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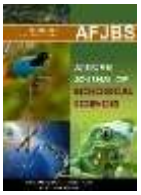

Underutilized plants of North East India: A promising source for Anti-inflammatory Treatment

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ABSTRACT

Since the dawn of civilization, humans have forged an intimate alliance with nature. Plants, a cornerstone of existence, have provided not only sustenance but also medicine. Sophisticated traditional medicine systems, practiced for millennia, serve as testaments to this reliance. In estimates by the World Health Organization, a staggering 80% of the global population still utilizes traditional medicines for primary healthcare.

Northeast India, a biodiversity hotspot nestled in the Eastern Himalayas, harbors a remarkable wealth of plant life. This rich flora has fostered a deep connection between indigenous communities and their environment, leading to the development of a robust ethnomedicinal tradition. Tribal communities, acting as stewards of this knowledge, have passed down generations of wisdom regarding the therapeutic properties of various plant species. This knowledge informs traditional healing practices like Ayurveda and Unani, where specific plants are used to target a wide range of ailments, from inflammatory conditions to infectious diseases. Plants offer a potential avenue for treating inflammation, analogous to their role in other ailments. The success of this approach depends on the specific phytoconstituents (bioactive compounds) found within the plant.

This study focuses on some underutilized plants found in Northeast India, the geographical distribution of these plants, the documented ethnomedicinal uses for treating inflammation and other ailments, and the identification of their major phytoconstituents. By exploring these underexploited resources, the study seeks to contribute valuable knowledge to the field of ethnopharmacology.

Keywords: North East India, Inflammation, Phytoconstituents, Ethanobotanical, Anti-inflammation.

➢ INTRODUCTION

In developing nations such as India, the utilization of plants as a source of medicinal compounds has become a significant part of the current healthcare infrastructure. Investigating it is crucial to preserve the traditional knowledge of ethnic people who use various plants to heal illnesses in the present for the benefit of society in the future. In the fields of agriculture and ethnobotany, the cultivation, preservation, and protection of valuable medicinal plants are currently opening up new avenues. As per the World Health Organization (WHO), more than 45,000 plant species in India possess therapeutic properties, and 70% of the rural population in India relies on traditional medicine as their primary healthcare system, which is derived from biological resources[1]. With a population of nearly 40 million, the eight states that make up North East India has a combined total geographical area of 262180 km2, or almost 8% of the nation's total area. The earth's soil, slope, altitude, and ecological diversity are home to a wide variety of life forms. The primary basis for human existence on the planet is plant biodiversity, which includes the agricultural production systems that exist within farming communities[2]. With consideration for the local environment and culture, Traditional ecological knowledge evolves from millennia of experience. Learning about the makeup and workings of local natural environments is essential for using their resources responsibly and sustainably for human benefit. It is believed that traditional ecological knowledge, which is passed down orally from generation to generation, is community intellectual property and intangible heritage. It is typically shared by a small group of people and might take the form of proverbs, folklore, stories, songs, native languages, rituals, and/or cultural values[3]. There are so many tribes in northeast India follow traditional method of medicine like in Assam (karbi, boro,miri, kachari,ahom,mishing tribes), Meghalaya (khasi, jaintia, garo, tribes), Arunachal Pradesh (apatani, adi,galo,nyishi,monpa), Nagaland (angami, chang, konyak,phom), Mizoram (lushei,ralte, Hmar tribes), Manipur (meiti,nagas tribes), Tripura (riang, chakma, noatia, kuki, halam, bhutia tribes), Sikkim (rai, chhetri, tamang, gurung) etc.Therefore, from prehistoric times to the present, herbs have played a significant part in human life. For the treatment of common wound, swelling, inflammation, illnesses, the majority of people employ a variety of native herbs as medicine. The community health care system and biodiversity preservation both benefit from the utilization of this traditional knowledge of therapeutic plants [4].Of India's biodiversity, half is found in North-EastIndia.

The people of Meghalaya employ around 377 species of the 850 medicinal plants that are found there for their primary medical requirements. The rural community in Assam uses herbal plants in households as a kind of self-help. Located in the Eastern Himalayan Region of India, Arunachal Pradesh is a treasure trove of ecological and sociocultural variety. The Imphal valley of Manipur, with the exception of Jiribam Subdivision, Imphal East, has been found to have a variety of forgotten minor edible fruits. According to Ayurvedic scriptures, Sikkim's diverse flora contains a variety of raw medications. The tribespeople of the Sikkim Himalaya region

employ roughly 420 plants as remedies for a range of ailments. A total of 25 medicinal plants have been identified by the elderly and medicine men of different Tripuran communities [5].

➢ INFLAMMATION

Inflammation is the body's natural reaction to injury or infection. It's like a swelling or redness that helps fight germs and heals tissue. The word "inflammation" even comes from a latin word meaning "to burn" because sometimes inflammed areas feel hot. Inflammation is a protective and positive body response to harmful stimuli.It is a protective response involving immune cell blood vessels and molecular mediator. Inflammation occurs to eliminate the initial cause of cell injury and initiate tissue repair Inflammation serves as the body's initial defense against microbial invaders and foreign antigens. However, the intensity of this response is critical. Insufficient inflammation can leave the body vulnerable, while an overzealous response can transition into chronic inflammation. This chronic state is linked to various diseases, including osteoarthritis, rheumatoid arthritis, inflammatory bowel disease (including Crohn's disease), and even metabolic syndrome-associated disorders. [6].In post-natal life the inflammatory responses is an inevitable to any kind of tissue injury The inflammatory response is the earliest of protective mechanism even before the development of nervous system.There are many surveys doctors use to diagnose things like depression, tiredness, sleep problems, confussion and pain. But none of these surveys were designed specifically to look for changes in thinking and behaviour caused by inflammation. Instead of creating new surveys, researches have been using to existing ones even through they weren't perfect for this purpose. More than one in five people with Inflammatory Bowel Disease (IBD) experience depressive symptoms in which sleep problems and Fatigue are even more common. Depression along with (IBD) can worsen the course of the disease making flare-ups and surgery more likely. Unfortunately treating depression alongside (IBD)with psychological therapy has shown mixed results[7].
It is observed that depressive symptoms occur in over 20% of people with (IBD) which is around 2-4 times more common than in the general population.
To account for the dynamic nature of inflammation investigation into the relationship between inflammation and depression must incorporate the temporal dimensions. Inflammation can fluctuate rapidly within an individual due to various environmental factors such as inmicrobial burden and exposure to stressors as well as internal variables like the diurnal variation of cortisol levels [8].While inflammation is linked to both healthy and unhealthy bodily function, we understand much more about its role in disease (pathological aspects) than its importance in normal body processes (physiological function) [9].There's no doubt that inflammation is a crucial adaptation triggered by harmful stimuli and situations, like infections or tissue damage. While we've made significant strides in understanding the cellular and molecular mechanisms behind acute inflammation caused by infections, the same can't be said for tissue injury. Our knowledge remains particularly limited when it comes to the events leading to localized chronic

