



REVIEW ARTICLE

Ethnomedicinal plants of Assam, India: A review on bioactive metabolites, therapeutic potential and future perspectives

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Abstract

Ethnomedicinal plants are integral to the traditional healthcare systems of indigenous communities in Assam, India. Groups such as the Bodo, Mising, Dimasa, Karbi, Rabha and Deori have long utilized a diverse range of local flora to treat ailments ranging from infections and fevers to chronic inflammatory and metabolic disorders. This review synthesizes current knowledge on bioactive metabolites derived from ethnomedicinal plants of Assam and evaluates their therapeutic relevance and future research prospects. A systematic literature survey was conducted using major scientific databases including Scopus, Web of Science, PubMed and Google Scholar. A total of 139 studies were included in the final analysis, documenting 86 ethnomedicinal plant species belonging to 48 families, traditionally used to treat major ailment categories, with gastrointestinal disorders, dermatological conditions and inflammatory diseases being the most frequently reported. Phytochemical investigations revealed the presence of diverse classes of bioactive metabolites, including alkaloids, flavonoids, phenolics, terpenoids, glycosides and saponins. Several species demonstrated significant pharmacological activities such as antioxidant, antimicrobial, anti-inflammatory, antidiabetic and anticancer properties, corroborating traditional therapeutic claims. The review highlights critical research gaps, including limited metabolite profiling, lack of clinical validation and concerns regarding sustainable utilization. Future perspectives emphasize the need for integrative ethnobotanical-phytochemical approaches, advanced metabolomics and conservation-oriented strategies to harness Assam's ethnomedicinal wealth for drug discovery and sustainable healthcare development. Integrating traditional knowledge with modern scientific approaches can both preserve cultural heritage and contribute meaningfully to global drug discovery and sustainable healthcare solutions.

Keywords: Assam; bioactive compounds; ethnomedicinal plants; indigenous communities; phytochemistry; traditional medicine

Introduction

The North-Eastern region of India is a rich reservoir of ethnomedicinal flora. Owing to its distinctive climate, varied topography and rich ecological diversity, Assam stands as a key state in the region, supporting an extensive range of plant species used traditionally for healthcare by its indigenous populations. Approximately 15.64 % of Assam's 30.9 million residents belong to tribal communities that comprise the Bodo, Mising, Karbi, Dimasa, Garo, Hmar, Rabha and Deori (1). Within their culture, these communities have relied on locally available medicinal plants for treating a range of ailments, integrating them deeply into their cultural and spiritual traditions. This wealth of ethnobotanical knowledge also offers immense potential for applications in pharmaceuticals and nutraceuticals.

Assam possesses a remarkable diversity of medicinal and wild edible plants, many of which are commonly integrated into traditional diets and healing practices. Ethnobotanical surveys confirm that most traditional remedies are plant-based and are widely practiced among the state's ethnic communities (2). Despite regional differences in plant nomenclature and utilization, the exchange of ethnobotanical knowledge is

widespread, particularly in multi-ethnic villages located adjacent to protected forest areas. Recent surveys across Assam's districts highlight the widespread and continued use of traditional medicine, underscoring the urgent need to preserve this valuable knowledge system.

Globally, the scientific pursuit of naturally sourced bioactive and therapeutic compounds, which hold immense potential for developing safer and more sustainable medicines has grown significantly in recent decades (3). This renewed interest has encouraged extensive research into plants, fungi and other natural materials as potential reservoirs of novel pharmacologically active molecules.

Ethnomedicinal studies serve as a cornerstone in this pursuit, providing crucial leads for identifying novel bioactive molecules (4). Increasing scientific evidence now validates the therapeutic effectiveness of numerous traditional plant-based remedies (5). Currently, about 25 % of pharmaceutical drugs are sourced from plants (6) and in many developing nations, nearly 70 % to 95 % of the population depends on medicinal plants for primary healthcare (7). Plants synthesize a wide range of secondary metabolites-including alkaloids, flavonoids, phenolics,

saponins and terpenoids which, though primarily involved in defense and adaptation, have demonstrated significant health-promoting properties in humans (8). Produced through specialized secondary biosynthetic pathways, these compounds function as ecological tools for protection, attraction and communication (9). Historically, plant-derived substances formed the basis of early medicinal practices and the emergence of modern pharmacology can be traced to their systematic isolation and characterization in the 19th century (10).

Despite remarkable strides in synthesizing modern drugs, medicinal plants persist as key contributors of raw materials for the pharmaceutical industry (11). Growing clinical and pharmacological evidence has further heightened awareness of their therapeutic value, contributing to a global shift toward herbal medicines that are perceived as both effective and safer alternatives to many synthetic formulations (12). Yet, a substantial proportion of phytochemical constituents across diverse plant species remains uninvestigated (13). Existing research is often fragmented and disproportionately centered on a limited number of well-known species, leaving numerous potentially valuable plants insufficiently studied. This disparity underscores the need for comprehensive, systematic investigations.

Considering these issues, this review intends to bring together and critically examine available research on the ethnomedicinal flora of Assam and their associated bioactive metabolites. By identifying existing gaps in knowledge and highlighting understudied taxa, this review aims to guide and inform future research priorities in the domains of ethnobotany, phytochemistry and natural product drug discovery.

Methodology

A systematic literature search was conducted to collect information on bioactive metabolites from ethnomedicinal plants of Assam, India. The search was performed across multiple electronic databases, including PubMed, Scopus, Web of Science, Google Scholar, ScienceDirect, SpringerLink and relevant books, theses and conference proceedings. Peer-reviewed articles, theses and authoritative reports were screened using keywords related to ethnomedicinal plants of Assam, bioactive metabolites, phytochemistry and pharmacological activities. Scientific names of plants were validated using authoritative botanical databases such as: International Plant Names Index (IPNI) (<https://www.ipni.org>), POWO: Plants of the World Online (<https://powo.science.kew.org>), World Flora Online Plant List (<https://wfoplantlist.org/>). Synonyms were updated and standardized to ensure consistency.

Floristic and ethnomedicinal diversity

Assam harbors ~3000–3500 species of flowering plants, representing about 25 % of India's angiosperm diversity. Of these, 600–700 plant species are reported to have ethnomedicinal importance. The vegetation ranges from tropical wet evergreen and semi-evergreen forests to grasslands and riparian ecosystems, contributing to high plant diversity. Assam forms part of the Indo-Burma Biodiversity Hotspot, known for high endemism and species richness. The state's varied geoclimatic landscape, coupled with the coexistence of multiple native communities, has played major contribution to the development of a well-established tradition of ethnobotanical expertise and plant-based healing practices. The region's traditional therapeutic practices are deeply anchored in the indigenous wisdom of its culturally diverse

ethnic groups. In Assam, ethnomedicinal wisdom is primarily preserved through oral transmission across successive generations. The perpetuation of this knowledge rests largely on village elders, herbalists and traditional healers collectively known as ojhas or bej (Fig. 1) who serve as its primary custodians. These practitioners primarily utilize native plant species that are widely available and readily accessible in their immediate environment.

