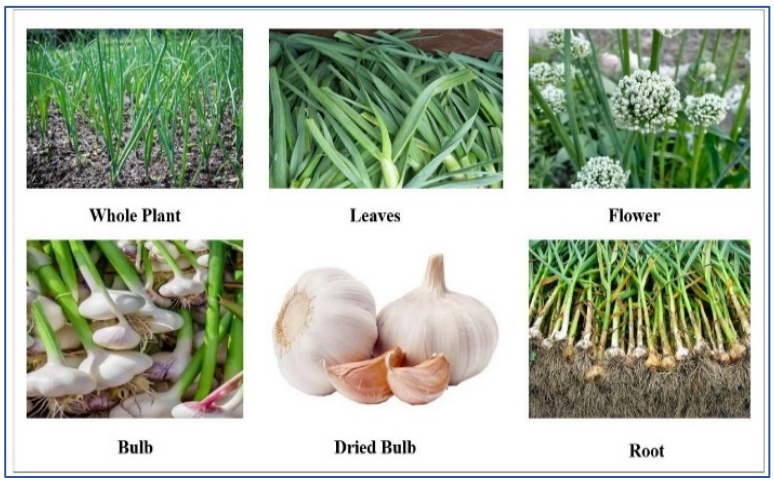


Figure 2**.** Different parts of *A. sativum* used in traditional medicine

Table 1. Phytochemical Constituents of *Allium sativum*.

Compound	Plant Parts	Extraction Method	Analytical Method	Reference
Allicin, diallyl disulfide, ajoene	Bulb	Crushing / aqueous-organic extraction	HPLC (organosulfur quantification)	Sekar et al. 2015; Alam et al. 2016
S-allyl cysteine (SAC)	Bulb	Aqueous extraction	HPLC	Gorrepati et al.2024
Quercetin, kaempferol	Bulb, leaf	Ethanolic extraction	HPLC	Gorrepati et al.2024
Gallic acid, caffeic acid	Bulb	Ethanolic extraction	HPLC	Gorrepati et al.2024
β-Carotene	Bulb	Solvent extraction	HPLC	Gorrepati et al.2024

Pharmacological activities

The plant is rich in several pharmacological properties. A tabular presentation is showing pharmacological activities of *A. sativum.*

Table 2. Summarization of the pharmacological activities of *Allium sativum*. The pharmacological properties are derived from scientific literature of various indigenous communities in Bangladesh**.** Evidence type follows a four tier hierarchy-Traditional, In vitro, in vivo (animal), Clinical (human).

Pharmacological Activities	**Description**	**Evidence Type**	**References**
Antibacterial	Effective against Gram positive and Gram negative bacteria; allicin disrupts lipid synthesis in microbial membranes.	In vitro	Tesfaye 2021
Anti inflammatory	Inhibits inflammatory mediators such as cytokines and prostaglandins; useful in arthritis.	in vitro, in vivo (animal)	Tesfaye 2021
Antioxidant	Scavenges free radicals; protects DNA and cell membranes from oxidative damage.	In vitro	Okoro *et al.* 2023
Antihypertensive	Lowers blood pressure; improves lipid profile by reducing LDL and triglycerides, increased HDL; prevents thrombosis.	In vivo, clinical (limited)	Mondal *et al.* 2021
Anticancer	Sulfur compounds inhibit cancer cell proliferation; effective against stomach, colon, prostate, and breast cancers.	In vitro, in vivo (animal)	Nasir *et al*. 2020
Hepatoprotective	Reported to protect liver cells and reduce oxidative stress and gentamycin-induced hepatotoxicity in studies.	in vivo (animal)	Sripanidkulchai 2019
Anti Alzheimer's	Reduces acetylcholinesterase (AChE) activity; supports neurotransmitter function and antioxidant protection in the brain.	In vitro	Del *et al.* 2022
Immunomodulatory	Stimulates natural killer cells and macrophages, suggesting enhanced immune response.	In vitro, in vivo (animal)	Tesfaye 2021

***Colocasia esculenta* (L.) Schott.**

The annual herb *Colocasia esculenta* L.*,* is a member of the Araceae family, has long been used in traditional medicine, particularly in tropical and subtropical areas. It is majorly cultivated in Southeast Asia by several common names like Arbi, Arvi and Eddoe (Sharma *et al*. 2020).

