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A Comprehensive Review on Phytochemical Constituents and Pharmacological Activities of *Nyctanthes arbor-tristis* and *Althaea officinalis Linn*

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❖ **ABSTRACT:**

Medicinal plants remain significant in both traditional and contemporary healthcare systems, valued for their natural origins and therapeutic benefits. Two such widely utilized species are *Nyctanthes arbor-tristis* and *Althaea officinalis*, each recognized for a range of pharmacological effects. This review outlines their classification, chemical composition, pharmacognostic features, and medicinal applications. *Nyctanthes arbor-tristis*, part of the *Oleaceae* family, has long been employed in traditional remedies for conditions including fever, cough, arthritis, inflammation, and various skin ailments. Its bioactive constituents such as flavonoids, alkaloids, glycosides, tannins, terpenoids, and carotenoids underlie its antioxidant, anti-inflammatory, antimicrobial, antimalarial, liver-protective, immune-modulating, pain-relieving, and anticancer properties. *Althaea officinalis*, from the *Malvaceae* family, is particularly rich in mucilage polysaccharides, along with flavonoids, phenolic compounds, tannins, coumarins, and phytosterols. It is commonly used to treat respiratory and digestive tract disorders, thanks to its soothing, cough-suppressing, anti-inflammatory, antioxidant, antimicrobial, gastroprotective, wound-healing, and antiulcer effects. The extensive medicinal potential of these two plants underscores their importance as valuable sources of natural bioactive agents for use in herbal medicine and pharmaceutical development.

Keywords: *Nyctanthes arbor-tristis*, *Althaea officinalis L*., Parijatak, Marshmallow, Medicinal plants, Phytochemical Activities, Pharmacological Activities, Pharmacognostic study.

❖ **INTRODUCTION:**

Medicinal plants have played a central role in traditional medicine for centuries and remain a focus of scientific research due to their therapeutic promise. Two notable examples, *Althaea officinalis* and *Nyctanthes arbor-tristis*, are widely acknowledged for their pharmacological benefits and complex phytochemical profiles. Both are commonly used in Ayurvedic, Unani, and folk healing practices to address conditions such as respiratory issues, inflammation, infections, and oxidative stress.Althaea officinalis, also known as marshmallow or Khatmi, is a member of the *Malvaceae* family and is particularly prized for its soothing and demulcent effects. Its roots and leaves are rich in mucilage, flavonoids, tannins, polysaccharides, and antioxidants, which underlie its antitussive, anti-inflammatory, antimicrobial, gastroprotective, and wound-healing properties. These characteristics make it a common ingredient in herbal teas, syrups, and throat remedies.*Nyctanthes arbor-tristis*, commonly referred to as Parijat or Harsinghar, belongs to the *Oleaceae* family and is extensively used in traditional Indian medicine. Various parts of the plant contain alkaloids, flavonoids, glycosides, terpenoids, steroids, and phenolic compounds, which contribute to its antioxidant, anti-inflammatory, liver-protecting, antimicrobial, antimalarial, immunomodulatory, and anticancer effects. Emerging research also suggests it may help reduce oxidative damage and shield organs from inflammation-related harm.Together, these plants offer substantial medicinal potential, supported by both long-standing traditional use and increasing scientific evidence. Their wide range of bioactive compounds and proven biological activities highlight their relevance in developing effective herbal treatments.

❖ **Habitat of Nyctanthes arbor-tristis**

Parijat, also called Night-flowering Jasmine, goes by the scientific name *Nyctanthes arbor-tristis L*. This plant shows up across tropical and subtropical parts of Asia, often valued both for medicine and looks. Found naturally in the Indian subcontinent, it thrives in places like India, Nepal, Bangladesh, Sri Lanka, along with various nations in Southeast Asia. Its sweet-smelling blooms and healing uses make it a common sight near homes, temples, city parks, even beside roads. Warmth and moisture suit it best, helping it settle into hot climates without trouble. You might spot it growing wild in open woods, dry leaf-shedding forests, or on farmed plots where land has been worked. Soil that drains well - sandy or loamy, rich and moist - lets N. arbor-tristis thrive when it gets steady light, not too harsh. Even if conditions shift now and then, this plant grows strongest where rain falls gently and weather stays calm. Starting new plants? Seeds work, but so do pieces of stems, which take root without much fuss. Because it handles change well and holds value in healing practices, people grow Nyctanthes arbor-tristis widely across India - not just for remedies, but also because it looks good in gardens. Found in many regions, its reach stretches far.

