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FROM TRADITIONAL MEDICINE TO MODERN DRUG DISCOVERY – A COMPREHENSIVE REVIEW OF NYCTANTHES ARBOR-TRISTIS LEAF PHYTOCHEMICAL

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ABSTRACT

Nyctanthes arbor-tristis L., commonly known as Harshingar or Parijat, is a medicinal plant belonging to the family Oleaceae and has an important place in traditional systems of medicine. Different parts of this plant have been traditionally used for managing various health conditions, including fever, inflammation, arthritis, and certain skin disorders. Scientific investigations have identified several groups of phytochemicals in the plant, including iridoid glycosides, flavonoids, phenolic compounds, sterols, and terpenoids. These constituents have been investigated for a range of pharmacological activities, such as antioxidant, anti-inflammatory, antimicrobial, hepatoprotective, and antimalarial effects. However, the molecular mechanisms responsible for many of these activities are not yet fully understood. Network pharmacology provides a systematic approach to exploring the possible relationships between multiple plant-derived compounds, molecular targets, and disease-associated biological pathways. This review aims to critically examine the phytochemical composition and reported pharmacological properties of N. arbor-tristis, with particular emphasis on the application of network pharmacology in understanding its multi-target therapeutic mechanisms. It also discusses the potential role of compound–target network analysis, protein–protein interaction studies, pathway enrichment, and molecular docking in identifying promising bioactive constituents for further investigation. In addition, the review

highlights important research gaps, including variations in phytochemical composition, limited mechanistic evidence, insufficient pharmacokinetic information, and the need for systematic toxicity assessment. Integrating phytochemical research with network pharmacology may help prioritize compounds for experimental validation and guide future natural-product drug discovery. Nevertheless, computational predictions must be supported by appropriate laboratory studies before therapeutic applications can be established.

KEYWORDS: Nyctanthes arbor-tristis; Harshingar; Parijat; phytochemicals; network pharmacology; molecular targets; pharmacological activities; molecular docking; pathway analysis; drug discovery.

INTRODUCTION

Medicinal plants have been an important part of traditional healthcare for centuries. They contain a wide range of naturally occurring chemical compounds that may contribute to different biological activities. In recent years, scientific interest in medicinal plants has increased because researchers are exploring their chemical composition, pharmacological properties, and possible applications in the development of new therapeutic agents. The study of plant-derived compounds can provide valuable information about their biological effects and help identify promising candidates for further pharmaceutical research. However, the effectiveness and safety of any plant-based preparation must be established through appropriate scientific investigations.

Nyctanthes arbor-tristis L., commonly known as Harshingar, Harsingar, or Parijat, belongs to the family Oleaceae. It is a flowering plant widely recognized for its traditional medicinal importance. The plant is known for its fragrant flowers, which bloom at night, and its leaves, seeds, bark, and roots have also been used in traditional medicinal practices. Different parts of the plant have been associated with the management of conditions such as fever, joint discomfort, inflammation, and certain skin problems. These traditional applications have encouraged researchers to investigate the plant's phytochemical composition and biological properties. Nevertheless, traditional use alone does not establish clinical effectiveness, and further scientific evidence is necessary to understand its therapeutic value.

Phytochemical investigations of N. arbor-tristis have reported several groups of naturally occurring compounds, including iridoid glycosides, flavonoids, phenolic compounds, sterols, and terpenoids. The composition of these compounds may vary according to the plant part,

geographical origin, harvesting conditions, and extraction method. Some reported constituents have been investigated for antioxidant, anti-inflammatory, antimicrobial, hepatoprotective, and antimalarial activities. These findings suggest that the plant may contain compounds of interest for pharmacological research. However, the activity observed with a crude extract cannot automatically be attributed to an individual constituent, because several compounds may contribute to the overall response. Therefore, identifying the active constituents and understanding their possible mechanisms of action are important steps in the scientific evaluation of this medicinal plant.