inflammation, especially in chronic infections and autoimmune diseases. [10]. When the body is infected or injured the immune system cells called the leukocytes are sent to the area along with other blood components. This is called the acute inflammatory response. Scientists understood this process best for infection caused by germs especially bacteria. In these cases, immune system receptors called (TOLL)-like receptors (TLRs) and (NOD) (nucleotide-binding oligomerization-domain protein) trigger the response[11].

➢ TYPES/CLASSIFICATION OF INFLAMMATION:

Inflammation is majorly classified into two different types:

1. Acute Inflammation

2. Chronic Inflammation

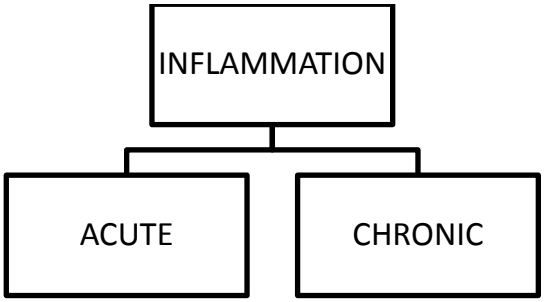


Fig: Types of Inflammation

▪ Acute Inflammation:

Acute inflammation unfolds like a well-rehearsed play. Immune system cells, guided by chemical messengers like cytokines, chemokines, and acute-phase proteins, meticulously migrate to the injured site. This initial response, depending on the severity of the injury, can be enough to mend the damage and kickstart healing. However, if the trigger persists or the body mistakenly attacks its own tissues, inflammation can become chronic. [12]

▪ Chronic Inflammation:

When the acute inflammation is not treated for a longer period of time it eventually starts to damage your body cells which may lead to tissue damage and can even cause severe disease such as Cancer, Stroke.

- **Chronic inflammation may also be caused by various other reasons such as:**

• Persistent triggers of acute inflammation, such as unresolved infections or unhealed injuries.

• A disease triggered by a malfunction of the immune system, leading it to launch an attack on healthy tissues instead of protecting them.

• Repeated breathing in of irritants, like chemicals from factories or pollutants in the air, over a long period of time.

In addition to these known causes, several other lifestyle factors are suspected to play a role in chronic inflammation, including smoking, excessive alcohol consumption, chronic stress, and advancing age.

➢ ETIOLOGY OF INFLAMMATION:

The incidence of inflammatory diseases is rising globally [13]. Inflammation is a complex choreography of cellular and vascular events triggered by specific substance. It involves the coordinated movement of white blood cells including (including monocytes, Basophils, Eosimophils and Neutrophils) plasma and fluids to the inflamed area. Immune cells release a variety of chemicals messengers like histamine and prostaglandins that contribute to the inflammatory response[14]. Inflammation comes in two main forms: acute and chronic. Each seems to be driven by a distinct underlying process[15]. These immune responses which involved in acute inflammation can be divided into vascular and cellular. Within minutes of tissue injury or infection, a series of events unfolds in the blood vessels (micro vasculature). These rapid vascular events triggered by the inflammatory stimuli cause the vessels to widen (vasodilation) and becomes leaky. This allow inflammatory mediators to enter the surroundings tissues, leading to fluid builup (interstitial edema).[16] While foreign pathogens are well-established triggers of inflammation, directly gauging the activity of key messengers within cells remains a challenge. These intracellular messengers include STAT3 (signal transducer and activator for transcription-3), along with critical inflammatory transcription factors like NF-κB (nuclear factor-kappaB), NFAT (nuclear factor of activated T cells), and AP1 (activator protein 1). [17]

- **Cellular Processes and ROS: A Double-Edged Sword**

Our cells naturally generate reactive oxygen species (ROS) as byproducts during various activities in compartments like the endoplasmic reticulum, mitochondria, and peroxisomes. These highly reactive molecules can oxidize proteins, lipids, and even damage DNA. However,

in normal amounts, ROS act as important signaling molecules, influencing cell growth, adhesion, and differentiation. They achieve this by modifying specific protein structures through a process called posttranslational modification [18].

- **The Link Between ROS and Inflammation**

Interestingly, ROS play a complex role in inflammation. They are involved in initiating, progressing, and resolving inflammatory responses. Chronic inflammation, in turn, leads to increased ROS production. This creates a vicious cycle, where ROS activate various signaling molecules like the transcription factor NF-kB, promoting the expression of genes that drive inflammation. When ROS production becomes excessive during chronic inflammation, it can damage cells and tissues, potentially leading to serious diseases[19].

- **Cellular Sources of ROS in Inflammation**

Neutrophils, a type of white blood cell, are the primary producers of ROS in the immune system. However, other immune cells like macrophages also contribute significantly to the increased ROS levels during an inflammatory response[20].

- **Inflammation and ROS: A Connected Pathway**

When bacteria are engulfed by immune cells (phagocytosis), an enzyme called NADPH oxidase (NOX) activates and generates superoxide radicals inside the compartment surrounding the bacteria. Other factors, like altered cellular metabolism and oxidative stress, can also increase ROS production.