❖ **Plant Description**



Fig* 1*: Nyctanthes arbor-tristis

Biological Source

Parijatak consists of the leaves, flowers, and seeds of *Nyctanthes arbor-tristis* belonging to the Family *Oleaceae.*

Vernacular Names

English: Night jasmine, coral jasmine,

Hindi: Parja, Har, Siharu, Harsing har,saherwa, seoli, Nibari,

Shefali.

Kannada: Parijata, harashingar

Odia: Shingadahar, harashingar, gangaseuli, jharasephali

Tamil: Pavilamalligai, manja-pu, pavazahamalligai

Telagu: karuchiya, swetasarasa

Malayalam: Pavilamalli, parijatam, pavizhamalli, parijatakam

Marathi: Khurasli, Parijataka, Purijat

Table No.1: Taxonomical Classification

Kingdom	Plantae
Subkingdom	Tracheobionta
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Asteridae
Order	Lamiales
Family	*Oleaceae*
Genus	Nyctanthes
Species	*Nyctanthes arbor-tristis L.*

Geographical Source:

Parijatak is widely distributed throughout India and is commonly found in tropical and subtropical regions. It is cultivated in gardens and also grows wild in forests and hilly areas.

Morphological Characteristics:

Leaves

Opposite, simple, rough, and hairy

Ovate with entire margin

Green in color and bitter in taste

Flowers

Small, white petals with orange-red tubular center

Highly fragrant and bloom during night

Flowers fall off in the morning

Fruits

Flat, brown, heart-shaped capsules containing seeds

Medicinal Uses:

Parijatak is traditionally used for:

Cough cold and Fever

Arthritis

Asthma

Anti-inflammatory activity

Antioxidant activity

❖ **Phytochemical Classification :**

Parijatak, or *Nyctanthes arbor-tristis L.*, blooms at night and carries many natural chemicals tied to healing uses. While flowers add bright orange hues thanks to crocin and crocetin, the leaves pack strong doses of flavonoids and phenolics. Roots bring tannins into the mix - bitter substances linked to protective body responses. From seed to stem, each section holds unique molecules shaped by nature over time. Medicinal value hides not just in one part but spreads across petals, bark, even underground threads. Crocin shows up where light fades, coloring dusk-time blossoms deep orange. Terpenoids rise from leaf surfaces, working quietly against irritation and damage. Instead of single-purpose traits, this plant layers functions - one compound after another. Seed chemistry leans on glycosides, building slow-acting support systems inside tissues. Bark delivers triterpenes, sturdy structures that help balance internal defenses. Though small, the flower drives much of what makes the species stand out scientifically. Flavonoid levels in foliage explain why certain extracts calm swelling so well. Deep within roots, complex organics team up to shield liver cells under stress. Not only does it fight microbes, it adjusts immune behavior without sharp spikes. Orange tubes open when others close, releasing scent plus rare carotenoids together. Tannins appear again in stems, reinforcing strength through structural complexity. Because compounds differ by region of plant, preparation methods must adapt carefully. Hepatoprotection emerges slowly, built molecule by molecule from multiple sources. Even malaria-related activity traces back to how ingredients interact - not one alone. Nature packed variety here: every piece contributes something distinct yet connected.

Among the leaves and flowers of *Nyctanthes arbor-tristis*, natural chemicals appear in many forms - this partly explains why it has long been turned to when treating fevers, persistent coughs, joint pain, skin issues, swelling, or infections. Research today confirms those plant-based substances carry real biological effects, pointing science back toward this herb as something worth exploring for new medicines.