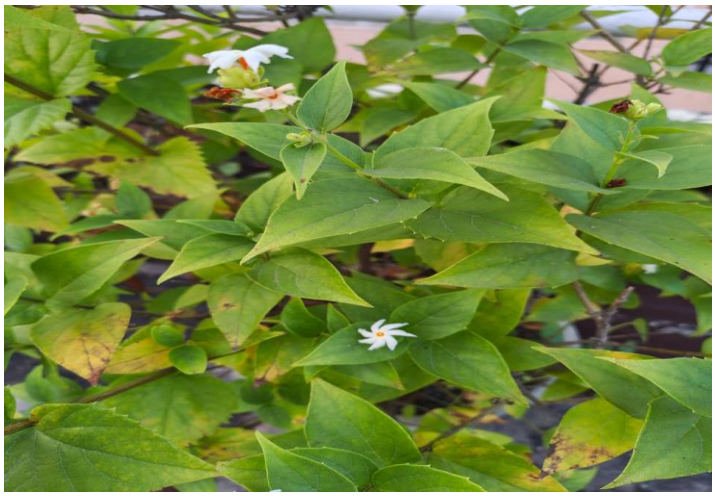
Conventional drug discovery often focuses on identifying a specific compound that acts on a particular biological target. Although this approach has contributed significantly to pharmaceutical development, it may not fully explain the complex effects of plant extracts containing numerous chemical constituents. In some cases, different compounds may interact with several proteins and influence interconnected biological pathways. Understanding these relationships requires an approach that considers the interactions between chemical compounds and biological systems rather than examining each component in isolation.

Network pharmacology has emerged as a useful research approach for investigating these complex relationships. It combines information from phytochemistry, pharmacology, bioinformatics, systems biology, and computational analysis to explore possible connections between bioactive compounds, molecular targets, biological pathways, and diseases. Techniques such as compound–target network construction, protein–protein interaction analysis, Gene Ontology enrichment, and pathway analysis can help researchers identify potentially important targets and biological processes. When used alongside molecular docking, these methods can also help investigate whether selected compounds may interact with particular proteins. However, computational predictions provide hypotheses rather than definitive proof of biological activity, and their reliability depends on the quality of the available data and subsequent experimental validation.

Applying network pharmacology to N. arbor-tristis may provide a broader understanding of its reported pharmacological activities. By integrating information about its phytochemical constituents with available evidence on molecular targets and disease-associated pathways, researchers can examine possible mechanisms underlying its biological effects. This approach may also help prioritize compounds for further investigation and identify areas where existing evidence is incomplete. For example, a compound reported in Harshingar may be examined

for its possible relationship with inflammatory signaling proteins, but any predicted interaction must be distinguished from a mechanism demonstrated experimentally. Similarly, the identification of a potential molecular target does not establish that the plant or its extract can treat the associated disease in humans.

Despite the growing interest in medicinal plants, several challenges remain in translating phytochemical findings into useful therapeutic candidates. Differences in extraction procedures and analytical techniques can make results difficult to compare between studies. In addition, the concentration of individual compounds, their absorption and metabolism, their safety profiles, and their biological availability may influence their practical value. Many reported pharmacological effects also require confirmation through well-designed experiments. Addressing these limitations is essential for distinguishing promising research findings from claims that are not yet sufficiently supported.



Taxonomical classification

Taxonomic category	Classification
Kingdom	Plantae
Division	Tracheophyta
Class	Magnoliopsida
Order	Lamiales
Family	Oleaceae
Genus	Nyctanthes
Species	Nyctanthes arbor-tristis L.

Vernacular Names

Language	Common name
English	Night-flowering jasmine, coral jasmine
Hindi	Harshingar, Harsingar

Sanskrit	Parijata, Sephalika
Bengali	Seuli, Shefali
Kannada	Parijata
Tamil	Pavazhamalli, Paarijaatham
Telugu	Parijatamu

Traditional use and Ethnomedical uses

Nyctanthes arbor-tristis L., commonly known as Harshingar or Parijat, has been used in traditional medicine for generations. Different parts of the plant, including the leaves, flowers, seeds, bark, and roots, are valued in traditional healthcare practices. In Ayurveda and various folk medicine systems, the plant has been used for complaints associated with fever, inflammation, joint pain, digestive problems, and skin disorders. Its long history of medicinal use has encouraged researchers to investigate its chemical constituents and possible pharmacological properties.