Separately, inflammatory messengers (cytokines) trigger STAT3 protein to move into the cell nucleus. There, STAT3 acts as a switch, turning on genes involved in inflammation. Recent research has revealed an additional layer of complexity. A specific form of STAT3, phosphorylated at serine 727, can enter the mitochondria (cell's power plant) and directly stimulate ROS production. This finding highlight how inflammatory signals can indirectly boost ROS generation within the mitochondria [21].

➢ ARACHADONIC ACID PATHWAY:

Arachidonic acid (AA), also known as eicosa-5,8,11,14-tetraenoic acid, is an omega-6 polyunsaturated fatty acid (PUFA) primarily found in cell membranes as part of phospholipids. During times of cellular stress, AA is liberated from these phospholipids by enzymes like phospholipase A2 (PLA2) and phospholipase C (PLC), releasing free arachidonic acids. These free acids serve as precursors to proinflammatory bioactive mediators through three metabolic pathways[22].

Arachidonic acid (AA) serves as a substrate for the generation of diverse eicosanoids, potent autocrine and paracrine bioactive mediators that significantly influence physiological and pathological processes. These eicosanoids are synthesized through three primary pathways: the cyclooxygenase (COX) pathway, which metabolizes AA into prostaglandins (PGs) and thromboxanes (TXs); the lipoxygenase (LOX) pathway, responsible for the conversion of AA to leukotrienes (LTs) and lipoxins (LXs); and the cytochrome P450 (CYP450) pathway, leading to the formation of epoxyeicosatrienoic acids (EETs) and hydroxy eicosatetraenoic acids (HETEs). [23].

Arachidonic acid (AA) metabolism begins with cyclooxygenase (COX) enzymes acting on AA liberated from cell membranes by phospholipases. COX converts AA into prostaglandin G2 (PGG2) and then PGH2, which are precursors to various prostanoids like prostaglandins (PGs) and thromboxane A2 (TXA2)[24].

Specific prostaglandin (PG) synthases further modify PGH2 molecules into their final PG forms. Notably, there are two types of COX enzymes: COX-1 is constitutively expressed in most cells, meaning it's constantly produced. This COX-1 is responsible for the baseline production of prostanoids essential for everyday cellular functions[25].

➢ OVERVIEW OF ACARADHONIC ACID PATHWAY:

The COX pathway, also known as the prostaglandin G/H synthase (PGHS) pathway, metabolizes arachidonic acid (AA) into PGH2 and PHG2. These prostaglandins (PGs) serve as substrates for downstream enzymes, which generate specific PGs such as PGE2, PGI2, PGD2, PGF2, and TXA2. The key distinction between the two COX enzymes is that while COX-1 is constitutively expressed in most tissues, COX-2 is an inducible enzyme, although there are some notable exceptions[26].

COX enzymes exhibit selectivity with downstream synthases. While not absolute, COX-1 preferentially interacts with thromboxane synthase, PGF synthase, and cytosolic (c) PGE synthase (PGES) isoforms, leading to the production of specific prostanoids[27].

➢ Arachidonic acid physiological functions:

- **Cell membrane fluidity**

Arachidonic acid's unique structure, containing four double bonds in a cis configuration, confers high fluidity and selective permeability to cell membranes. These properties arise from the molecule's increased flexibility and ability to adopt various shapes. By regulating membrane fluidity, arachidonic acid influences specific membrane proteins critical for cellular signaling. The ability of arachidonic acid to maintain cell and organelle integrity, along with regulating vascular permeability, is likely crucial for its involvement in several critical processes. These include proper neuron function, the brain's capacity for synaptic plasticity (the ability of synapses to strengthen over time), and even long-term potentiation within the hippocampus, a brain region essential for memory formation. [28].

- **Ion channels**

Free arachidonic acid (ARA) plays a surprising role in how our brains, hearts, and muscles function. It influences the excitability of nerve cells and communication between them by interacting with specific channels in cell membranes. These channels, called voltage-gated ion channels, act like tiny switches that control the flow of charged particles (ions) across the cell membrane. The specific ions allowed to pass determine how excitable a cell is, affecting nerve impulses, muscle contractions, and hormone release[29,30].

Voltage-gated ion channels are built from protein subunits with specific functions. One part, formed by four segments (S1-S4), acts as a voltage sensor that responds to changes in the electrical charge across the membrane. Another part, made of two segments, creates a pore for specific ions to pass through. ARA's influence comes from its interaction with the voltage sensor. The flexible tail of ARA can position itself near a positively charged region of the sensor. This interaction, likely through electrical attraction, may influence how easily the sensor responds to voltage changes, potentially affecting when the channel opens and allows ions to pass[31,32].

- **Receptors and enzymes**

Arachidonic acid (ARA), whether produced within the cell (endogenously) or introduced from external sources (exogenously), has been shown to significantly influence the function of ligand-gated ion channels. Notably, ARA enhances the activity of the gamma-aminobutyric acid receptor (GABA-R) on neuronal membranes. This modulation appears to occur through altered interaction characteristics between the GABA-R and its natural ligands[30,33].

On the other hand, exposure to free arachidonic acid (ARA) has the opposite effect, inhibiting both muscle and neuronal nicotinic acetylcholine receptors (nAChRs). These nAChRs are essential membrane proteins embedded deeply within the postsynaptic region of a neuron. They have a unique structure, featuring a central ion channel flanked by two binding sites for activating molecules (agonists).The inhibitory effect of ARA on nAChR function is likely due to its ability to displace lipids from their binding sites within the plasma membrane. Displaced lipids may then allow ARA to directly act as an antagonist at a specific polyunsaturated fatty acid (PUFA)-protein interface on the nAChR[34].