❖ **Pharmacology of *Nyctanthes arbor-tritis:***

Sr. No.	Phytochemical Class	Phytochemical Constituents	Plant Part Reported
1.	**Alkaloids**	Nyctanthine	Leaves, Seeds
2.	**Flavonoids**	Astragalin, Nicotiflorin, Quercetin derivatives	Leaves, Flowers
3.	**Glycosides**	Arbortristoside A, Arbortrisstoside B, Arbortristoside C	Seeds, Leaves
4.	**Iridoid Glycosides**	6β-Hydroxyloganin, Nyctanthoside	Seeds
5.	**Terpenoids**	Lupeol, Oleanolic acid	Leaves, Bark
6.	**Steroids**	β-sitosterol, Stigmasterol	Leaves, Seeds
7.	**Phenolic Compounds**	Phenolic acids, Polyphenols	Leaves, Flowers
8.	**Tannins**	Hydrolysable tannins, Condensed tannins	Leaves, Bark
9.	**Carotenoids**	Crocin, Crocetin	Flowers
10.	**Saponins**	Triterpenoid saponins	Roots, Leaves
11.	**Essential Oils**	Benzoic acid derivatives, Volatile oils	Flowers
12.	**Fatty Compounds**	Palmitic acid, Oleic acid	Seeds
13.	**Carbohydrates & Polysaccharides**	Glucose, Mannitol	Leaves, Flowers
14.	**Proteins & Amino Acids**	Essential amino acids	Seeds
15.	**Resinous Compounds**	Resin and gum constituents	Bark

Fig 2: **phytochemical Constituents Found in *Nyctanthes Jarbor-tristis (Parijatak)***

Nyctanthes arbor-tristis L., commonly known as Parijatak or Night-flowering Jasmine, is a widely recognized medicinal plant in Ayurvedic and traditional folk medicine. Various parts of the plant—such as leaves, flowers, seeds, bark, and roots—are traditionally used to treat conditions including fever, cough, arthritis, malaria, skin infections, inflammation, and digestive issues. Modern scientific research has validated many of these uses, revealing that the plant exhibits a range of pharmacological effects due to bioactive components like flavonoids, alkaloids, iridoid glycosides, tannins, terpenoids, carotenoids, and phenolic compounds.

1. Anti-inflammatory Activity

Among its most well-documented properties is the plant's anti-inflammatory activity. Studies show that leaf extracts can significantly reduce swelling and inflammation in experimental models. This effect is primarily attributed to flavonoids, tannins, and iridoid glycosides, which may inhibit the release of inflammatory mediators involved in pain, redness, and tissue irritation. Traditionally, this makes the plant useful in managing arthritis, rheumatism, joint discomfort, and muscle inflammation. Evidence also suggests it may help mitigate chronic inflammation and protect tissues from long-term damage.

2. Antioxidant Activity

The plant demonstrates strong antioxidant activity, thanks to its rich content of phenolics, flavonoids, tannins, and carotenoids such as crocin and crocetin. These compounds neutralize free radicals produced during oxidative stress—a process linked to aging, tissue damage, and chronic diseases. By scavenging reactive oxygen species, N. arbor-tristis helps preserve cellular integrity and supports normal physiological function. This antioxidant action also underpins its anti-inflammatory, liver-protective, and potential anticancer effects.

3. Antimalarial Activity

Historically used to treat malarial and recurring fevers, *Nyctanthes arbor-tristis* has shown antimalarial activity in scientific studies, particularly through leaf and bark extracts acting against Plasmodium species. The plant appears to reduce parasite levels, lower fever, and support immune function during infection. Iridoid glycosides and phenolic compounds are believed to be responsible for these benefits, reinforcing its role in Ayurvedic fever treatments.

4. Hepatoprotectective Activity

Research indicates that extracts of the plant can protect the liver from chemical-induced damage. This hepatoprotective effect is largely tied to antioxidants that reduce oxidative stress and lipid peroxidation in liver tissue. Studies have found that treatment with plant extracts can normalize liver enzyme levels and aid in restoring liver cell structure, supporting its traditional use in liver disorders and detoxification practices.

5. Antimicrobial Activity

Extracts from different parts of the plant have shown inhibitory effects against various bacteria and fungi. The antimicrobial activity is linked to phenolic compounds, tannins, flavonoids, and essential oils, which disrupt microbial growth and survival. These findings validate traditional applications in treating skin conditions, wounds, and infections, and suggest potential for inclusion in herbal antimicrobial preparations.