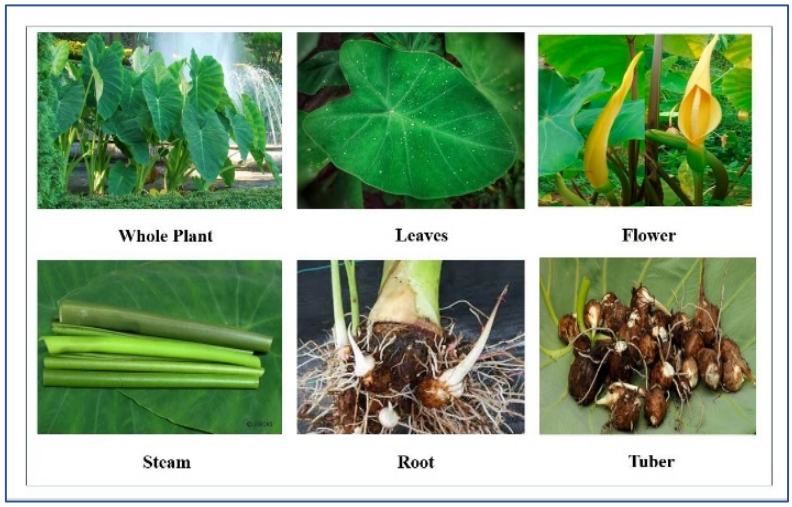


Figure 3. Different parts of *C. esculenta* used in traditional medicine

Taxonomic description of *C. esculenta*

C. esculenta, commonly known as taro, a tropical herbaceous plant classified under the kingdom Plantae, is a multicellular plant. It belongs to the class Equisetopsida. It is part of the order Alismatales and the family Araceae. The genus is *Colocasia*, and the species is *Colocasia esculenta* (L.) (Jain *et al.* 2023). It is tuberous geophyte and grows primarily in the wet tropical biome. It is distributed to Bangladesh, Assam, India, Myanmar, Malaya, Nepal, China Southeast, East Himalaya, Laos, Sumatera, Taiwan, Thailand (POWO, 2026).

Phytochemical constituents

Colocasia leaf extracts contain flavonoids and triterpenoids, two pharmacologically active compounds. The presence of other phytoconstituents contribute to nutritional, medicinal, and functional properties (Sudhakar *et al.* 2020).

Table 3. Phytochemical Constituents of *Colocasia esculenta*.

Compounds	Plant parts	Extraction Method	Analytical Method	References
Quercetin, kaempferol, gallic acid, caffeic acid, luteolin-7-rutinoside, chlorogenic acid, vitexin, rutin	Leaves	Ethanolic extraction	LC-MS	Varghese et al. 2024
Gallic acid, benzoic acid, catechin, chlorogenic acid, astilbin, quercetin, kaempferol, rutin, vitexin, ellagic acid, caffeic acid, luteolin-6,8-C-diglucoside, 6,2′,4′-trimethoxyflavanone	Whole plant (ethanolic extract)	Ethanolic extraction	HPLC	Elmosallamy et al, 2021
Stearic acid, arachidonic acid, 8-heptadecene, (S)-citronellic acid, D-germacrene	Whole plant (petroleum ether extract)	Petroleum ether extraction	GC	Elmosallamy et al, 2021
3,4,5-tri-O-methyl gallic acid and related phenolics	Corm (tuber)	Solvent extraction	HPLC-DAD; confirmed by NMR/MS	Corm phenolic study, Giardino della Minerva, Salerno
Pyrogallic acid, gallic acid, syringic acid, benzoic acid, vanillic acid	Tuber	Solvent extraction	HPLC	Pertiwi et al, 2025
p-Coumaric acid, trans-ferulic acid, rosmarinic acid, myricetin, kaempferol	Leaves	Solvent extraction	HPLC DAD	Wen et al 2005

Pharmacological properties

Table 4. Summarization of the pharmacological activities of *C. esculenta*. The pharmacological properties are derived from scientific literature of various indigenous communities in Bangladesh. Evidence type follows a four tier hierarchy - Traditional, In vitro, in vivo (animal), Clinical (human).