A systematic ethnobotanical analysis reported 273 species of medicinal plants from 83 families utilized by different tribal groups in districts like Dima Hasao and Karbi Anglong, addressing 10 broad disease categories and 91 specific ailments, highlighting extensive plant use patterns (14). Traditional medicine has long been integral to community health and well-being in Assam. Although the therapeutic benefits and treatment methods associated with many plants are well recognized, the specific bioactive compounds responsible for these effects often remain unidentified. In recent years, several researchers have documented the ethnomedicinal practices prevalent in various parts of Assam. In Dibrugarh, the Bodo community uses 129 medicinal plant species across 18 ailment categories, presenting strong quantitative traditional use values like use value (UV), relative frequency of citation (RFC) and Informant Consensus (15). Across different ethnobotanical surveys in Assam, 50–181 ethnomedicinal plant species have been documented in single district studies (16,17). Most surveys report that leaves are the most frequently used plant part, followed by roots, stems and whole plants, indicating a common pattern of traditional remedy preparations (16). Many of these ethnomedicinal species belong to families known for rich phytochemistry (e.g., Fabaceae, Lamiaceae, Asteraceae), which often contain alkaloids, flavonoids, terpenoids and phenolics, aligning floristic diversity with potential bioactive metabolite sources (18). However, only a small fraction of the region's rich plant diversity has been scientifically evaluated for its phytochemical composition and antioxidant properties (19). This highlights the need for further systematic studies to validate traditional knowledge and identify new therapeutic agents.



Fig. 1. A tradition healer or bej preparing medicine for locally available plant resources.

Positioned in a globally recognized biodiversity hotspot, Assam has a long-standing tradition of utilizing a variety of plant species to cure or alleviate human illnesses. Phytochemicals, synthesized through secondary metabolism, are non-nutritive plant compounds recognized for their protective and health-promoting functions. These secondary metabolites, distributed across plant parts like leaves, roots and stems, play a vital role in shielding plants from pathogens and ecological stressors (20). Exploring these compounds deepens our understanding of their ecological roles and offers important insights into their potential for development of novel pharmaceutical agents.

Plant bioactive compounds

Naturally sourced bioactive phytochemicals significantly contribute to human health and help lower the vulnerability to a range of diseases. Bioactive compounds, commonly known as phytochemicals or secondary metabolites, possess a broad spectrum of structural and functional variations that underpin their biological activities (21). These compounds are widely present in plant-derived foods such as vegetables, fruits, grains, seeds and nuts serving as the plant's built-in defenses against environmental challenges, pathogenic organisms and herbivores.

While traditional phytochemistry outlines broad classes such as alkaloids, flavonoids and terpenoids, evidence from Assam's medicinal flora identifies specific bioactive constituents linked to documented ethnomedicinal uses. *Acorus calamus* L. rhizomes collected from Lower Assam contain high concentrations of α - and β -asarone, compounds reported to exhibit antimicrobial and gastroprotective activities (22). *Curcuma caesia* Roxb. rhizomes from Assam showed the presence of flavonoids, phenolics, alkaloids and other phytoconstituents validating traditional uses (23). Essential oil composition of *C. caesia* revealed several biologically active compounds with potential anticancer actions (24). Similarly, *Curcuma* species used in Upper Assam have been shown by HPLC and GC-MS studies to be rich in curcuminoids and ar-turmerone, which correlate with strong antioxidant and anticancer effects (25). Locally studied *Zingiber officinale* Roscoe cultivars demonstrate elevated gingerol content, aligning with demonstrated anti-inflammatory effects (26). Tinosporaside has been characterised from Assam specimens of *Tinospora cordifolia* (Wild) Hook. f & Thomson, demonstrating immunomodulatory effects that support traditional therapeutic applications (27). Despite these insights, many Assam plants such as *Phlogacanthus thyriformis* (Roxb. ex Hardw.) Mabb. and *Clerodendrum serratum* (L.) Moon requires more detailed compound isolation and pharmacological validation using modern analytical platforms (28).

When categorized by their biosynthetic origin, secondary metabolites fall into 6 major groups: phenolics, terpenes, alkaloids, saponins, glycosides and polysaccharides. Each group contains a wide variety of compounds with distinct therapeutic properties, such as antioxidant, anti-inflammatory, antimicrobial and anticancer activities. Assam, recognized for its rich ethnomedicinal traditions, hosts a wide range of indigenous plant species that contain noteworthy bioactive molecules, enhancing their medicinal significance. The list of these plants along with their key bioactive components is shown in Table 1.

Polyphenols

Polyphenols are part of the diverse array of plant-derived secondary metabolites synthesized by plants that, although not essential as nutrients, play highly significant biological roles. They are abundantly present in a wide range of fruits, vegetables, seeds and other plant-derived foods, representing one of the most extensive groups of active secondary metabolites. These molecules are primarily formed through the phenylpropanoid pathway, originating from the amino acid L-phenylalanine.

Defined by the presence of one or more phenolic rings, polyphenols display remarkable structural variability, which contributes to their diverse functional attributes. These compounds fall into multiple major subclasses, including flavonoids, phenolic acids, lignans, stilbenes, tannins and coumarins. Beyond their biochemical significance, polyphenols also influence key sensory qualities of plant foods, such as colour, flavour and aroma.

Their strong antioxidant potential enables polyphenols to neutralize reactive oxygen species, thereby alleviating oxidative stress within biological systems. This protective mechanism has been linked to a lower incidence of multiple chronic health conditions, including cancer, cardiovascular diseases, inflammatory disorders, neurodegenerative diseases and age-associated ailments (29).

Phenolic acids

Phenolic acids are a group of phytochemicals characterised by the presence of one or more hydroxyl (-OH) groups attached to an aromatic ring. These compounds play essential roles in plants, contributing to pigmentation, facilitating pollination and providing protection against pathogenic microorganisms. They occur widely in plant-derived foods, with notable dietary sources including fruits, vegetables, coffee, tea and wine; however, their concentration and distribution vary across different plant tissues.

In addition to their ecological importance, phenolic acids are involved in numerous physiological processes within plants, such as reproductive development, cell growth and responses to environmental stress (30). From a biological and medicinal perspective, phenolic acids display significant antimicrobial properties, help stabilize ascorbic acid and inhibit lipid peroxidation, thereby reducing the initiation and progression of carcinogenic processes (31). Their multifunctional roles make them important contributors to both plant health and human nutrition.