6. Antipyretic Activity

Used traditionally to treat fevers, *Nyctanthes arbor-tristis* has demonstrated significant antipyretic effects in experimental studies, particularly with leaf extracts. The mechanism may involve suppressing inflammatory mediators and modulating prostaglandin synthesis, which regulates body temperature. This explains its widespread use in Ayurveda for managing fever associated with infections and malaria.

7. Analgesic Activity

The plant exhibits notable pain-relieving properties in animal models. Extracts appear to reduce pain by interfering with inflammatory pathways and dampening peripheral pain signals. This supports its traditional application in alleviating pain from arthritis, rheumatism, and muscle-related conditions.

8. Immunomodulatory Activity

Studies suggest that N. arbor-tristis can influence immune function by enhancing the body's defense mechanisms. Certain phytochemicals may boost immune cell activity, improving resistance to infections and inflammatory conditions. This immunomodulatory effect could be beneficial in managing chronic illnesses, recurrent infections, and inflammatory diseases.

9. Antidiabetic Activity

Experimental evidence shows that extracts of the plant can reduce blood glucose levels and support metabolic health. The antidiabetic effect is likely due to flavonoids and phenolic compounds that improve glucose uptake and reduce oxidative stress linked to diabetes. These findings point to its potential role in managing hyperglycemia and related metabolic complications.

10. Anticancer Activity

Emerging research suggests that specific compounds from *Nyctanthes arbor-tristis* such as flavonoids, benzofuran derivatives, and phenolics may inhibit the growth and spread of cancer cells in laboratory settings. Some studies also indicate interference with

tumor-related angiogenesis and oxidative damage. While clinical data are still limited, current findings highlight its promise in cancer research.

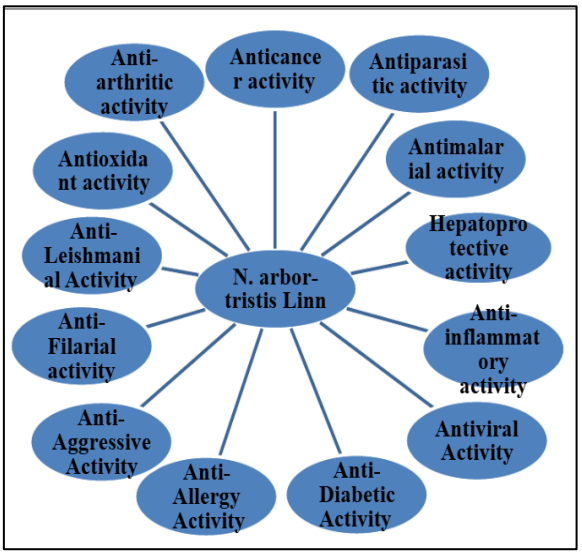


Fig 3: **Pharmacological Activity of *Nyctanthes arbor-tritis L.***

❖ **Habitat of Althaea officinalis L.**

Althaea officinalis L., commonly referred to as marshmallow or Khatmi, is a perennial herb in the *Malvaceae* family with significant medicinal value. Originating in Europe, Western Asia, and parts of North Africa, it is now grown and has become naturalized in many regions worldwide due to its therapeutic and ornamental appeal. This plant typically thrives in moist, temperate climates and is often found in wetlands, marshes, along riverbanks, in meadows, coastal zones, canals, and damp grassy areas. It favors rich, well-drained sandy or loamy soils that retain sufficient moisture and grows most successfully in full sun to partial shade, particularly near water sources where the ground stays reliably damp. While it prefers humid environments, established plants can withstand periods of moderate drought. In the wild, it is commonly seen along field edges, roadsides, open woodlands, and low-lying areas with average rainfall. Because of its medicinal properties, *Althaea officinalis* is cultivated across various parts of Asia, Europe, and North America. It adapts readily to farmland and garden settings and is primarily propagated by seed or by dividing the roots. Its resilience across a range of growing conditions has supported its wide distribution and ongoing use in both traditional and contemporary herbal medicine.

❖ **Plant Description:**



Fig 4: Althaea officinalis L.