Pharmacological Activities	Description	Evidence Type	References
Antimicrobial & Antifungal	Exhibits activity against a broad range of fungi and bacteria for having various bioactive compounds.	In vitro	Jain *et al.* 2023
Antidiabetic	Hypoglycemic effects attributed to alkaloids, flavonoids, tannins, dietary fiber, and saponins.	in vivo (animal)	Jain *et al.* 2023
Anticancer	Contains immunostimulatory and tumor-specific compounds; induces anti-cancer activity. In vivo and clinical evidence is lacking.	In vitro	Jain *et al.* 2023
Anti inflammatory	Suppresses COX and LOX pathways; bioactive flavonoids, alkaloids, and tannins modulate inflammation.	in vivo (animal)	Prajapati et al. 2011
Antihepatotoxic	Protects liver due to antioxidant and membrane-stabilizing activity of flavonoids, tannins, and polysaccharides.	in vivo (animal)	Pawar *et al*. 2018
Antioxidant	Scavenges free radicals; helps prevent oxidative stress-linked diseases like diabetes, cancer, and cardiovascular disorders.	In vitro	sudhakar *et al.* 2020
Anthelmintic	Active against parasitic worms; disrupts worm metabolism and motility.	In vitro	sudhakar *et al.* 2020

***Datura metel* L.**

One known poisonous plant in the Solanaceae family is *Datura metel* L. The plant has long been used to treat broad range of illnesses, such as heart and neurological conditions, fever, pain, diarrhea, skin conditions, insects bite, chronic bronchitis, asthma, digestive issues, etc (Islam *et al*. 2023).

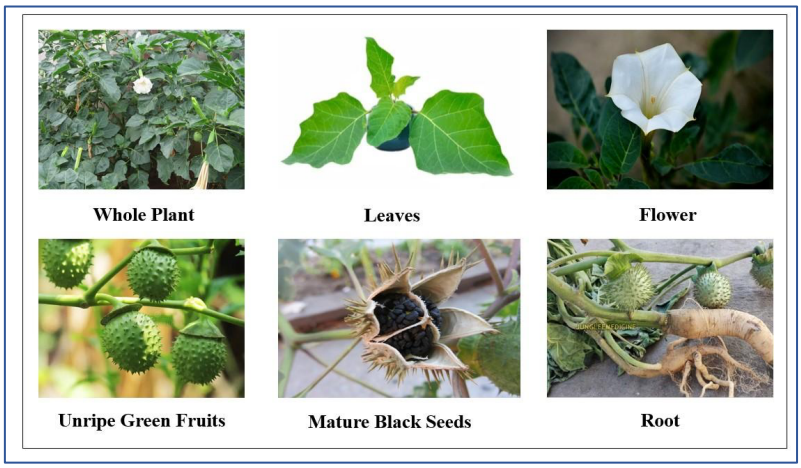


Figure 4. The use of different parts of *D. metel* in traditional medicine

Taxonomic description of *D. metel*

D. metel, a well-known plant belongs to the kingdom Plantae and is further placed in the class Equisetopsida *and* is categorized under the subclass Magnoliidae, also belongs to the order Solanales. Within this order, it is a member of the family Solanaceae **(**Islam *et al*. 2023). It is distributed worldwide including Bangladesh, China, India, Africa, Southeast Asia, and many Pacific and American territories and they possess medicinal uses (POWO, 2026)

Phytochemical Constituents

Several phytoconstituents present in *D. metel* including steroids, flavonoids essential oils etc.

Table 5. Phytochemical Constituents of *Datura metel*.

Compounds	Plant parts	Extraction Method	Analytical Method	References
Hyoscyamine, scopolamine	Leaves, seeds	Solvent extraction	HPLC / GC-MS	Cinelli et al. 2021
Meteloside F, meteloside G (new steroids), plus 6 known steroids	Seeds	Column chromatography (silica gel, ODS)	HPLC, NMR and HR-ESI-MS	Yang et al. 2020
Caffeic acid	Leaves	Solvent extraction	GC-EI/TOF-MS	Rahmoune et al, 2017

Pharmacological Activities

Table 6. Summarization of the pharmacological activities of *Datura metel*. The pharmacological properties are derived from scientific literature of various indigenous communities in Bangladesh**.** Evidence type follows a four tier hierarchy - Traditional, In vitro, In vivo (animal), Clinical (human).