Flavonoids

Flavonoids constitute one of the most prominent subclasses of polyphenols and are abundantly found in a wide variety of plant-derived foods and beverages. They occur particularly in richly pigmented fruits such as grapes, cherries, berries, plums and cranberries. Broadly, flavonoids are categorized into 2 primary groups: anthocyanins and anthoxanthins. Anthocyanins impart the bright red, blue and purple pigmentation observed in numerous fruits and flowers, while anthoxanthins, generally colorless, comprise key subclasses such as flavones, isoflavones, flavanols and flavanones. Several well-studied flavonoids, including anthocyanins, kaempferol, hesperidin, naringenin, myricetin and quercetin, demonstrate a wide spectrum of biological activities. These compounds exhibit antioxidant, anticancer, anti-inflammatory and immunomodulatory activities,

Table 1. List of ethnomedicinal plants of Assam and their reported bioactive compounds

| Sl. No. | Botanical name | Family | Local name | Plant parts used | Method of preparation | Mode of administration | Medicinal use | Bioactive compounds | Reference |
|---------|---|----------------|--------------|------------------|---|------------------------|---|--|-----------|
| 1. | <i>Acmella paniculata</i> (Wall. ex DC.) R.K.Jansen | Asteraceae | Bon najji | Flowers, leaves | Decoction | Oral | Toothaches, sore throat, stimulant | phenolics, flavonoids, antioxidants | 57 |
| 2. | <i>Aegle marmelos var. mahurensis</i> Zate | Rutaceae | Bel | Flowers, leaves | 1. Paste of leaves 2. Juice of leaves | Topical | 1. Small pox 2. Menstrual problem, digestive aid | skimmianine, aegelin, lupeol, cineol, citral, marmin, tannin | 58 |
| 3. | <i>Ageratum conyzoides</i> L. | Asteraceae | Gundhua bon | Leaf | Paste | Topical | Cuts and wounds | stigmasterol, β -sitosterol alkaloids, carbohydrate, flavonoids, | 59 |
| 4. | <i>Alpinia nigra</i> (Gaertn.) B.L.Burtt | Zingiberaceae | Tora | Tuber | Juice | Oral | Digestive disorders, Nail infection | glycosides, phenols and saponins | 60 |
| 5. | <i>Amaranthus spinosus</i> L. | Amaranthaceae | Khutura | Root, Leaf | cooked | Oral | Pitted keratolysis, septic, asthma, diuretic | amaranthine, isoamaranthine, hydroxy-cinnamates, quercetin, kaempferol glycosides | 61 |
| 6. | <i>Andrographis paniculata</i> (Burm.f.) Wall. ex Nees, | Acanthaceae | Sirata | Leaf | extract | Oral | Diabetes, worm infection, liver problem, malaria | andrographolide, flavones, lactones | 62 |
| 7. | <i>Asparagus racemosus</i> Willd. | Asparagaceae | Satmul | Root | Extract | Oral | Nerve problem, Diabetes, kidney stone, constipation | phenols (flavonoids and hydroxycinnamic acids), saponins | 63 |
| 8. | <i>Averrhoa carambola</i> L. | Oxalidaceae | Kordoi | Fruit | Juice | Oral | Cough | ascorbic acid, β -carotene, flavonoids, γ - and δ -tocopherol | 64 |
| 9. | <i>Azadirachta indica</i> A.Juss. | Meliaceae | Neem | Leaves | Decoction, paste | Topical, Oral | Skin infection, intestinal worm | isoprenoids, gedunin, vilasinin and csecomeliacins such as nimbin, salanin, azadirachtin | 65 |
| 10. | <i>Bacopa monnieri</i> (L.) Wettst. | Plantaginaceae | Brahmi | Whole plant | Juice | Oral | Memory booster | bacoside, triterpenoid, saponin, glycosides | 66 |
| 11. | <i>Bambusa balcooa</i> Roxb. | Poaceae | Bholuka banh | Immature culms | extract | Topical | insect bites | flavonoids, saponins, phyosterols | 67 |
| 12. | <i>Cannabis sativa</i> L. | Cannabinaceae | Bhang | Leaf | Steam of the boiled dried leaves is inhaled | Nasal | Sinusitis | alkaloids, cardiac glycosides, flavonoids, | 68 |
| 13. | <i>Centella asiatica</i> (L.) Urb. | Apiaceae | Bormanimuni | Leaf | extract | Oral | Stomach ulcers, memory booster, asthma, gastritis | resins, steroids, terpins | 69 |
| 14. | <i>Cinnamomum verum</i> J. Presl | Lauraceae | Dalchini | Bark | extract | Oral | Digestive aid, anti-inflammatory, anti-diabetic | asiatic acid, asiaticoside, madecassic acid, madecassoside | 70 |
| 15. | <i>Citrus aurantiifolia</i> (Christm.) Swingle | Rutaceae | Golnemu | Fruit | juice | Oral | Dysentery, stomachache | hydroquinone, 1,4-cyclohexanedione, cinnamaldehyde | 71 |
| 16. | <i>Citrus limon</i> (L.) Osbeck | Rutaceae | Nemu | Root fruit | extract | Oral | Menstruation pain, Stomachache, Dysentery, scurvy | flavonoids, limonin, trans-bergamotene, limonexic acid, isolimonexic | 72 |
| 17. | <i>Citrus maxima</i> (Burm.) Merr. | Rutaceae | Singkin | Fruit | Directly consumed | Oral | Indigestion | phenolic compounds as well as vitamins, minerals, dietary fiber, essential oils, carotenoids | 73 |
| 18. | <i>Clerodendrum infortunatum</i> Dennst. | Lamiaceae | Bhatai tita | Leaves, roots | 1. Boiled 2. Paste | 1.Oral 2.Topical | Anti-inflammatory, Skin infection | naringin, phenols, carotenoids | 74 |
| 19. | <i>Clerodendrum chinense</i> (Osbeck) Mabb. | Lamiaceae | Dapai tita | Leaves | 1. Paste 2.decoction | 1. Topical 2. Oral | Malaria, Leech bite | limonene, phytol, catechol, hexadecenoic acid, squalene, dodecanoic acid, vitamin E, hydroxymethylfurfural, stigmasterol | 75 |