The leaves are among the most commonly used parts of the plant in traditional medicine. Leaf preparations have traditionally been used for fever, joint discomfort, rheumatism, and conditions associated with inflammation. In some communities, leaf juice or decoctions have also been used for digestive complaints and intestinal worm infestations. These applications have attracted scientific interest because researchers are investigating whether particular compounds in the leaves may contribute to the reported biological effects.

The flowers are valued for their fragrance and have also been used in traditional remedies. Ethnomedicinal accounts describe their use for certain digestive complaints, skin conditions, and other health-related purposes. In some traditional practices, flower preparations have also been associated with calming effects. However, the specific uses and preparation methods vary among communities and should not be considered standardized treatments.

The seeds have traditionally been used for selected skin and scalp conditions, including complaints associated with hair loss. Some traditional practices also describe their use against intestinal parasites. The bark and other plant parts have been mentioned in folk remedies for respiratory complaints and other conditions. Such uses demonstrate the diversity of traditional knowledge associated with the plant, although the evidence supporting individual applications differs considerably.

Overall, the traditional use of Harshingar provides a starting point for pharmacological research. Nevertheless, historical use alone cannot establish the safety, appropriate dosage, or

clinical effectiveness of a plant preparation. Scientific studies are required to determine which constituents contribute to particular effects and whether these effects can be reproduced under controlled conditions.

Ethnomedicinal Uses

Ethnomedicinal research examines how different communities use plants for healthcare and how this knowledge is passed from one generation to another. Nyctanthes arbor-tristis is an important example because its different plant parts have been used in several regional medicinal traditions, particularly across South Asia.

In Indian folk medicine, leaf preparations have traditionally been used for intermittent fever, joint pain, rheumatic complaints, and sciatica. Some communities have also used the leaves for digestive disturbances and intestinal worm infestations. The bitter taste of the leaves is a characteristic often mentioned in traditional descriptions. However, the preparation, amount used, and duration of use may differ considerably between regions.

In certain traditional practices, fresh leaves are applied externally to affected skin areas, including sores and other inflammatory complaints. The flowers have also been used in folk remedies for skin-related and digestive problems. Reports from different communities describe additional uses of the plant for cough, respiratory discomfort, and selected liver-related complaints. These applications represent ethnomedicinal observations rather than confirmed clinical indications.

Traditional records from parts of South and Southeast Asia also describe the use of Harshingar as a remedy for fever and parasitic diseases. Some reports mention its use in managing malaria-related fever. Such historical observations have encouraged scientific investigations into the plant's possible antipyretic, anti-inflammatory, and antiparasitic properties. However, traditional use should not replace established medical treatment for malaria or other serious infections.

The medicinal use of Harshingar illustrates the relationship between traditional knowledge and modern natural-product research. Information gathered from local communities can help researchers identify plant parts and biological activities worthy of further investigation. When combined with phytochemical analysis, pharmacological testing, and network pharmacology,

this information may help generate hypotheses about the compounds and molecular targets associated with particular biological effects.

Despite its traditional importance, further research is needed to establish the safety, dosage, pharmacokinetic properties, and clinical relevance of individual preparations and isolated compounds. Careful documentation of traditional practices, botanical authentication, and scientifically controlled studies will be important for evaluating the plant's potential contribution to future drug discovery.

Phytochemical Composition

S.NO	Phytochemical	Potential Biological Activity
1	Flavonoids	Antioxidant and anti-inflammatory
2	Phenolic compound	Antioxidant
3	Tannis	Astringent and potential antimicrobial
4	Alkaloids	Various pharmacological activity
5	Terpenoids	Potential anti-inflammatory activity
6	Iridoid glycosides	Potential anti-inflammatory and other biological effects
7	Abortristosides	Investigated for pharmacological properties
8	Nyctanthic acid	Repoted plant constituent under phytochemical investigation

1-Flavonoids: Flavonoids are naturally occurring plant compounds known for their antioxidant properties. They may help protect cells from oxidative damage and contribute to the biological activities of Harshingar.

2-Phenolic Compounds: These compounds are important secondary metabolites that can neutralize free radicals. They are studied for their possible antioxidant and anti-inflammatory effects.