Pharmacological Activities	Description	Evidence Type	References
Anti asthmatic	Bronchodilating and anticholinergic effects; alkaloids like atropine and scopolamine inhibit muscarinic receptors to relieve bronchospasms.	In vitro	Alam *et al.* 2021
Antioxidant	Contains compounds that scavenge free radicals; helps prevent cellular damage.	In vitro	Damergi *et al.* 2023
Antimicrobial	Active against bacteria, fungi, and some viruses; due to alkaloids, flavonoids, essential oils, tannins, saponins and phenolics.	In vitro	Ali and Awake ,2021
Anti inflammatory	Inhibits pro-inflammatory mediators like prostaglandins, histamine, and cytokines.	In vitro, In vivo (animal)	Ruksiriwanich *et al.* 2023
Anticancer	Alkaloids and flavonoids induce apoptosis and inhibit cancer cell proliferation.	In vitro	Islam *et al.* 2023
Antidepressant	Influences neurotransmitter systems; attributed to alkaloid and flavonoid content.	In vivo (animal)	Sharma *et al.* 2021
Antifertility	Contraceptive effects in animal models; influences hormones and gamete formation.	In vivo (animal)	Pandiarajan *et al.* 2012
Hypoglycemic	Enhance insulin secretion, improve glucose uptake, and inhibit carbohydrate digesting enzymes.	In vivo (animal)	Murthy *et al.* 2004

***Moringa oleifera* L.**

Moringa oleifera L. is the most used species because of its numerous phytoconstituents and having pharmacological properties related to human health benefit (Ma *et al.* 2020).Traditionally, Nervous debility, fever, cough, asthma, paralysis, blood pressure, diabetes, diarrhea, cholera, spasms, infection and ulcer, enlarged liver and spleen, and inflammation have all been treated using *M. oleifera* leaves (Sultana 2020).

Taxonomic description of *M. oleifera*

M. oleifera, commonly known as the drumstick tree in Bangladesh, belongs to the kingdom Plantae, taxonomically, it falls under the class Equisetopsida, and the subclass Magnoliidae. Within the plant classification hierarchy*, M. oleifera* belongs to the order Brassicales. The species is a member of the family Moringaceae. Its native is India, Pakistan but distributed subtropical Bangladesh, Southeast Asia, most of sub-Saharan Africa, the Caribbean, Central America, and Pacific islands (POWO, 2026).

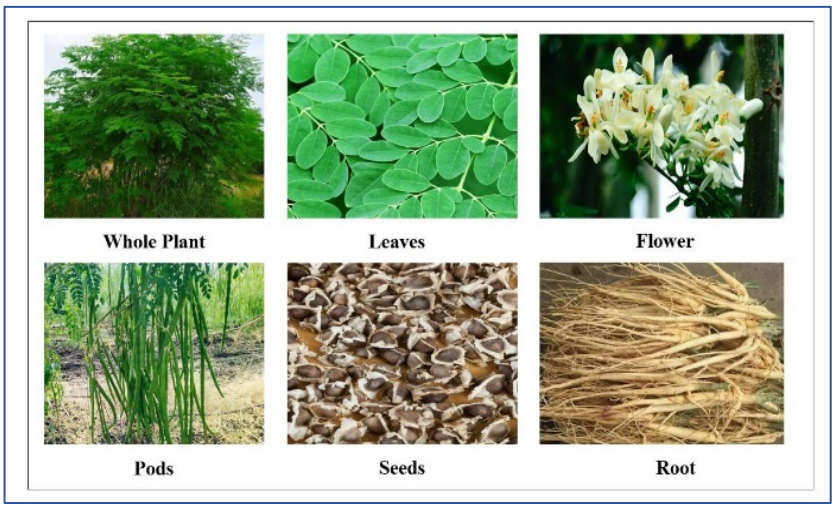


Figure 5. The use of different parts of *M. oleifera* in traditional medicine

Phytoconstituents

M. oleifera contains rich source of various phytoconstituents (Pareek et al. 2023, Table 7).

Table 7. Phytochemical Constituents of *Moringa oleifera*.