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| 20. | <i>Clerodendrum colebrookeanum</i> Walp. | Lamiaceae | Nefafu | Leaves | Cooked | Oral | Hypertension, anti-inflammatory | tannic acid, quercetin, catechin, reserpine, ascorbic acid, gallic acid | 76 |
| 21. | <i>Colocasia antiquorum</i> var. <i>esculenta</i> (L.) Schott | Araceae | Kosu | Sap, Leaves | Directly used | Topical | Cuts and wounds | carbohydrates, protein, thiamine, riboflavin, niacin, oxalic acid, calcium oxalate, minerals, lipids, unsaturated fatty acids, anthocyanins | 77 |
| 22. | <i>Commelina benghalensis</i> Wall. | Commelinaceae | Kona ximolu | Leaf, stem | Extract | Oral, Topical | Infertility, boil, eye infection | nonanoic acid, oxiraneethanol, propanoic acid, phytol, heptasiloxane | 78 |
| 23. | <i>Corchorus capsularis</i> L. | Malvaceae | Mora | Leaf | Dried leaves boiled | Oral | Allergy, Fever | fatty acids, tocopherols, phenols, | 79 |
| 24. | <i>Cryptolepis sinensis</i> Merr. | Apocynaceae | Harjora | Stem | Paste | Topical | Bone fracture | alkaloids, saponins, cardiac glycosides, phenols, tannins, flavonoids, anthocyanins, phlobatannins, lignin, steroids | 80 |
| 25. | <i>Curcuma caesia</i> Roxb. | Zingiberaceae | Kola haldi | Rhizome | Juice | Oral | Blood purifier, tonsil, menstruation pain, eye infection | Curzerenone, Eucalyptol, Flavonoids, Phenolics, Alkaloids, Terpenoids, saponins | 23 |
| 26. | <i>Curcuma longa</i> L. | Zingiberaceae | Haladhi | Rhizome | 1. Paste 2. Juice | 1. Topical 2. Oral | Cuts and wounds, skin infection, body ache | alkaloids, glycosides, steroids, flavonoids, saponins, phenol, resins | 81 |
| 27. | <i>Cynodon dactylon</i> (L.) Pers. | Poaceae | Dubori | Whole plant | Extract, juice | Oral | Digestive disorder, antiseptic, stop epistaxis | cyanidin, luteolin, apigenin, β -sitosterol. | 82 |
| 28. | <i>Dillenia indica</i> Blanco. | Dilleniaceae | Ou tenga | Fruit | Cooked or eaten raw | Oral | Diabetes, urethritis | tannin, dillenetin, betulinic acid, rhamnetin, dihydro- | 83 |
| 29. | <i>Dioscorea alata</i> L. | Dioscoraceae | Kath alu | Tuber | juice | Oral | contraceptive | phenols, flavonoids | 84 |
| 30. | <i>Drymaria cordata</i> (L.) Roem. & Schult. | Caryophyllaceae | Lajjabori | Tender shoot | 1. Juice 2. Boiled and steam is inhaled | 1. Oral 2. Nasal | Allergy, headache, sinusitis | glycolipid | 85 |
| 31. | <i>Eclipta alba</i> var. <i>prostrata</i> (L.) Miq. | Asteraceae | Keyaras | Whole plant | extract | Oral | Septic, diarrhoea, jaundice | triterpenoids, 3-acetylaleuritic acid, stigmasterol, fatty esters, aromatic components | 86 |
| 32. | <i>Euphorbia hirta</i> L. | Euphorbiaceae | Gakhirioti | Leaves | cooked | Oral | Lactation | steroids, terpenoids, saponins, tannins, quinone | 87 |
| 33. | <i>Ficus racemosa</i> Willd. | Moraceae | Dimoru | Latex, Leaf | Juice and latex is directly consumed | Oral | Haemorrhoids, Diabetes, Dysentery | tannin, wax, saponin gluanol acetate, β sitosterol, lupeol, ceryl behenate, lupeol acetate, α -amyirin | 88 |
| 34. | <i>Garcinia pedunculata</i> Roxb. | Clusiaceae | Thekera | Fruit | Juice | Oral | Menstruation pain, Dysentery | alkaloids, carbohydrates, saponin, phenolic compounds, proteins along with fixed oils and fats, glycosides, amino acid | 89 |
| 35. | <i>Garcinia xanthochymus</i> Hook.f. | Clusiaceae | Tepor tenga | Fruit, Leaves | Juice | Oral | Piles, abdominal disorder, vomiting, anaemia, urine problem | xanthones, benzophenones, flavonoids, isocoumarin | 90 |

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|-----|---|----------------|--------------|--------------------------|-------------------------------------|-----------------------|--|---|-----|
| 36. | <i>Gloriosa superba</i> L. | Colchicaceae | Agnilata | Tendrill | Juice | Oral | Intestine worm | alkaloid, flavonoids, glycosides, phenols, saponins, steroids, tannin, terpenoids | 91 |
| 37. | <i>Hellenia speciosa</i> (J.Koenig) S.R.Dutta | Costaceae | Jom lakhuti | Rhizome, tender leaves | extract | Oral | Anti-inflammatory, diuretic | Alkaloids, flavonoids, phenols, sterol, quinines | 92 |
| 38. | <i>Houttuynia cordata</i> Thunb. | Saururaceae | Mosundori | Leaf, tender stem, roots | paste | Oral | Dysentery, gastritis | chlorogenic acid, rutin, hyperin, quercitrin, piperolactam, aristolactam B, cepharadione B | 93 |
| 39. | <i>Hydrocotyle rotundifolia</i> Roxb. | Araliaceae | xorumanimuni | Whole plant | extract | Oral | Diarrhoea, Allergy, asthma digestive disorders, general weakness, liver complaints and other health ailments | phenolics, flavonoids and tannins | 94 |
| 40. | <i>Ipomoea aquatica</i> Forssk. | Convolvulaceae | Kolmou | Tender shoot and leaves | extract | Oral | Anti-inflammatory, analgesic | ellagic acid, quercetin glycosides, phenolic acids, flavonoids, alkaloids | 95 |
| 41. | <i>Justicia adhatoda</i> L. | Acanthaceae | Bahaka | Leaves, stem | extract | Oral | Urinary problem, Kidney stone, Nail and foot infection | carbohydrate, protein, total phenolics, flavonoids, alkaloid. | 96 |
| 42. | <i>Kalanchoe pinnata</i> (Lam.) Pers. | Crassulaceae | Dupor tenga | Leaf, young shoots | extract | Oral | Piles, wounds, menstrual problem | alkaloids, flavonoids, saponins, tannins | 97 |
| 43. | <i>Lasia spinosa</i> (L.) Thwaites | Araceae | Sengmora | Bulb | cooked | Oral | Memory booster, pneumonia, gastritis, tonsil | alkaloids, carbohydrates, proteins, flavonoids, terpenoids, phenolic compounds, steroids, saponins, glycosides, ascorbic acid, tannins | 98 |
| 44. | <i>Leucas plukenetii</i> (Roth) Spreng. | Lamiaceae | Duron bon | Leaf, shoot tip | extract | Oral | Digestive aid | long chain aliphatic compound, triterpenes, sterols, novel phenolic compounds | 99 |
| 45. | <i>Manihot esculenta</i> Crantz. | Euphobiaceae | Ximolu | Roots, Leaves | Boiled | Oral | 1. Diarrhoea 2. Skin infection | flavonoids, anthocyanins, phenolic compounds. | 100 |
| 46. | <i>Mentha arvensis</i> L. | Lamiaceae | Pudina | Leaves | 1. Juice 2. Paste | 1. Oral 2. Topical | Dysentery | menthol, isomenthone, menthone, cineole, flavonoids, alkaloids | 101 |
| 47. | <i>Mikania micrantha</i> Kunth. | Asteraceae | Prem-Lota | Leaf | extract | Oral | Dysentery, Hypertension | phenolic compounds, flavonoids, antioxidants, hydrocarbon compounds, sesquiterpenes | 102 |
| 48. | <i>Moringa oleifera</i> Lam. | Moringaceae | Sojina | Fruit, Leaves | Cooked | Oral | Diarrhoea, dysentery, diabetes, improve digestion | tocopherols (γ and α), phenolic compounds, β-carotene, vitamin C, phytates, tannins, quercetin-3-O-glucoside, kaempferol-3-O-glucoside, vicenin-2 | 103 |
| 49. | <i>Murraya koenigii</i> (L.) Spreng. | Rutaceae | Norohinga | Leaf | cooked | Oral | Dysentery, Diabates, intestinal worm | lutein, tocopheral, carotene, koenimbine, isomahanimbine. | 104 |
| 50. | <i>Musa balbisiana</i> Colla. | Musaceae | Athia kol | Fruit, Rhizome | 1. Fruit Cooked 2. Rhizome Juice | Oral | Pneumonia, toothache, chronic dysentery, menstruation problem | Flavonoids, polyphenols, crude fibres. | 105 |
| 51. | <i>Musa paradisiaca</i> L. | Musaceae | Bhim kol | Fruit, tuber | Raw, cooked | Oral | Piles, hypertension | flavonoids, alkaloids, phenolics, tannins, | 106 |
| 52. | <i>Nyctanthes arbor-tristis</i> L. | Oleaceae | Sewali | Leaf, flower | cooked | Oral | | ascorbic acid, saponins, β-carotene, lycopene | 107 |
| | | | | | | | | carbohydrates, tanins, alkaloids, triterpenoids, saponins, flavonoids | |