SOME UNDERUTILIZED MEDICINAL PLANTS FOUND IN NORTHEAST INDIA USED IN TREATMENT OF INFLAMMATION

1. INDIAN OLIVE

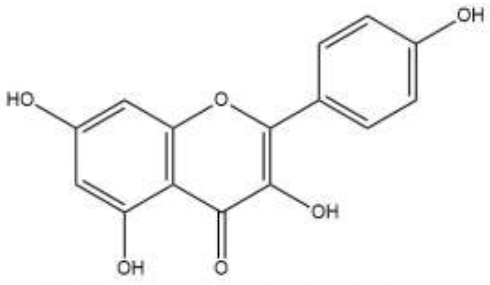
Scientific name: *Elaeocarpus floribundus*

Elaeocarpus floribundus, an evergreen tree species with a spreading canopy, is found commonly in Northeast India and is native to a region spanning India, Nepal, Sri Lanka, and Bangladesh. Traditionally harvested from the wild, it serves a dual purpose: a local food source due to its edible fruits and a potential medicinal resource.

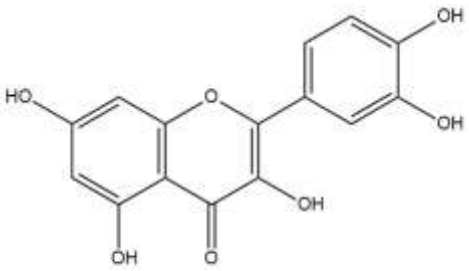
Elaeocarpus floribundus has several regional names: Jolpai (Assamese), Jalpai, Jamun, Gastong Say (Arunachal Pradesh), Jalpui (Tripura), and Chorphon (Manipur).

The fruits of *Elaeocarpus floribundus* are consumed directly or processed into pickles. Additionally, an infusion prepared from the bark and leaves finds application as a general tonic and a topical mouthwash for treating inflamed gums. Furthermore, these same plant parts are utilized in poultice form for ulcer treatment.

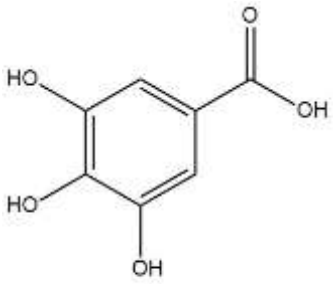
KEY PHYTOCONSTITUENTS:



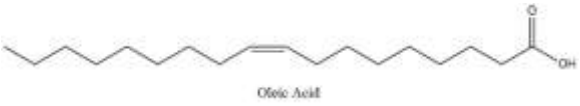
3,5,7-trihydroxy-2-(4-hydroxyphenyl)-4*H*-chromen-4-one
[Kaempferol]



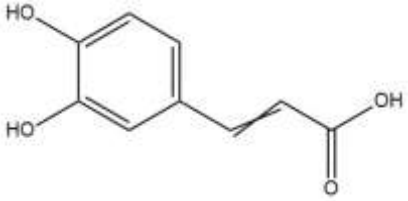
2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxy-4*H*-chromen-4-one
[Quercetin]



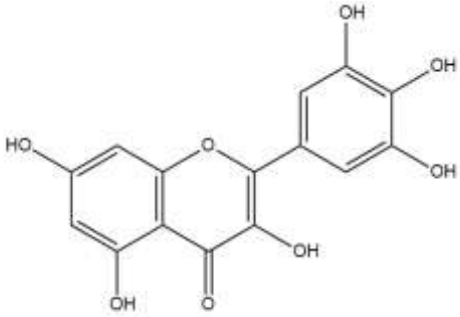
3,4,5-trihydroxybenzoic acid
Gallic Acid



Oleic Acid



3-(3,4-dihydroxyphenyl)acrylic acid
Caffeic Acid



3,5,7-trihydroxy-2-(3,4,5-trihydroxyphenyl)-4*H*-chromen-4-one
[Myricetin]

Elaeocarpus floribundus has a history of ethnobotanical use in treating conditions like diabetes, urinary tract infections (UTIs), inflammation, malaria, and potentially even cancer.[35-43]

2. HYACINTH BEAN

Scientific name: *Lablab purpureus*

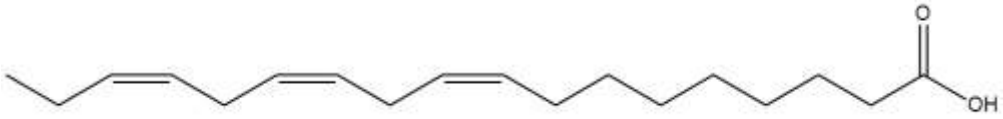
A versatile summer legume, it thrives as either an annual or a short-lived perennial. This herbaceous vine, twining or climbing in its growth habit, can reach lengths of 3-6 meters. Beyond its attractive appearance, Lablab offers culinary value. Its immature seeds and pods, along with young leaves, are all edible and enjoyed as cooked vegetables. Even the mature dried

beans are consumable, though they require extended cooking with multiple water changes to ensure palatability.

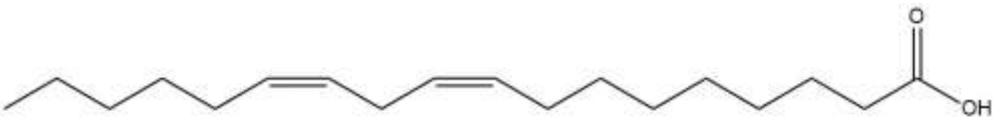
Lablab purpureus exhibits a broad geographic distribution, cultivated as an annual or short-lived perennial crop across tropical and subtropical regions. Its documented cultivation range encompasses South and Central America, the East and West Indies, China, Southeast Asia, and Australia.*Lablab purpureus* finds itself cultivated across a significant portion of India, with documented presence in states like Uttar Pradesh, Odisha, West Bengal, Assam, Bihar, Jharkhand, Andhra Pradesh, and Tamil Nadu.

This plant is known by various vernacular names in North East India, including Urohi and sem (Assamese), Orsha (Arunachal Pradesh), Lubeya (Tripura), and Hawaithamoak (Manipur).