3-Tannins: Tannins are polyphenolic compounds found in several plant parts. They possess astringent properties and may contribute to the antimicrobial activity of plant extracts.

4-Alkaloids: Alkaloids are nitrogen-containing natural compounds that may exhibit various biological activities. Their presence and concentration in Harshingar extracts depend on the plant part and extraction method.

5-Terpenoids: Terpenoids are plant metabolites investigated for their potential anti-inflammatory, antioxidant, and other pharmacological effects.

6-Iridoid Glycosides: These compounds are important constituents reported in Nyctanthes arbor-tristis. They have attracted scientific interest because of their potential medicinal properties.

7-Arbortristosides: Arbortristosides are bioactive constituents associated with Harshingar and have been investigated for their possible pharmacological effects.

8-Nyctanthic Acid: Nyctanthic acid is a reported constituent of Harshingar that has received attention in phytochemical studies.

9-Essential Oils: Certain plant parts may contain volatile compounds that contribute to their characteristic aroma. Their composition varies according to the plant part and extraction technique.

Bioactive compounds

S.no	Bioactive compound	Chemical class	Reported plant part	Potential pharmacological Activity
1	Arbortistoside A	Iridoid glycosides	Seeds	Antileishmanial, anti-inflammatory and anticancer activities investigated experimentally
2	Arbortistoside B	Iridoid glycosides	Seeds	Potential anti- inflammatory and antileishmanial activities
3	Arbortistoside C	Iridoid glycosides	Seeds	Investigated for potential pharmacological activities
4	Calceolariosides A	Phenylethanoid glycoside	Leaves	Potential antileishmanial activities
5	β-Sitosterol	Phytosterol	Leaves	Potential Anti-inflammatory activities
6	Oleanolic acid	Triterpenoid	Leaves	Potential anti-inflammatory and hepatoprotective activities
7	Ursolic acid	Triterpenoid	Leaves and other reported plant part	Potential antioxidant and anti-inflammatory activities
8	Astragalin	Flavonoid glycosides	Leaves	Astragalin Flavonoid glycoside Leaves Potential antioxidant and anti-inflammatory activities
9	Nicotiflorin	Flavonoid glycosides	Leaves	Nicotiflorin Flavonoid glycoside Leaves Potential antioxidant and anti-inflammatory activities
10	Quercetin	Flavonoid	Reported in phytochemical study	Antioxidant and anti-inflammatory activities
11	Nyctanthin	Flower pigment	Flower	Nyctanthin Flower pigment Flowers Contributes to the characteristic orange coloration of flowers

12	D- Mannitol	Sugar alcohol	Leaves and Flower	D-Mannitol Sugar alcohol Leaves and flowers Osmotic properties; pharmacological significance depends on the
13	Nyctanthic acid	Organic acid	Leaves and seed	constituent; specific pharmacological effects require further evidence
14	Friedelin	Triterpenoid	Leaves	Friedelin Triterpenoid Leaves Potential anti-inflammatory and other biological activities
15	Lupeol	Pentacyclic triterpenoid	Leaves	Potential anti-inflammatory and antioxidant activities
16	Crocetin glycosides	Carotenoid-related compound	Flower	Crocetin glycosides Carotenoid-related compounds Flowers Antioxidant activity and other potential biological effects
17	Tannins	Polyphenolic compound	Leaves and Flower	Astringent properties and potential antimicrobial activity
18	Iridoid glycosides	Glycosides	Leaves, seeds, and stem, bark	Iridoid glycosides Glycosides Leaves, seeds and stem bark Potential anti-inflammatory and other pharmacological activities

Pharmacological Activities

1. Anti-inflammatory Activity

Inflammation is a natural protective response of the body to infection, injury, or tissue damage. However, prolonged or excessive inflammation may contribute to the development of several health conditions. Nyctanthes arbor-tristis has attracted scientific interest because extracts from different plant parts have demonstrated anti-inflammatory effects in experimental investigations.