Biological Source:

Marshmallow root consists of the dried roots of *Althaea officinalis L.* belonging to the family *Malvaceae.*

Vernacular name:

English: Marshmallow, White Mallow

Hindi: Gulkhairo, Khatmi

Kannada: Sri Mudre gida, Mudre gida, Hetutti, Paniyarattuti

Odia: Pedipedika

Tamil: Thutthi, Cimaittutti, Simaittutti, Shemaitute

Telagu: Tutturi benda, Khatmi

Malayalam: Mudre gida , Thuththi

Marathi: Mudra, Gulkhair, Khaira

Table No.2: Taxonomical Classification

Kingdom	Plantae
SubKingdom	Tracheobionta
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Dilleniidae
Order	Malvalea
Family	*Malvaceae*
Genus	Althaea
Species	*Althaea officinalis L.*

Geographical Source:

Marshmallow is native to Europe, Western Asia, and North Africa. It is cultivated in many temperate regions and is widely used in herbal medicine.

Morphological Characteristics:

Root

Thick, cylindrical, and fleshy

Yellowish-white in color

Soft fibrous texture

Slightly sweet mucilaginous taste

Leaves

Soft, velvety, and ovate

Covered with fine hairs

Flowers

Pale pink to white flowers

Bloom during summer season

Medicinal Uses:

Marshmallow root is commonly used for:

Cough

Sore throat

Bronchitis

Respiratory irritation

Gastric ulcers

Inflammation of mucous membranes

❖ **Phytochemical Classification:**

Althaea officinalis L., commonly known as marshmallow, is a medicinal plant containing a wide range of bioactive phytochemicals that underlie its therapeutic and pharmacological effects. Various parts of the plant—roots, leaves, flowers, and seeds—are sources of multiple secondary metabolites, such as mucilage polysaccharides, flavonoids, phenolic compounds, tannins, coumarins, terpenoids, sterols, glycosides, and fatty acids. These compounds are primarily responsible for the plant's demulcent, antitussive, anti-inflammatory, antioxidant, antimicrobial, gastroprotective, and wound-healing properties. Recent reviews have emphasized their relevance in formulating herbal remedies and nutraceuticals.The roots are especially high in mucilage polysaccharides, which create a protective, soothing film over inflamed mucous membranes, accounting for the plant's effectiveness in relieving coughs and irritation. The antioxidant and anti-inflammatory actions are largely attributed to flavonoids and phenolics found in the leaves and flowers. Meanwhile, the seeds contain fatty acids, phytosterols, and proteins, suggesting potential benefits in both nutrition and medicine. The broad spectrum of these phytochemicals validates the traditional use of marshmallow in treating respiratory ailments, gastrointestinal discomfort, wounds, and inflammatory conditions.

Sr. No.	Phytochemical Class	Major Constituents	Plant Part
1	**Mucilage Polysaccharides**	Arabinogalactans, Rhamnogalacturonans, Pectins	Roots, Leaves
2	**Flavonoids**	Quercetin, Kaempferol, Hypolaetin derivatives	Leaves, Flowers
3	**Phenolic Compounds**	Phenolic acids, Polyphenols	Leaves, Flowers
4	**Tannins**	Hydrolysable tannins	Roots, Leaves
5	**Coumarins**	Scopoletin	Leaves
6	**Terpenoids**	Monoterpenes, Triterpenes	Roots
7	**Sterols / Phytosterols**	β-sitosterol, Stigmasterol	Seeds, Roots
8	**Glycosides**	Flavonoid glycosides	Leaves
9	**Fatty Acids**	Palmitic acid, Linoleic acid	Seeds
10	**Amino Acids**	Essential amino acids	Seeds
11	**Carbohydrates & Starch**	Starch, Glucose, Sucrose	Roots
12	**Volatile Oils**	Aromatic volatile compounds	Flowers
13	**Proteins**	Plant proteins and peptides	Seeds
14	**Organic Acids**	Malic acid, Citric acid	Roots, Leaves

Fig 5: **Phytochemical Classification of *Althaea officinalis L.* (Marshmallow)**

❖ **Pharmacology of Althaea officinalis L.:**

Althaea officinalis L., commonly referred to as marshmallow or Khatmi, is a well-known medicinal plant valued in both traditional and contemporary herbal medicine. Various parts of the plant, particularly the roots and leaves, contain bioactive compounds such as mucilage polysaccharides, flavonoids, phenolic substances, tannins, coumarins, and terpenoids, which underlie its wide range of pharmacological effects. Research and scientific reviews have confirmed that this plant exhibits multiple biological activities, including cough suppression, anti-inflammatory, antioxidant, antimicrobial, gastroprotective, wound-healing, and immune-modulating properties. These effects validate its historical use in managing respiratory, digestive, and inflammatory conditions.