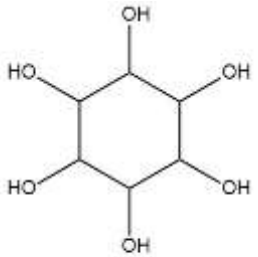
KEY PHYTOCONSTITUENTS:



(9Z,12Z,15Z)-octadeca-9,12,15-trienoic acid
Alpha-linolenic Acid



(9Z,12Z)-octadeca-9,12-dienoic acid
Linoleic Acid



cyclohexane-1,2,3,4,5,6-hexaol
Inositol

In addition to these bioactive compounds, Lablab purpureus boasts a diverse profile of other chemical constituents. These include flavonoids, saponins, lectins, alkaloids, proteins, steroids, anthraquinones, phenolic compounds, coumarins, and terpenoids.

Lablab purpureus has a history of ethnobotanical use for a variety of health conditions. Traditionally, it has been employed to manage diabetes, inflammation, pain, and oxidative stress. Additionally, it may play a role in lowering blood lipid levels, combating microbial infections, protecting liver function, and even aiding in iron deficiency anemia. [44-53]

3. CUSTARD APPLE

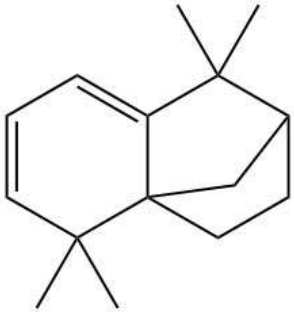
Scientific name: *Annona squamosa*

Native to the Annonaceae family, *Annona squamosa*, commonly known as custard apple, is a significant tropical fruit cultivated across a vast region. This area encompasses the West Indies, South and Central America, countries like Ecuador, Peru, and Brazil, as well as India, Mexico, and even islands like the Bahamas and Bermuda. The cultivation of custard apple (*Annona squamosa* L.) is practiced across a wide range of Indian states.Notably, this fruit tree flourishes in various states across the country, including Maharashtra, Bihar, Gujarat, Uttar Pradesh, Tamil Nadu, Karnataka, Assam, and Arunachal Pradesh.

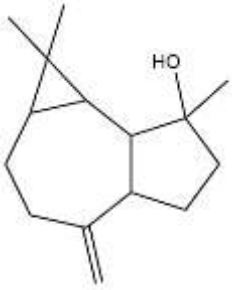
Custard apple (*Annona squamosa*) boasts unique names across different regions. Assamese people call it "Ata-kathal," whereas Bengalis know it as "Ata phol."

Annona squamosa boasts a rich history of utilization in both traditional medicine and various food applications. The pulp, constituting 50-80% of the fruit, finds favor as a natural flavoring agent in ice cream and other food products. Additionally, a significant portion of the fruit is suitable for consumption, often processed into juice. The leaves of the custard apple plant have garnered scientific interest for their potential health benefits. This interest stems from the remarkable diversity of phytochemicals they contain.

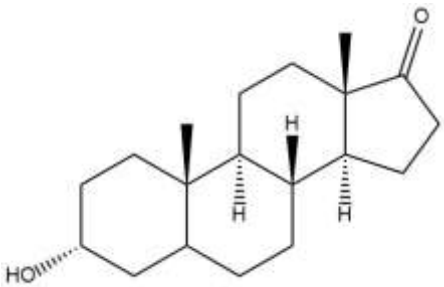
KEY PHYTOCONSTITUENTS:



9,10-dehydro-isolongifolene



Spathulenol



Androsterone

Scientific studies have documented the presence of a wider range of chemical compounds in A. squamosa. These include alkaloids, carbohydrates, tannins, phenolic compounds, isomeric hydroxyl ketones, cyclopeptides, and acetogenins. It's important to note that these compounds may be found in varying concentrations within different parts of the plant.

Annona squamosa has been attributed with a diverse range of potential health benefits due to its possession of various bioactive properties. These properties include antioxidant, antiviral, antifungal, anti-inflammatory, anticancer, and antiparasitic effects, among others.

Commercially available *Annona squamosa* products encompass a range of options to cater to diverse consumer preferences. These include custard apple leaf extracts, custard apple seed oil, leaf tea in loose or bag form, capsules or tablets containing concentrated extracts, and even syrups.[54-60]

4. NIGHT JASMINE

Scientific name: *Nyctanthes arbor-tristis*

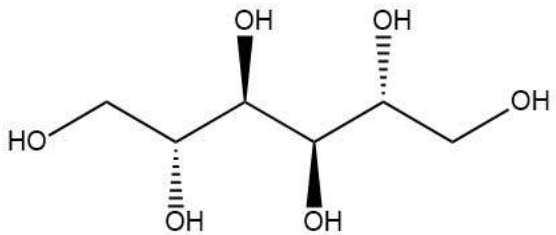
Night jasmine (*Nyctanthes arbor-tristis*), a well-researched woody perennial shrub or small tree, reaches up to 10 meters in height. This terrestrial plant typically has a lifespan of 5 to 20 years. *Nyctanthes arbor-tristis* has its origins in South Asia. Within India, this tree flourishes primarily in the Himalayan region, extending its presence to states like West Bengal, Assam, Arunachal Pradesh, and Odisha. Additionally, it can be found in neighboring Bhutan.

Traditionally, various parts of *Nyctanthes arbor-tristis* hold significance in local and folk medicine. The plant finds documented use in the Ayurvedic, Siddha-Ayurvedic, and Yunani medicinal systems.

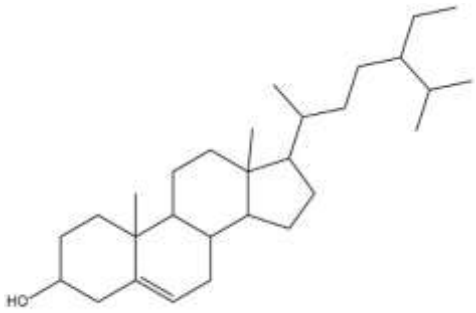
Within Assam, *Nyctanthes arbor-tristis* is known as 'Sewali.' While, in Manipur, the local name for this tree is 'Singari.'