Compounds	Plant parts	Extraction Method	Analytical Method	References
Quercetin, kaempferol, rutin, isorhamnetin, apigenin, chlorogenic acid, caffeic acid, ferulic acid, gallic acid, p-coumaric acid	Leaves	Methanolic extraction	HPLC-MS	Narigara et al. 2025
β-Sitosterol, stigmasterol, campesterol; gamma-sitosterol	Leaves	Methanolic extraction	GC-MS/MS	Taher et al. 2025
Glucosinolates, isothiocyanates	Leaves, seeds	Methanol/water extraction	HPLC LC-MS	Maldini et al.2014

Pharmacological activities

Table 8. Summarization of the pharmacological activities of *Moringa oleifera*. The pharmacological properties are derived from scientific literature of various indigenous communities in Bangladesh. Evidence type follows a four tier hierarchy-Traditional, In vitro, in vivo (animal), Clinical (human).

Pharmacological Activities	Description	Evidence Type	References
Anti asthmatic	Alleviates airway inflammation and bronchoconstriction; bronchodilatory and anti-inflammatory actions.	In vivo C	Malage *et al.* 2020
Antidiabetic	Regulates blood glucose levels; improves insulin sensitivity and β-cell function via flavonoids, alkaloids, and phenolic acids, suppression of excessive glucose production by the liver.	in vivo (animal)	Mthiyane *et al.* 2022
Antimicrobial	Broad-spectrum activity against bacteria, fungi, and viruses due to flavonoids, alkaloids, phenolics, and isothiocyanates.	In vitro	Malage *et al.* 2020
Anti inflammatory	Reduces inflammation through tannins, phenols, carotenoids, and alkaloids found in all plant parts. The leaf extract lowered eosinophil and monocytes count in the lung fluid.	In vitro, in vivo (animal)	Goyal *et al.* 2009
Antioxidant	Strong free radical scavenging (DPPH, ABTS, FRAP); prevents age-related oxidative stress and degenerative diseases.	In vitro	Bhuker *et al.* 2023

Anti allergic	Stabilizes mast cells; inhibits histamine release and anaphylaxis.	In vitro, in vivo (animal)	Pareek *et al.* 2023
Cardiovascular	Lowers blood pressure, reduces cholesterol, and protects against oxidative and inflammatory heart damage.	in vivo (animal)	Louisa *et al.* 2022
Urinary Tract Infection (UTI)	Stem bark extracts alleviate UTI symptoms; well-tolerated with no reported side effects.	Traditional/preliminary clinical observation	Pareek *et al.* 2023
Neuropharmacological	Leaf extracts show protective effects in Alzheimer's disease models; mechanism involve acetylcholinesterage inhibition, reduced amyloid-beta-related toxicity, and provide protection against oxidative and inflammatory damage.	in vivo (animal)	Srivastava *et al.* 2024
Anticancer	Induces apoptosis, inhibits angiogenesis, and protects against DNA damage; acts on various cancer types in vitro/in vivo.	In vitro, in vivo	Khor *et al.* 2018
Anthelmintic	Kills parasitic worms; leaf and seed extracts immobilize and eliminate earthworms.	in vivo (animal)	Malage *et al.* 2020

Table 9. Comparative ethnobotanical uses of selected medicinal plants among the tribal communities in Bangladesh.

Plants	Tribal community	Region in Bangladesh	Ethnobotanical use	Plant parts	Preparation method	Mode of Administration	Dosage	References
A. sativum	Chakma, Marma	Chittagong Hill Tracts	Respiratory, digestive	Bulb	Raw/mixed with food	Oral	Not specified in source	Rahmatullah et al. 2012
C. esculenta	Chakma, Lushai, Khumi, Marma	Moulvibazar, Rajshahi	Wounds, GI disorders	Leaves, tubers	Cooked/leaf paste	Oral (cooked); topical (paste)	Not specific data in source	Kabir et al. 2014; Shahidullah et al. 2009
D. metel	Garo, Marma, Tripura community	Chittagong, Sylhet Divisions also in Durgapur and madhupur	Asthma, pain	Leaf, flowers, seeds	Smoke/paste	Inhalation (smoke); topical (paste)	Used cautiously due to toxicity	Khan et al. 2015; Shahidullah et al. 2009; Islam et al. 2023
M. oleifera	Chakma, Marma, Garo	Mymensingh, Netrokona, Chittagong	Diabetes, infection,	Leaves, pods, flowers, seeds, bark, roots	Decoction	Oral	8 g/day powdered leaves	Preanto et al. 2025; Pareek *et al.* 2023