The anti-inflammatory activity of the plant may be associated with its iridoid glycosides, flavonoids, and other secondary metabolites. These compounds are being investigated for their ability to influence inflammatory mediators and cellular pathways involved in the inflammatory response. Some experimental models have reported a reduction in inflammation following treatment with plant extracts.

From a drug-discovery perspective, the interaction of plant-derived compounds with inflammatory signalling pathways is particularly important. For example, pathways involving nuclear factor kappa B (NF-κB) and inflammatory cytokines could be investigated to understand the mechanisms responsible for the observed effects. However, these mechanisms should not be attributed to a particular Harshingar compound without direct experimental evidence.

Overall, the anti-inflammatory properties reported for N. arbor-tristis support further investigation of its phytochemicals. Additional studies are required to establish the active constituents, effective concentrations, toxicity profile, and potential clinical applications.

2. Antioxidant Activity

Oxidative stress develops when the production of reactive oxygen species exceeds the body's antioxidant defence capacity. Excessive oxidative stress can damage cellular components, including proteins, lipids, and DNA. Natural products containing antioxidant compounds are therefore widely investigated for their ability to neutralize free radicals and limit oxidative damage.

Nyctanthes arbor-tristis contains several phytochemical groups that may contribute to antioxidant activity, particularly flavonoids and phenolic compounds. These substances can interact with free radicals through different chemical mechanisms, including electron or hydrogen donation. Their activity depends on their chemical structures, concentrations, and the experimental conditions used to evaluate them.

Antioxidant properties of plant extracts are commonly assessed using laboratory methods such as the DPPH, ABTS, and ferric reducing antioxidant power assays. These methods provide information about the ability of an extract to participate in specific antioxidant reactions. However, results obtained from chemical assays do not necessarily demonstrate antioxidant benefits in living organisms.

In further research, the relationship between the phytochemical composition of Harshingar extracts and their antioxidant effects could be examined using chromatographic analysis and biological models. Such investigations may help identify the compounds most strongly associated with antioxidant activity.

Therefore, the antioxidant potential of N. arbor-tristis represents an important area of phytochemical research, although its relevance to human health requires additional investigation.

3. Antimicrobial Activity

Antimicrobial resistance has become an important public health concern because some microorganisms are becoming less responsive to commonly used medicines. This has encouraged researchers to investigate plants as potential sources of new antimicrobial compounds.

Extracts prepared from the leaves, flowers, and other parts of Nyctanthes arbor-tristis have been examined for activity against selected microorganisms. Depending on the plant material, extraction solvent, and test conditions, some extracts have shown inhibitory effects against particular bacterial or fungal species.

The antimicrobial properties of the plant may be related to the combined effects of its secondary metabolites. Phenolic compounds, flavonoids, and tannins are among the phytochemical groups commonly investigated for their possible interactions with microbial cells. Such compounds may affect cellular structures, enzymes, or other biological processes, although the precise mechanism must be established for each active extract or isolated constituent.

Common laboratory methods for evaluating antimicrobial activity include agar diffusion assays, broth dilution methods, and minimum inhibitory concentration testing. These methods help determine whether an extract inhibits microbial growth and, where appropriate, identify the concentration required to produce an inhibitory effect.

Further studies should compare different plant parts, characterize the active constituents, and evaluate their activity against clinically relevant microorganisms. Researchers must also investigate toxicity and selectivity to determine whether an extract affects microbial cells without causing unacceptable damage to human cells.

Although preliminary findings may support the antimicrobial potential of Harshingar, its extracts should not be considered substitutes for established antimicrobial treatments without adequate evidence.

4. Antimalarial Activity

Malaria is a parasitic disease caused by Plasmodium species and remains an important global health concern. In traditional medicine, Harshingar has been used in the management of fever and fever-associated conditions. This traditional background has encouraged scientific interest in evaluating its possible antimalarial properties.

Experimental investigations have examined extracts and certain isolated constituents of Nyctanthes arbor-tristis for activity against malaria-related parasites. Some reported findings suggest that particular plant-derived preparations may affect parasite growth under experimental conditions. However, traditional use for fever does not itself establish activity against Plasmodium.

The chemical constituents of the plant may provide starting points for investigating possible antiparasitic mechanisms. Further research should identify the compounds responsible for any observed activity and determine whether they selectively affect the parasite rather than host cells.