SYNONYM: Sewali Ful (Assamese),parijat, coral jasmine, Thabal lei (Manipur)

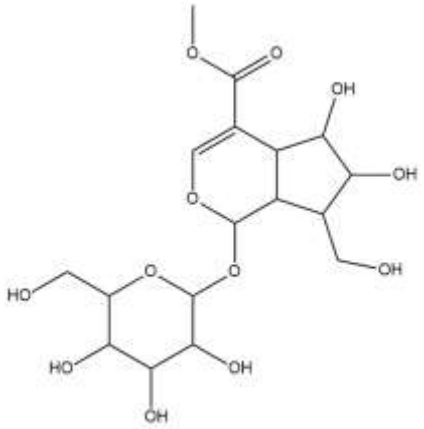
KEY PHYTOCONSTITUENTS:



Mannitol



β-sitosterol



Nyctanthoside

Nyctanthes arbor-tristis contains a diverse profile of other chemical constituents. These include phenolic acids, glycosides, saponins, terpenoids, flavonoids.

Historical records document the use of *Nyctanthes arbor-tristis* in various ailments. Traditionally, it has been employed to treat piles (hemorrhoids), eliminate lice, manage asthma, and even remove dandruff. Today, its use continues in some regions for conditions like rheumatism, piles, liver and biliary disorders, and even as a potential remedy for roundworms and threadworms in children.

This plant is utilized in a variety of commercially available products to cater to diverse consumer needs. These products encompass leaf extracts, capsules or tablets, tea, topical creams or ointments, and even syrups.[61-65]

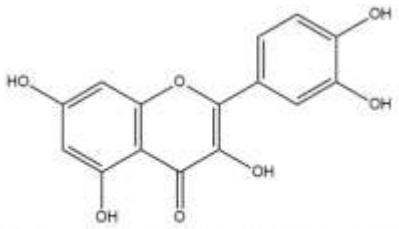
5. QUINCE

Scientific name: *Cydonia oblonga*

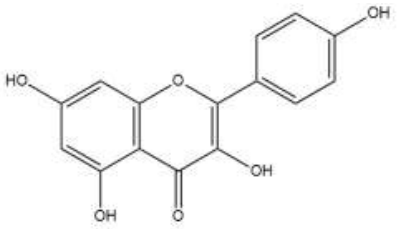
Cydonia oblonga, the sole member of the Rosaceae genus known as quince, is a small medicinal, nutritional, and ornamental shrub or tree reaching 5-8 meters tall and 4-5 meters wide. Its fruit, a popular dietary source, is used to make jams and jellies.It is known as Kejuriin Assamese.

In India it is found in Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Punjab, Haryana, Assam, Arunachal Pradesh, and Nagaland.

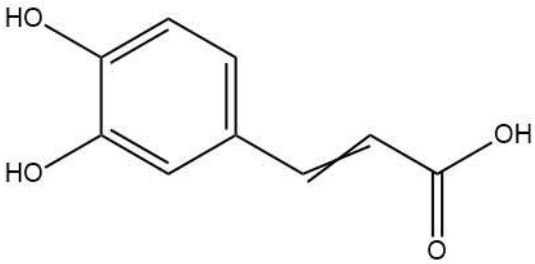
KEY PHYTOCONSTITUENTS:



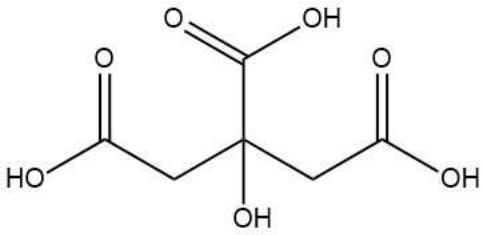
2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxy-4*H*-chromen-4-one
[Quercetin]



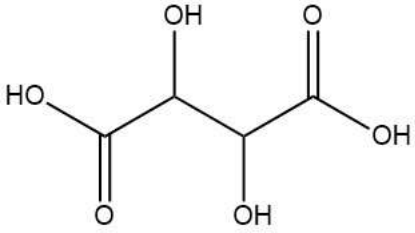
3,5,7-trihydroxy-2-(4-hydroxyphenyl)-4*H*-chromen-4-one
[Kaempferol]



3-(3,4-dihydroxyphenyl)acrylic acid
Caffeic Acid



Citric Acid



Tartaric Acid

Other phytoconstituents include tannins, phenolic acids, pectin, malic acid, and essential oils.

Ethnomedical record shows this plant has a history of use in various health conditions potentially with inflammation, oxidation, digestion, microbial infections, and astringent properties. Additionally, traditional practices have employed it for ulcers and diabetes.

It is available in the form of extracts, syrups, teas, and infused products in the market.[66-71]

6. BLACK TURMERIC

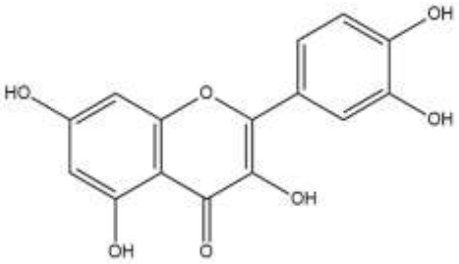
Scientific name: *Curcuma caesia*

Curcuma caesia, a member of the Zingiberaceae family encompassing the familiar ginger plant, is more commonly known as black turmeric. This herbaceous species has a well-documented history of utilization within Ayurvedic medicine. Both the leaves and rhizomes of *Curcuma caesia* are extensively employed in traditional remedies for a range of ailments.

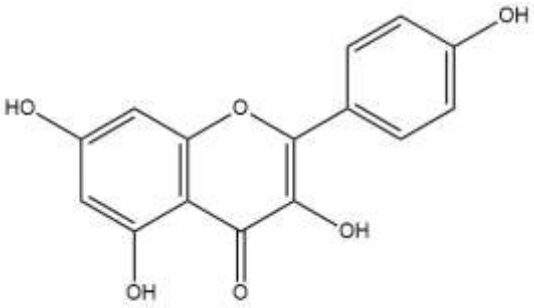
It is native to South Asia. Within India, this plant's distribution is concentrated in the Himalayan region, extending to states like West Bengal, Assam, Arunachal Pradesh, and Odisha.

In Assamese, *Curcuma caesia* is known as Kola halodhi, while Hindi speakers refer to it as kali haldi. Additionally, in Arunachal Pradesh it is known as Changlu Saga.