Toxicity studies of the plants

Understanding toxicity is crucial for ensuring safe use of medicinal plants in traditional use. The potential toxicity of our selected plants based on their known phytoconstituents and documentation (Table 10).

Table 10. Toxicity, safety profile and contraindications of the selected medicinal plants.

Species	Toxic Constituents	Reported Toxicity	Toxic Dose	Contraindications	Preparation-Related Toxicity	Pregnancy Safety	Drug Interactions	References
Allium sativum	Allicin, organosulfur compounds	Mild GI irritation in high doses; rare hemolytic anemia in animals	No established human LD50; adverse effects reported above typical	Bleeding disorders, hypersensitivity	Raw/crushed (allicin-forming) more irritant than cooked; concentrated supplements carry higher risk than culinary use	Generally acceptable in food-level amounts.	Increases bleeding risk with warfarin/anticoagulants	Okoro et al. 2023; Sripanidkulchai 2019

			dietary intake					
Colocasia esculenta	Calcium oxalate crystals	Oral irritation, throat burning, potential kidney stones	No established LD50, but conc. aqueous leaf extract showed lethality on animal model.	History of calcium oxalate kidney stones, gout	Leaves cause acute oral/throat irritation, thorough cooking	No specific contraindication reported	Not well documented, theoretical concern with oxalate load in patients on medications affecting renal calcium handling	Sudhakar et al. 2020
Datura metel	Tropane alkaloids (atropine, scopolamine, hyoscyamine)	Highly toxic: hallucinations, delirium, respiratory failure, death at high doses	Narrow margin of safety, precise human toxic-dose thresholds not well quantified in the literature	Glaucoma, cardiac arrhythmia, urinary retention, pregnancy	Both smoke inhalation and seed/leaf ingestion carry high risk of anticholinergic toxidrome	Tropane alkaloids cross the placenta, anticholinergic, teratogenic risk	Additive anticholinergic effects with antihistamines, tricyclic antidepressants, exacerbated toxicity with CNS depressants	Pawar et al. 2018; Islam et al. 2023
Moringa oleifera	Alkaloids, glucosinolates, isothiocyanates	Root, seed extracts may cause hypotension, liver toxicity, antifertility effects in high doses	Leaves generally safe at dietary intake, root, seed toxicity shown in animal studies at higher experimental doses.	Root/bark preparations traditionally avoided due to abortifacient/uterotonic properties	Root and seed preparations carry higher risk than leaf preparations (decoction/cooked leaves)	Root and seed preparations should be avoided	Potential additive effect with antihypertensive and antidiabetic medications	Shahidullah et al. 2009; Malage et al. 2020; Pareek et al. 2023

Synthesis and Implications

This overview combines ethnobotanical, phytochemical and pharmacological information from a range of sources to highlight similarities in the use of plants with medicinal properties amongst various tribal peoples in Bangladesh. The four common uses of these plants have been identified as follows: products from the plant being used for antimicrobial activity and the reduction of inflammation, volatile oils and other constituents found in certain plants used to enhance respiratory function, gastrointestinal/metabolic regulation of the body, and the use of *Datura metel* and *Moringa oleifera* for both neuropharmacological and ritualistic purposes. The plants preferred by tribal groups reflect both their accessibility (Figs. 2-5) as well as their biologically active constituents); while more complex herbal formulations prepared by herbal healers often highlight the practical application of these various botanical products.