1. Antitussive Activity

A key therapeutic attribute of *Althaea officinalis* is its ability to suppress coughs. The root contains high levels of mucilage polysaccharides, which create a protective, soothing film over irritated mucous membranes in the throat and respiratory passages. This demulcent action alleviates discomfort and dampens the cough reflex. Clinical and experimental evidence suggests that preparations from the plant can help relieve symptoms of dry cough, bronchitis, sore throat, and respiratory inflammation. As a result, it is frequently used in herbal cough syrups, teas, lozenges, and related formulations.

2. Anti-inflammatory Activity

Studies have shown that extracts of A. officinalis possess notable anti-inflammatory activity. Compounds such as flavonoids, tannins, and phenolics appear to reduce inflammation by inhibiting key mediators involved in the inflammatory response. This effect supports its application in conditions involving respiratory, gastrointestinal, joint, and skin inflammation. Additionally, the mucilage helps calm inflamed tissues and aids in recovery from irritation or injury.

3. Antioxidant Activity

The plant's antioxidant capacity is primarily due to flavonoids, phenolic acids, and other polyphenolic constituents. These compounds help scavenge harmful free radicals, thereby minimizing oxidative stress—a factor linked to chronic diseases, aging, and tissue damage. By mitigating oxidative injury, Althaea officinalis may help preserve cellular function and contribute to overall health.

4. Antimicrobial Activity

Extracts from the plant have demonstrated inhibitory activity against certain bacteria and fungi. The presence of phenolics, flavonoids, and tannins is thought to be responsible for this antimicrobial action. This property supports its traditional use in treating infections, oral discomfort, wounds, and inflammatory conditions, and may also help prevent secondary infections in compromised tissues.

5. Gastroprotective Activity

Traditionally used for digestive complaints such as gastritis, ulcers, and intestinal inflammation, the plant has been supported by scientific findings. The mucilage forms a protective layer over the stomach lining, shielding it from acid-induced damage and reducing irritation. Its anti-inflammatory and antioxidant properties further enhance this protective role and promote healing of injured mucosal tissue.

6. Wound-Healing Activity

Research indicates that Althaea officinalis can support tissue repair and regeneration. The mucilage provides a moist environment for injured skin, reduces inflammation, and accelerates healing. Combined with antimicrobial and antioxidant actions, it helps prevent infection and oxidative damage at wound sites. Traditionally, it has been applied topically for burns, ulcers, skin irritation, and minor injuries.

7. Immune-Modulating Activity

Certain polysaccharides and phenolic components in A. officinalis have been found to influence immune system activity. Studies suggest these compounds may enhance protective immune responses and improve resistance to infections and chronic inflammation. This immunomodulatory potential adds to the plant's value in managing respiratory and long-term inflammatory conditions.

8. Demulcent and Soothing Activity

The demulcent property is one of the most defining features of marshmallow. Mucilage from the roots and leaves coats and soothes irritated mucous membranes, offering relief in conditions like dry cough, sore throat, gastritis, and urinary tract discomfort. Its emollient effect also softens and hydrates the skin, making it useful in skincare products and topical treatments.

9. Mild Diuretic Activity

Traditional sources note that Althaea officinalis has mild diuretic properties. It may help increase urine output and ease irritation in the urinary system. This effect has led to its historical use in managing urinary inflammation and minor urinary tract issues.

10. Antiulcer Activity

Experimental data suggest that marshmallow extracts can help prevent ulcer formation by reducing gastric irritation and reinforcing mucosal defenses. The mucilage forms a physical barrier over damaged areas, while antioxidant components reduce inflammation and oxidative stress linked to ulcer development.The diverse pharmacological profile of *Althaea officinalis* underscores its significance as a valuable herb in natural medicine and pharmaceutical research. Its traditional uses are increasingly validated by modern science, positioning it as a promising source for developing safe and effective therapeutic agents.