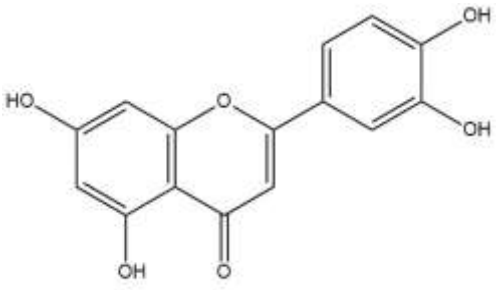
KEY PHYTOCONSTITUENTS:



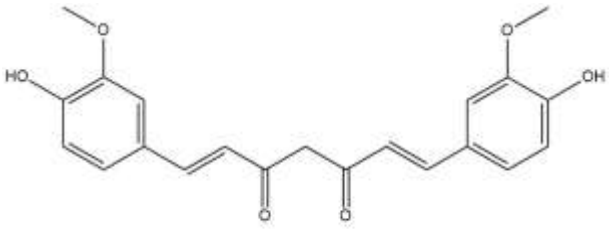
2-(3,4-dihydroxyphenyl)-3,5,7-trihydroxy-4*H*-chromen-4-one
[Quercetin]



3,5,7-trihydroxy-2-(4-hydroxyphenyl)-4*H*-chromen-4-one
[Kaempferol]



Luteolin



Curcumin

Various studies have reported that *C. caesia* possesses a range of biological activities, including antioxidant, antimicrobial, and anti-inflammatory properties.

Various products formulated from different parts of *C. caesia* is available in the form of supplements, herbal teas, creams and ointments, etc.[72-74]

7. INDIAN PRICKLY ASH

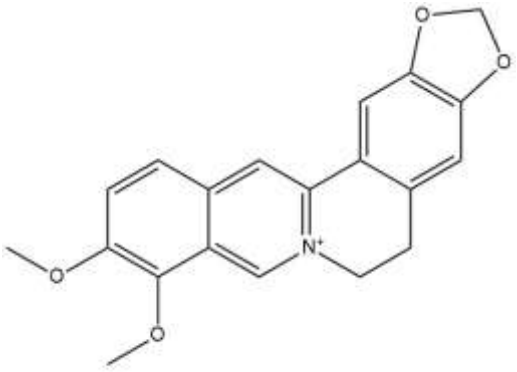
Scientific name: *Zanthoxylum rhesta*

Zanthoxylum rhetsa, belonging to the Rutaceae family, is a plant species widely distributed across subtropical regions. Notably, it thrives in Bangladesh, India, Sri Lanka, Indonesia, Malaysia, Vietnam, and China.In India, it is found in Sikkim, Arunachal Pradesh, Assam, Meghalaya, Himachal Pradesh, Jammu and Kashmir etc.

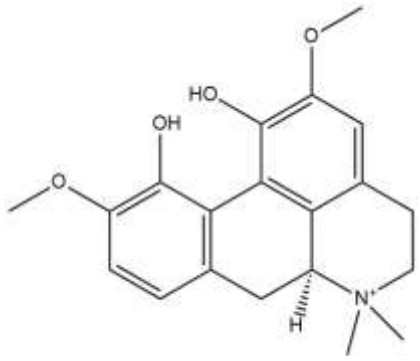
Zanthoxylum rhetsa is a deciduous tree reaching up to 35 meters in height. This medium-sized tree features a spreading crown for its canopy, and its branches are equipped with defensive prickles. The leaves exhibit a compound, imparipinnate arrangement. They are alternate, meaning they arise singly on either side of the stem at different heights, and display a spiral pattern along the branches.

Nearly every part of the plant finds a use. For instance, a paste prepared from the plant is a time-tested remedy for toothache due to its numbing effect. Additionally, the fruits are traditionally used to alleviate stomachache and diarrhea, while the bark's juice is believed to be beneficial for various ailments like vomiting, cough, dysentery, and headaches.

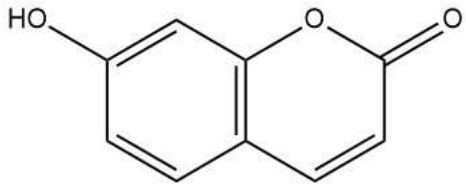
KEY PHYTOCONSTITUENTS:



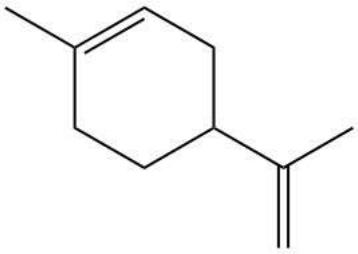
Berberine



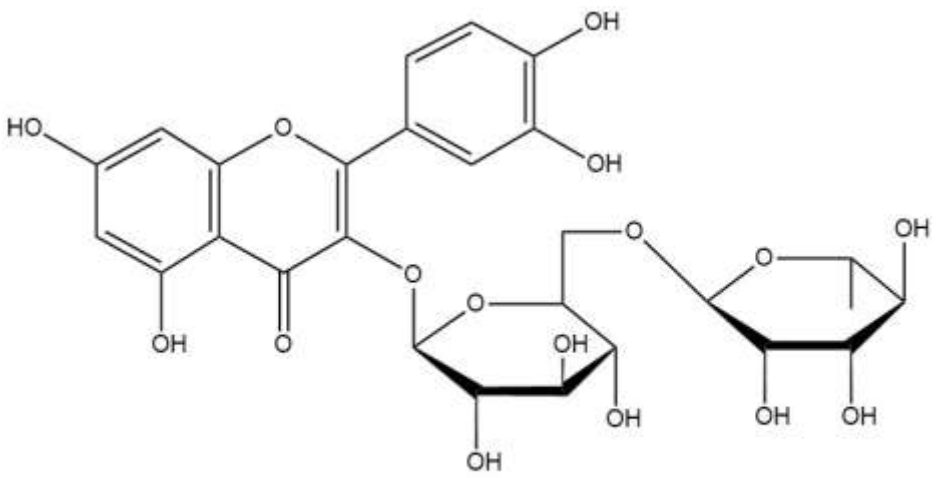
Magnoflorine



Umbelliferone



Limonene



Rutin

It also contains chelerythrine, quercetin,kaempferol, sesamin, sesamolin, scopoletin,beta-pinene, sabinene.