Implications for Ethnobotanical Science and Drug Discovery

This synthesis is a bridge from tribal and indigenous knowledge to bioprospecting. Future research should focus on (1) clinical testing of tribal doses (2) Research into Polyherbal Formulations (3) Documenting plants with little research or documentation (4) Governance for the conservation of plants native to the Hill Tract region as they are affected by climate change. This review creates a basis for different types of hypothesis testing, allowing for advancements in ethnomedicine based on solid science, while at the same time preserving tribal culture, and promoting sustainably sourced pharmacological agents.

Limitation and future prospects of the review

While this integrative review provides a broad overview of four medicinal herbs used by various tribal communities in Bangladesh, there are constraints to consider. The review is constrained by the availability and accessibility of published articles, which are fragmented region specific. However, due to language barriers and the oral nature of traditional

knowledge transmission, much valuable indigenous knowledge may remain undocumented. The study also lacks uniformity in data collection methodologies across sources, which affects the comparability of ethnobotanical data. While 70% claims align (e.g., *M. oleifera* antidiabetic flavonoids), 30% gaps (e.g., *D. metel* neuro-rituals) underscore need for tribe specific trials, advancing ethno neuropharmacology (Bletter, 2007). Moreover, many of the documentations are not supported by phytochemical or pharmacological validation, limiting their application in evidence based medicine. Lastly, the review may unintentionally omit certain tribal groups or underrepresent less documented plants due to the uneven distribution of ethnobotanical studies across Bangladesh. The selected plants (e.g., *Allium sativum*, *Moringa oleifera, Colocasia esculenta and Datura metel*) have demonstrated bioactive compounds. These results should encourage focused bioprospecting initiatives to discover and isolate new compounds that can be potential for drug development. Research is crucial for proper documentation and regulate the quality of those plants within the contemporary medical framework.

Discussion

The antimicrobial, antioxidant and anti-inflammatory activity of these four species is convergent, because they share a similar background of phenolic and flavonoid compounds; each species is chemically characterized by a predominant compound class, not shared by the other three. The organosulfur compounds, allicin, diallyl disulfide, ajoene and S-allyl cysteine, are the defining features of the wide ranging antibacterial and antihypertensive effects of *A. sativum* (Sekar et al. 2015; Gorrepati et al. 2024; Tesfaye 2021; Mondal et al. 2021). *D. metel* is almost exclusively a tropane alkaloids (hyoscyamine, scopolamine) which results in its narrow but powerful broncho dilatory, anticholinergic and CNS active properties, and, for the same reason, the lowest margin of safety among the four species (Cinelli et al. 2021; Sharma et al. 2021) and (Pawar et al. 2018; Islam et al. 2023). The anti-inflammatory and hepatoprotective activity of *M. oleifera*, combined with its relatively low toxicity (reported only when the dose of the root and seeds is very high (Shahidullah et al. 2009; Pareek et al. 2023)) is likely due to its unique phenolic acids, flavonoids, glucosinolate profile (Narigara et al. 2025; Maldini et al. 2014). *C. esculenta* is the least chemically resolved of the four with reported phytochemistry being a broad range of phenolic acids and flavonoids (quercetin, kaempferol, chlorogenic acid, rutin, vitexin, amongst the others) in different extracts (leaf, corm and whole plant) in all, but without any one clearly dominant bioactive marker as has been reported for allicin, tropane alkaloids or glucosinolates for the other three. The realization of these species with well-defined dominant therapeutic chemotype, compared to single species with toxicological chemotype, is of great interest and is indicative that *C. esculenta* is the key species to be analyzed in the future (GC-MS/HPLC/LC-MS) in the four species.