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| 53. | <i>Ocimum basilicum</i> L. | Lamiaceae | Tulokhi | Leaf, seeds | extract | Oral | Anti-microbial, anti-inflammatory, Cough | phenols, flavonoids, terpenes | 108 |
| 54. | <i>Ocimum tenuiflorum</i> L. | Lamiaceae | Tulokhi | Leaf | extract | Oral | Cough, malaria | eugenol, methylcinnamate, camphor, thymol | 109 |
| 55. | <i>Oldenlandia corymbosa</i> L. | Rubiaceae | Bonjaluk | Whole plant, root | extract | Oral | Jauntice, bone fracture | flavonoids, tannins, saponins, phenolics, alkaloids, terpenoids, | 17 |
| 56. | <i>Oroxylum indicum</i> (L.) Benth. ex Kurz. | Bignoniaceae | Bhat gila | Seed | extract | Oral | Vomiting, weakness | flavonoids, alkaloids, tannins, sterols, saponins, glycosides, phenols and quinones | 110 |
| 57. | <i>Oxalis corniculata</i> L. | Oxalidaceae | Tengesi tenga | Whole plant | extract | Oral | Dysentery | flavonoids, alkaloids, tannins, phenols | 111 |
| 58. | <i>Paederia foetida</i> L. | Rubiaceae | Bhedailota | Leaf | extract | Oral | Stomach ailments, gastric problems | saponin, tannin, phenol, flavonoid, terpenoid, cardiac glycoside, alkaloid | 112 |
| 59. | <i>Perilla frutescens</i> (L.) Britton. | Polygonaceae | Hugloti | Leaf | Boiled | Oral | Cough | β -tocopherol, γ -tocopherol, β -sitosterol, and stigmasterol, triterpene acids | 113 |
| 60. | <i>Persicaria hydropiper</i> (L.) H.Gross. | Polygonaceae | Bihlongoni | Shoot tip | extract | Oral | Septic | flavonoids, phenylpropanoid derivatives, sesquiterpenoids | 114 |
| 61. | <i>Phlogacanthus thysiformis</i> (Roxb. ex Hardw.) Mabb. | Acanthaceae | Titaphul | Flower, Leaf | extract | Oral | Blood purifier, pneumonia, asthma | tannins, phenolic compounds, flavonoids, coumarins, saponins, fixed oils and fats | 115 |
| 62. | <i>Phyla nodiflora</i> (L.) Greene. | Verbenaceae | Kurkuri bon | Leaves, flowers | Dried and powder | Topical | Skin infection | sugar, triterpenoids, flavonoids, phenol, steroids, essential oils, resins, tannins | 116 |
| 63. | <i>Phyllanthus acidus</i> (L.) Skeels. | Phyllanthaceae | Pora amlakhi | Leaves | Juice | Oral | Cough | alkaloids, tannins, flavonoids, lignans, | 117 |
| 64. | <i>Phyllanthus emblica</i> L. | Phyllanthaceae | Amlakhi | fruit | Eaten raw | Oral | Diabetes, anaemia, vomiting, piles | phenolics, terpenes | 118 |
| 65. | <i>Phynium pubinerve</i> Blume | Marantaceae | Koupat | Leaves | Slightly warmed | Topical | Eye injury | alkaloids, caridac glycosides, saponins | 119 |
| 66. | <i>Piper betle</i> L. | Piperaceae | Paan | Leaf, petiole, mature shoot tip | extract | External, Oral | Dog bite, nail infection, bleeding from nose, asthma | antioxidants, aliphatic alcohols, aromatics, oxygenated monoterpenes, diterpenes hydroxychavicol, eugenol, tannins, saponins, alkaloids, flavonoids, steroids, terpenoids, phenolic compounds | 120 |
| 67. | <i>Piper betleoides</i> C.DC. | Piperaceae | Jangjaluk | Root | Juice | Oral | Jaundice | pedicellamide | 121 |
| 68. | <i>Piper longum</i> Blume. | Piperaceae | Pipoli | Leaf, stem, fruit | extract | Oral | Pneumonia, asthma | piperine, pellitorine, guineensine, pipnoohine, trichostachine, piperonal | 122 |
| 69. | <i>Ricinus communis</i> | Euphorbiaceae | Era gos | Leaf | extract | External, Oral | Pain, piles, cancer | | |
| 70. | <i>Scoparia dulcis</i> L. | Plantaginaceae | Jalukbon | Whole plant | extract | Oral | Malaria | terpenes, alkaloids, Scoparic acid A, scoparic acid D, scutellarein, apigenin, luteolin, coisol, glutinol | 123 |
| 71. | <i>Sesamum indicum</i> L. | Pedaliaceae | Til | Seed | cooked | Oral | Stomachache, constipation | Flavanoids, flavanols, Lignans, phenolic compounds | 124 |
| 72. | <i>Solanum anguivi</i> Herb. Lamb. ex Dunal, | Solanaceae | Banko | Leaf | juice | Oral | Diarrhoea | gallic acid, caffeic acid, chlorogenic acid, quercetin | 125 |
| 73. | <i>Solanum nigrum</i> L. | Solanaceae | Xoru pokmou | Tender shoots | cooked | Oral | Jaundice | alkaloids, carbohydrates, flavonoids, glycosides, phenolic compounds, phytosterols, proteins, saponins, tannis | 126 |