Zanthoxylum rhetsa has been attributed with a broad spectrum of potential biological activities. These include anti-inflammatory, antioxidant, antibiotic, hepatoprotective, antiviral, and antifungal properties, among others.[75-78]

8. HAIRY BERGENIA

Scientific name: *Bergenia cilliata*

Bergenia cilliata is a rhizomatous herb, characterized by an underground creeping rootstock that is stout (thick and strong). This rootstock bears scars and intermittent axillary buds, from which fleshy leaves and upright stems sprout. The plant typically reaches up to 30 centimeters in height.

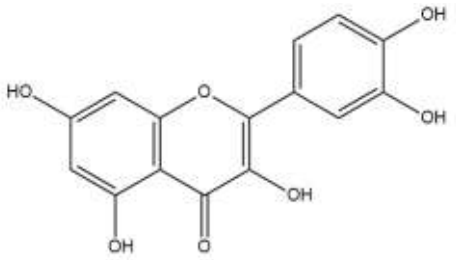
*Bergenia cilliata*is primarily distributed across the Himalayan region, encompassing countries like Bhutan, India, Tibet, Afghanistan, and Pakistan. Within India, its presence extends to several northeastern states, including Arunachal Pradesh, Meghalaya, West Bengal, and Sikkim.

Bergenia cilliata, bears different names across different states. In Assam, it is commonly known as Patharkuchi, while in other areas, it is referred to as La Khowang (in Khasi language), and Aamamg (in Tripura).

Ethnomedical records indicate a history of *Bergenia cilliata* use in traditional healing practices for various ailments. These include pulmonary infections, , piles (hemorrhoids), and potentially dissolving bladder and kidney stones. Furthermore, Ayurvedic medicine incorporates *Bergenia cilliata*as a tonic, astringent, antiscorbutic (combating vitamin C deficiency), laxative, and

remedy for spleen enlargement, dysuria (painful urination), and ulcers. Other uses include anti-inflammatory, antitussive (cough-suppressant), antioxidant, antiviral, antiulcer, hypoglycemic (blood sugar lowering), antibacterial, antifungal, antipyretic (fever-reducing), and cardiovascular activity, among others.[79-81]

KEY PHYTOCONSTITUENTS:



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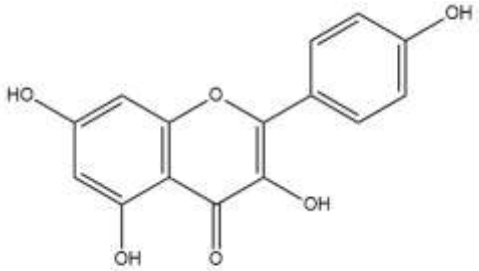
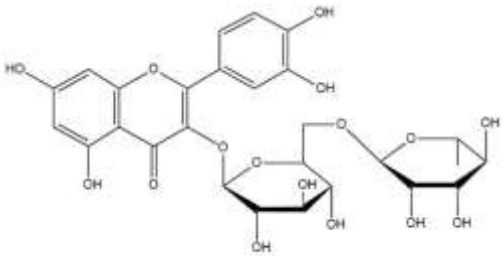
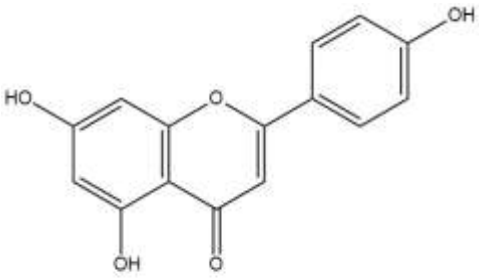
[Quercetin]



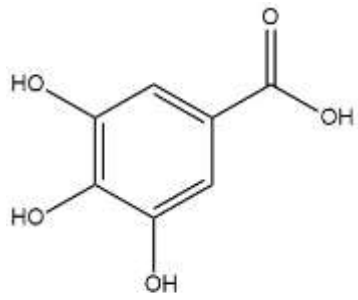
3,5,7-trihydroxy-2-(4-hydroxyphenyl)-4*H*-chromen-4-one
[Kaempferol]



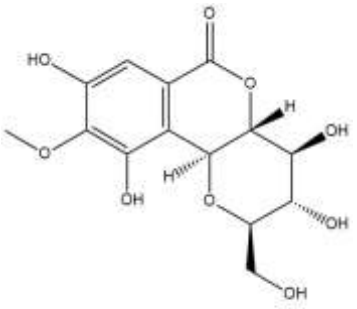
Rutin



Apigenin



Gallic Acid



Bergenin

CONCLUSION

North East India, recognized as a biodiversity hotspot and harboring diverse communities, possesses a rich legacy of traditional knowledge regarding the therapeutic application of natural resources for various ailments. This ethnobotanical wisdom, passed down through generations, continues to be actively utilized. Individuals often seek treatment from traditional healers for minor and, at times, chronic conditions. A critical need exists for the systematic documentation of this traditional knowledge base, followed by rigorous scientific validation of these claims.The recent resurgence of interest in plant-based medicines stems from concerns regarding the potential adverse effects of synthetic drugs. Exploring the diverse phytoconstituents (plant chemicals) and their mechanisms of action can illuminate the effectiveness of plants and contribute to a deeper understanding of their therapeutic potential.

The plant species reviewed in this work hold immense promise for further scientific exploration and potential drug development. These plants have been traditionally used to treat a wide range of ailments, suggesting a rich repository of bioactive compounds with therapeutic potential. Further research on these plants could lead to the discovery of novel and improved anti-inflammatory agents. Modern scientific techniques can be employed to isolate, identify, and characterize the active constituents responsible for their therapeutic effects. Additionally, investigating the mechanisms of action of these plant-derived compounds will provide valuable insights into their efficacy and potential safety profiles.

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