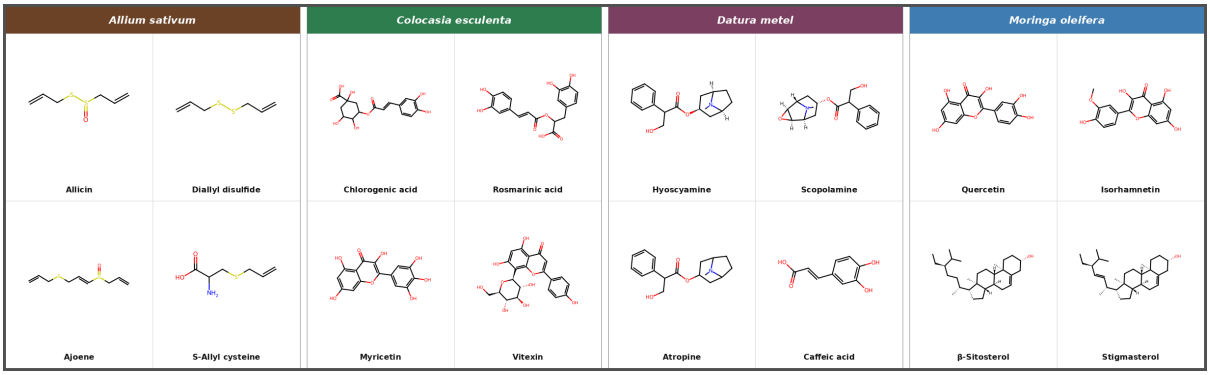


Figure 6. Chemical structures of key phytoconstituents identified in *Allium sativum*, *Colocasia esculenta*, *Datura metel*, and *Moringa oleifera*, as reported in Tables 1, 3, 5, and 7

The chemotype level distinct a clear correlation between documented traditional use and the pharmacological evidence. The respiratory effects of *D. metel* and *M. oleifera* are attributed to their bronchodilatory activity (due to anticholinergic tropane alkaloids) and anti - inflammatory activity, respectively, whereas gastrointestinal use of *A. sativum* and *C. esculenta* is related to their antimicrobial and mucosal protective properties. This alignment is best in the case of a single dominant chemotype (*D. metel, A. sativum*) and is comparatively weak in the case of *C. esculenta*, so that the phytochemical asymmetry previously noted is more apparent than it is in the former.

The four species are also socio culturally positioned differently, with implications for conservation and the retention of knowledge. *A. sativum, C. esculenta* and *M. oleifera* are not found in a specialized ritual niche but are an integral part of daily subsistence patterns and household practices and are possessed by the Chakma, Marma, Tripura and Santal groups. Deforestation and land use change in the Chittagong Hill Tracts also pose a risk to the habitat base of less cultivated species

(*D. metel*), The preservation of traditional knowledge of indigenous group in Bangladesh and natural ecosystems are intimately related to the preservation of the medicinal plants. The availability of plant resources that local communities use is decreasing in the Chittagong Hill Tracts (CHT) due to deforestation, land use change, forest degradation, the growth of agriculture and plantations, and other impacts on forest resources. Deforestation, diminishing land resources, insufficient institutional support, and modifications to land use are the significant reasons of causing declining the traditional knowledge of medicinal plants of CHT (Khan and Rashid, 2006).

Conclusion

This review aims to showcase the significant ethnobotanical, phytochemical and pharmacological potential of four medicinal plants that are indigenous to the traditional medical system of the tribal communities of Bangladesh like Chakma, Marma, Tripura, Santal and Garo people. The documented correlation of traditional use and modern drug uses highlights the importance of ethnobotanical knowledge as a basis for carrying out a pharmacological study, and the diversity of phytochemicals found within these species, serve as a valuable resource for future drug discovery research. All four species have several reported pharmacological activities, but these activities are only based on in vitro and animal studies and have not been standardized for the human dose. The preparation methods and dosages are highly variable between communities and there is limited toxicological information, especially human toxic dose and herb drug interactions. However, this does not mean that clinical validation, standardized extraction and formulation procedures and thorough toxicological studies are assumed, but are still needed to conclude on the therapeutic potential of these plants species There is a need to document and archive tribal knowledge to maintain a parallel record and preserve the importance of this ethnomedical heritage, as the traditional knowledge is also at risk to be lost due to habitat destruction and generational loss.

Declarations

Declaration of Generative AI and AI Assisted Technologies in the Writing Process

The authors used AI based tools (e.g., Claud Ai) to summarize literature only. The contents of the manuscript were written, and reviewed by the authors, and they are fully responsible for its accuracy and originality. No AI tools were used for data analysis, interpretation of scientific conclusions.

List of abbreviation: *A. sativum- Allium sativum*, *C. esculenta- Colocasia esculenta*, *D. metel-Datura metel*, and *M. oleifera - Moringa oleifera*, CHT- Chittagong Hill Tracts

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