| | | | | | | | | | |
|-----|--|----------------|--------------|--------------------------|------------------------|---------|---------------------------------|--|-----|
| 74. | <i>Solanum torvum</i> Schltld. | Solanaceae | Tita bangko | Fruit, Leaves | Eaten raw, cooked | Oral | Anti-oxidant, anti microbial | alkaloid, flavonoid, phenol, tannins, saponins, phytosterol, glycosides | 127 |
| 75. | <i>Tamarindus indica</i> L. | Fabaceae | Teteli | Fruit | Infusion | Oral | Hypertension | phenolics, flavonoids, antioxidants, organic acids, sugar | 128 |
| 76. | <i>Terminalia arjuna</i> (Roxb. ex DC.) Wight & Arn. | Combretaceae | Arjun | Bark | extract | Oral | Diabetes, Heart disease | tannins, triterpenoid saponins (arjunic acid, arjunolic acid, arjungenin, and arjunglycosides), flavonoids (arjunone, arjunolone, luteolin), gallic acid, ellagic acid, Oligomeric Proantho cyanidines, phytosterols | 129 |
| 77. | <i>Terminalia bellirica</i> (Gaertn.) Roxb. | Combretaceae | Bhomora | Fruit | Eaten raw | Oral | Stomach disorder | flavonoids, tannins, phlobotanins, saponins, steroids, cardiac glycosides | 130 |
| 78. | <i>Terminalia chebula</i> Retz. | Combretaceae | Xilikha | Fruit | Eaten raw, dried | Oral | Dysentery, pneumonia, gastritis | flavonoids, tannins, phlobotanins, saponins, steroids, cardiac glycosides | 130 |
| 79. | <i>Thunbergia grandiflora</i> Roxb. | Acanthaceae | Khakaloti | Roots | Juice | Topical | Ear infection | isoumedoside, grandifloric acid | 131 |
| 80. | <i>Tinospora cordifolia</i> (Willd.) Miers ex Hook.f. & Thomson. | Menispermaceae | Shaguni lota | Stem | extract | Oral | Back pain | alkaloids, glycosides, steroids, aliphatic compounds, essential oils, mixture of fatty acid, calcium, phosphorous, polysaccharides | 132 |
| 81. | <i>Vigna munga</i> (L.) Hepper. | Fabaceae | Matimah | Seed | Paste with mustard oil | Topical | Body ache | ferulic acid, protocatechuic acid, ferulic acid, gentisic acid and gallic acid | 133 |
| 82. | <i>Viola pilosa</i> Blume. | Violaceae | Banafsha | Whole plant | Juice | Oral | Haemorrhoids | alkaloids, proteins, tannins, carbohydrates, sterols, flavonoids, saponins, fats and oils | 134 |
| 83. | <i>Vitex negundo</i> L. | Lamiaceae | Posotia | Tender shoots and leaves | Boiled extract | Oral | Cough, pain, fever, allergy | protocatechuic acid; oleanolic acid; flavonoids, β sitosterol, β -selinine; α - cedrene; germacrene D; hexadecanoic acid; p-cymene and valencene | 135 |
| 84. | <i>Xanthium strumarium</i> L. | Asteraceae | Agora | Root | extract | Oral | Colic | xanthanolides (xanthatin, xanthinosin), phenolic acids, flavonoids, saponins. | 136 |
| 85. | <i>Zanthoxylum nitidum</i> (Roxb.) DC. | Rutaceae | Tezmoi | Root | extract | Oral | Pneumonia | rhoifoline A, alkaloids | 137 |
| 86. | <i>Zingiber officinale</i> Roscoe. | Zingiberaceae | Ada | Rhizome | Raw | Oral | Vomiting, cough, asthma | alkaloids, ascorbic acid, beta-carotene, polyphenols (flavonoids, flavones glycosides, rutin, etc.), terpenoids | 138 |

which collectively enhance their protective influence on human health (9). By neutralizing free radicals, flavonoids help prevent oxidative damage to cellular components and by influencing various signalling pathways, they play a vital role in regulating immune function and reducing the risk of chronic diseases.

Lignans

Lignans are identified as phenolic bioactive molecules produced by plants characterised by a dibenzylbutane structural framework and are commonly recognized as natural phytoestrogens due to their ability to modulate estrogenic activity in humans and animals. They occur broadly throughout the plant kingdom and are especially abundant in legumes, cereals, vegetables and fruits, where they are typically present as glycosides or as bio-oligomeric aglycones. Among dietary sources, flaxseed, linseed and sesame seeds are considered the richest reservoirs of lignans.

A variety of key lignans have been identified, including syringaresinol, pinoresinol, sesamol, sesamin, matairesinol, secoisolariciresinol, 7-hydroxymatairesinol and lariciresinol. These compounds demonstrate an impressive range of biological functions, exhibiting antiviral, antioxidant, insecticidal and antifeedant activities (32). Beyond these biological activities, lignans are associated with multiple beneficial impacts on health, including supporting hormonal balance, mitigating oxidative damage and offering protection against various long-term ailments such as cardiovascular conditions and cancers influenced by hormonal pathways.

Alkaloids

Alkaloids represent one of the most structurally and functionally diverse groups of naturally occurring compounds. These nitrogen-containing organic bases are neither nucleosidic nor peptidic and typically possess heterocyclic nitrogen rings. Approximately 5500 alkaloids have been identified to date, making them the largest class of phytoactive molecules (33). Many alkaloids exhibit potent biological activities and are utilized in both traditional and contemporary medicine, particularly for their analgesic, antimicrobial and neuroactive effects (34). Plants containing berberine-type alkaloids have long been used in traditional Chinese, Indian and Islamic medicine as antiseptics, sedatives and anti-inflammatory agents. Berberine, an isoquinoline alkaloid, also exhibits neuroprotective effects and antiviral activity against coronaviruses (35).

Terpenes

Terpenes, often referred to as terpenoids or isoprenoids constitute the most extensive class of natural products, with more than 55000 compounds documented to date. These structurally diverse molecules are integral to a wide range of industries, including food, cosmetics and pharmaceuticals, where they serve as flavor enhancers, aromatic components and biologically active agents. Well-known therapeutic terpenes include artemisinin, valued for its potent antimalarial activity and paclitaxel, a frontline chemotherapeutic drug (36). Beyond their industrial and medicinal relevance, terpenes display strong anti-inflammatory potential by regulating key molecular pathways associated with inflammation, thus contributing to the management of several chronic disorders (8).