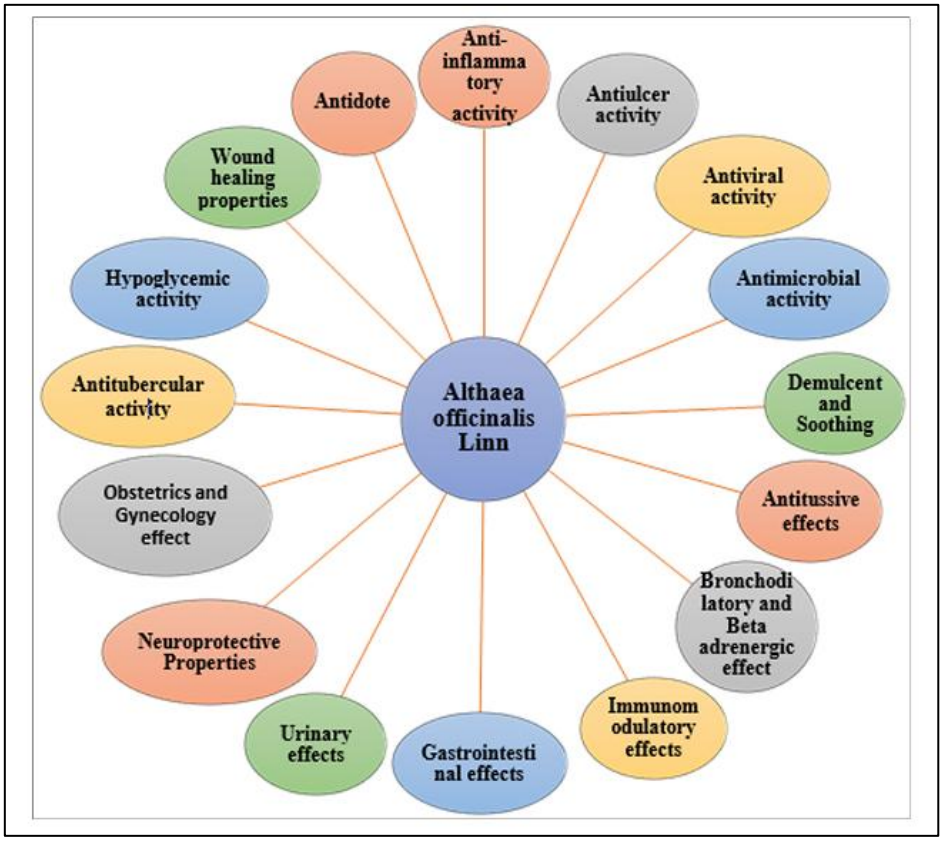


Fig* 6: Pharmacological Activity of *Althaea officinalis L.

❖ **Discussion:**

Nyctanthes arbor-tristis L. and *Althaea officinalis L.* are valued medicinal plants commonly used in traditional medicine due to their wide range of therapeutic effects. Their pharmacological benefits are primarily linked to bioactive compounds such as flavonoids, alkaloids, glycosides, tannins, phenolics, terpenoids, and mucilage polysaccharides.Research has shown that *Nyctanthes arbor-tristis* exhibits anti-inflammatory, antioxidant, antimalarial, antimicrobial, liver-protective, fever-reducing, and pain-relieving properties. These activities validate its traditional use in managing conditions like fever, arthritis, malaria, and inflammatory diseases. Likewise, *Althaea officinalis* has been found to have notable cough-suppressing, soothing, anti-inflammatory, antioxidant, gut-protective, antimicrobial, and wound-healing effects. The root and leaf parts, rich in mucilage, are particularly effective in

calming inflamed mucous membranes and easing coughs and throat discomfort.Pharmacognostic investigations of both species offer essential data for accurate identification, quality assurance, and standardization of herbal preparations. Their diverse phytochemical composition and extensive biological activities highlight their promise for use in herbal medicines and plant-based pharmaceuticals.While numerous laboratory studies affirm their medicinal potential, more clinical trials and toxicity assessments are needed to fully determine their safety, effectiveness, and practical applications in contemporary medical practice.

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