Saponins

Saponins are plant-origin amphiphilic glycosides that occur widely in nature and are typically classified into 2 major groups: triterpenoid saponins, which contain a five-ring backbone and steroidal saponins, which possess a characteristic four-ring nucleus. These bioactive compounds are known for their notable cardioprotective properties, attributed to their ability to regulate calcium balance, enhance cellular energy pathways and modulate inflammatory processes (37). Their characteristic tendency to produce long-lasting foams in liquid solutions serves as the foundation for their broad utilization across food, cosmetic and pharmaceutical applications. Beyond their physicochemical attributes, saponins demonstrate an extensive range of biological functions, encompassing antimicrobial, immunomodulatory, antioxidant and lipid-lowering activities, making them valuable contributors to both traditional remedies and contemporary therapeutic formulations.

Polysaccharides

Polysaccharides are intricate carbohydrate molecules commonly found in fruits, vegetables and various plant-derived sources. These macromolecular compounds provide multiple health advantages, particularly cardiovascular protection, which is mediated by their antioxidant, anticancer, anti-inflammatory and immunoregulatory properties (38). Among the most studied bioactive polysaccharides are plant-derived gums and marine-sourced fucoidans, both recognized for their potent antioxidant capacity and low toxicity (39). Beyond cardiovascular support, polysaccharides contribute to gut health by promoting beneficial microbiota, modulating metabolic processes and enhancing immune function. Owing to their multifunctional properties, biocompatibility and safety, polysaccharides are increasingly incorporated into nutraceutical, functional food and pharmaceutical formulations, highlighting their growing significance in health promotion and disease prevention.

Scientific investigation on medicinal plants bioactive compounds

A thorough review of available literature was performed to identify the active phytochemical components occurring in the medicinal plants referenced in this study. These compounds exhibit diverse therapeutic effects, with their efficacy varying according to plant species, plant part and dosage. Comparing existing phytochemical data with ethnobotanical surveys of medicinal flora offers valuable insights into the distribution of bioactive compounds without the need for exhaustive experimental analyses of every species. Qualitative and quantitative phytochemical evaluations of 7 medicinal plants *Bryophyllum pinnatum* (Lam.) Oken, *Ipomoea aquatica* Forssk., *Oldenlandia corymbosa* L., *Ricinus communis* L., *Terminalia bellirica* (Gaertn.) Roxb., *T. cordifolia* and *Xanthium strumarium* L. carried out using different extraction solvents and plant parts, revealed the presence of major medicinally important constituents in both aqueous and organic extracts, thereby supporting their traditional therapeutic applications (40). Phytochemical screening of *B. pinnatum* revealed alkaloids, polyphenols, flavonoids, terpenoids, carbohydrates and glycosides in the hexane, ethyl acetate and methanol extracts, with steroids not detected (41). Similarly, analysis of the leaves, stems and roots of *O. corymbosa*, *R. communis*, *I. aquatica*, *X. strumarium* and *Mentha piperita*, reported positive results for saponins, tannins, flavonoids, terpenoids, glycosides, alkaloids,

carbohydrates, steroids, coumarins and proteins (42). A high concentration of carbohydrates in *Clerodendrum viscosum* Vent. was reported using Fehling's test, underscoring its nutritional and therapeutic potential (43).

Phytochemical examination of raw *Hibiscus sabdariffa* seeds confirmed the occurrence of flavonoids, tannins, polyphenols, alkaloids and saponins, but did not show any traces of terpenes, steroids, or glycosides (44). A comprehensive review was summarized on the ethnomedicinal applications and phytochemical constituents of nine indigenous medicinal plants *O. corymbosa*, *R. communis*, *I. aquatica*, *T. bellirica*, *B. pinnatum*, *C. viscosum*, *Hibiscus sabdariffa* L., *X. strumarium* and *Mentha piperita* L. Their results verified the occurrence of a wide range of bioactive groups, such as steroids, terpenoids, alkaloids, flavonoids, tannins, saponins, glycosides, coumarins and carbohydrates. These compounds are associated with a wide range of pharmacological properties such as antimicrobial, antioxidant, anti-*Salmonella*, hepatoprotective, antispasmodic and anticancer activities demonstrating their potential as candidates for novel drug development (45). A quantitative survey of medicinal plants traditionally utilised by the Mising community of Northeast India documented 153 species, each exhibiting substantial phytochemical diversity, including alkaloids, flavonoids, phenolics, saponins, polyphenols, tannins, arecoline, quinones, coumarins and glycosides (46).

Several ethnomedicinal plants reported across different studies are shared among various tribal communities, indicating a broader cultural consensus regarding their therapeutic efficacy (47). A comprehensive ethnobotanical survey further identified 102 plant species belonging to 57 families used by tribal populations for treating human and livestock ailments. Of these, 33 species had previously undocumented ethnobotanical applications, while 8 were used specifically for managing livestock diseases (48). An extensive review highlighting the bio-pharmacological and therapeutic significance of phyto-bioactive compounds, emphasizing their potential as natural alternatives to synthetic drugs in disease management was also conducted (21). Similarly, a documentation of 206 ethnomedicinal plant species from 72 families in the Baksa district of Assam demonstrated the region's remarkable diversity and its continued reliance on traditional herbal medicine (49). There was also a record of 33 plant species (32 genera, 24 families) used by tea tribe communities in Morigaon district, Assam, for managing rheumatoid arthritis. Quantitative ethnobotanical indices such as use value (UV) and fidelity level (FL) were employed to assess their therapeutic relevance (50). A meta-analysis documenting the use of 273 plant species from 83 families by Eastern Himalayan indigenous communities of Assam for treating 91 distinct ailments was also reported (14). This synthesis underscores the region's vast ethnomedicinal heritage and the continuing importance of these plants as reservoirs of bioactive compounds for future pharmacological exploration.

Pharmacological properties and therapeutic potentials

Plants synthesize a vast array of bioactive chemical compounds through secondary metabolism (34). These bioactive molecules such as alkaloids, flavonoids, tannins, terpenoids, saponins and phenolic acids are widely found in the medicinal plants used by tribal communities. Their presence underpins a broad spectrum of pharmacological activities including antioxidant, antimicrobial,

anti-inflammatory and anticancer effects. Phytochemicals exert therapeutic actions by neutralizing free radicals, inhibiting carcinogen-activating enzymes and promoting detoxification pathways (51). Compounds like alkaloids, flavonoids, terpenoids and carotenoids exhibit diverse biological activities such as antidiuretic, anti-inflammatory, analgesic, anticancer, antiviral, antimalarial, antibacterial and antifungal effects, making them vital in disease prevention. Increasingly, plant extracts are gaining recognition for their effectiveness against growing antibacterial resistance (52), with crude extracts showing strong antibacterial properties (53). The purification and study of these bioactive compounds have become key areas of research (43). Recent research also highlights that natural antioxidant from medicinal plants help mitigate the harmful effects of oxidative stress and free radicals, exhibiting antimutagenic, antiallergic and anticarcinogenic properties along with free radical scavenging and antimicrobial activities (46). Recent studies showed that of the 4 medicinal plants reviewed, *Nigella sativa*, *Vernonia amygdalina*, *Azadirachta indica*, and *Eurycoma longifolia*, only *A. indica* showed preliminary in silico antiviral activity against SARS-CoV-2, while all demonstrated varying anti-inflammatory and immunomodulatory effects (54). Furthermore, bioactive compounds continue to be extensively used in traditional medicine systems for the management of diseases including type 2 diabetes (21). Among these compounds, berberine—a key plant-derived alkaloid exhibits significant therapeutic potential. Its broad pharmacological activities include anticancer, anti-inflammatory, antidiabetic, antimicrobial, cardioprotective and cholesterol-lowering effects. Collectively, these properties underscore their promise in managing conditions such as atherosclerosis, Alzheimer's disease and other chronic disorders, highlighting its potential for advancement in therapeutic applications (56).

Research gaps and standardization issues

Despite Assam's rich biodiversity and the extensive traditional knowledge surrounding its ethnomedicinal plants, several critical research gaps and challenges in standardization remain. A primary concern is the inadequate and fragmented ethnobotanical documentation. Much of the indigenous knowledge is transmitted orally through generations, with only a limited portion systematically recorded. This has led to the underrepresentation of many valuable plant species in scientific literature and databases. Additionally, the available information often lacks consistency regarding plant identification, specific plant parts used, methods of preparation, dosage and modes of administration—factors that hinder reproducibility, comparative analysis and scientific validation.

Another key research gap is the insufficient phytochemical and pharmacological profiling of these medicinal plants. Although some preliminary investigations have identified general classes of bioactive compounds such as alkaloids, flavonoids and phenolics, the precise molecules responsible for therapeutic effects remain largely uncharacterised. Advanced analytical tools such as high-resolution mass spectrometry, nuclear magnetic resonance (NMR) and metabolomics are rarely utilized in the study of these species. Moreover, traditional herbal formulations often comprise complex mixtures, yet the synergistic or antagonistic interactions among their constituents are seldom explored, leaving a significant gap in understanding their comprehensive pharmacological effects.

Furthermore, the regulatory framework governing the use and commercialisation of herbal products in Assam and the broader Northeastern region is still in its nascent stage. There is a notable absence of a regional pharmacopoeia that recognizes and standardizes the medicinal plants unique to this area, posing an obstacle to quality control and wider application of these ethnomedicinal resources in formal healthcare systems.

Integration of traditional knowledge with modern science

The integration of traditional knowledge with modern scientific research presents significant potential for the discovery and development of bioactive molecules from the ethnomedicinal plants of Assam. Indigenous communities such as the Bodos, Karbis, Misings, Dimasas and others have cultivated a rich legacy of ethnomedicinal practices, with remedies passed down orally through generations. These communities possess extensive knowledge about the therapeutic applications of local flora in treating both common ailments and chronic diseases. However, a substantial portion of this traditional wisdom remains undocumented or insufficiently explored through scientific inquiry.

Bridging this knowledge gap necessitates a respectful, systematic and participatory approach that actively involves traditional healers in the research process. Scientific validation of these traditional remedies through pharmacognostic evaluation, phytochemical analysis and bioactivity assays can substantiate traditional claims and lead to the identification of potent bioactive compounds. The application of advanced analytical tools such as chromatography, spectroscopy, molecular docking and omics-based approaches (genomics, metabolomics and proteomics) further enhances the ability to isolate, characterize and elucidate the mechanisms of action of these compounds at the molecular level. Establishing collaborative frameworks that include ethnobotanists, phytochemists, pharmacologists and indigenous knowledge holders is crucial for promoting ethical knowledge sharing and equitable benefit distribution. Additionally, the development of standardized protocols inspired by traditional formulations can support the creation of safe, effective and affordable phytotherapeutic products. Thus, the integration of traditional knowledge with scientific rigor not only serves to validate cultural heritage but also contributes to novel drug discovery and the sustainable utilization of Assam's ethnomedicinal plant diversity.

Roadmap for future research

Since antiquity, phyto-bioactive compounds have played a vital role in traditional medicinal systems worldwide, serving as effective remedies for a broad spectrum of ailments. Numerous scientific studies have highlighted their therapeutic efficacy, establishing these natural compounds as promising candidates for the development of novel drugs with superior efficacy and biocompatibility. Contemporary research continues to uncover additional pharmacological properties, thereby expanding their already wide-ranging applications in modern medicine.

In today's fast-paced lifestyle, the prevalence of oxidative stress has markedly increased, contributing to the onset and progression of chronic conditions such as diabetes mellitus, cancer and cardiovascular diseases. Simultaneously, the overuse and misuse of antibiotics have exacerbated the global issue of antibiotic resistance, posing serious threats to public health,

particularly within clinical environments. The growing limitations and side effects associated with synthetic pharmaceuticals have further emphasized the urgent need to explore plant-derived bioactive compounds as alternative therapeutic agents. Bioactive compounds including polyphenols, alkaloids and terpenoids have demonstrated significant therapeutic potential in mitigating oxidative stress, inflammation, microbial infections and chronic illnesses. Their efficacy in addressing complex diseases such as cancer, ulcers, diabetes, microbial resistance, platelet aggregation and tumor development is being increasingly recognized. Owing to their multitargeted mechanisms of action and low toxicity profiles, these compounds are considered promising candidates for future drug discovery and integrative healthcare strategies.

Conclusion

This review highlights the remarkable therapeutic potential of plant-derived bioactive compounds and their broad applicability across food, nutraceutical and pharmaceutical industries. These compounds play a pivotal role in the prevention and management of chronic health conditions, including cancer, cardiovascular disorders, neurodegenerative diseases, diabetes, obesity and other oxidative stress-related ailments. Their diverse biological properties encompassing antioxidants, anti-inflammatory, antidiabetic and neuroprotective activities collectively contribute to disease mitigation and overall health improvement. The growing incorporation of bioactive compounds into functional foods and nutraceuticals underscores their increasing global relevance in promoting long-term wellness. Moreover, the integration of ethnobotanical knowledge serves as a vital foundation for identifying and preserving traditional medicinal practices. Scientific validation of such traditional wisdom not only enriches our understanding of phytotherapeutics but also supports the harmonization of traditional healing systems with modern medical science. To fully realize this potential, future research must prioritize enhancing the bioavailability of these compounds through novel delivery systems, elucidating synergistic mechanisms of action and conducting large-scale clinical trials to ensure their safety and efficacy in human populations. Future research must prioritize the rigorous documentation of Assam's indigenous knowledge to prevent biopiracy, alongside developing sustainable agrotechnologies like tissue culture to conserve endangered species. Scientific efforts should focus on clinically validating traditional polyherbal formulations to translate ancient wisdom into safe, standardized therapeutics. This approach is essential to protect the region's biodiversity while elevating local ethnomedicinal practices to a global industrial scale.

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Authors' contributions

SND drafted the initial manuscript and validated the data. RD participated in the design of the study and prepared the table. MB reviewed and revised the manuscript. All authors read and approved the final manuscript.

Compliance with ethical standards

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