Reliable evaluation requires validated parasite-based assays, appropriate positive controls, toxicity testing, and investigation of pharmacokinetic properties. Researchers must also establish whether active concentrations can be achieved safely in the body.

Consequently, Harshingar may be considered a subject for further antimalarial drug-discovery research, but its effectiveness in preventing or treating malaria in humans has not been established by traditional use alone.

5. Antidiabetic Activity

Diabetes mellitus is a metabolic disorder characterized by persistent abnormalities in blood glucose regulation. Researchers have increasingly investigated medicinal plants for compounds that may influence glucose metabolism, insulin function, and related metabolic processes.

The antidiabetic potential of Nyctanthes arbor-tristis has been explored in experimental research. Certain plant extracts have been investigated for their possible effects on blood glucose levels and biochemical indicators associated with diabetes. These observations have encouraged further interest in its phytochemical composition.

The biological effects of plant extracts may depend on the presence of multiple constituents rather than a single compound. Potential mechanisms worth investigating include effects on carbohydrate-digesting enzymes, glucose uptake, oxidative stress, and pathways associated with insulin signalling. Nevertheless, each proposed mechanism requires appropriate experimental confirmation. In vitro studies can help identify possible interactions with enzymes involved in carbohydrate digestion, while animal studies may provide preliminary information about glucose regulation and metabolic changes. These findings must be interpreted carefully because laboratory activity does not automatically translate into a clinically meaningful effect.

Further research should focus on identifying the active compounds, determining their dose-response relationships, assessing toxicity, and examining possible interactions with antidiabetic medicines.

Overall, the antidiabetic activity of N. arbor-tristis remains a research area of interest, but further evidence is required before its use as an effective diabetes treatment can be recommended.

6. Hepatoprotective Activity

The liver performs essential functions, including the metabolism of nutrients, processing of medicines, and removal of harmful substances. Liver injury may occur because of toxic chemicals, certain medicines, infections, and other damaging factors. Plant-derived compounds are sometimes investigated for their ability to reduce liver damage in experimental models.

Nyctanthes arbor-tristis has been examined for possible hepatoprotective effects. In this context, hepatoprotection refers to the reduction of liver injury or the preservation of liver function under particular experimental conditions.

The potential protective effects of the plant may be related to antioxidant and anti-inflammatory mechanisms. Compounds capable of reducing oxidative damage or influencing inflammatory responses could help explain some observations in experimental models. However, the contribution of individual phytochemicals must be established rather than assumed from their presence in an extract.

Hepatoprotective activity is commonly investigated by measuring biochemical indicators such as alanine aminotransferase (ALT) and aspartate aminotransferase (AST), together with histological examination of liver tissue. These measurements can provide information about liver injury and tissue changes when appropriate experimental controls are used.

Future research should identify the constituents responsible for any observed protective effects and determine their safety at relevant doses. Studies must also distinguish between improvements in experimental biomarkers and demonstrated benefits in patients.

Thus, the possible hepatoprotective properties of Harshingar provide a basis for further investigation, but they do not establish that the plant can prevent or treat liver disease in humans.

7. Anticancer Activity

Cancer comprises a group of diseases characterized by abnormal cell growth and the ability of malignant cells to invade surrounding tissues or spread to other parts of the body. Natural products have contributed to drug discovery, making medicinal plants an important subject of anticancer research.

Certain constituents and extracts of Nyctanthes arbor-tristis have attracted attention for their possible effects on cancer-related biological processes. Experimental investigations of plant-derived compounds may examine their ability to influence cell proliferation, survival, or programmed cell death.

The presence of diverse phytochemicals provides opportunities to investigate different molecular targets. For example, researchers may examine whether particular isolated constituents affect proteins involved in cell-cycle regulation or apoptosis. Such mechanisms should only be reported as demonstrated findings when supported by direct experimental evidence.

Initial anticancer screening generally involves testing compounds against selected cancer cell lines. Additional experiments may investigate effects on normal cells, helping determine whether the observed activity is selective. More advanced studies are required to evaluate absorption, distribution, metabolism, toxicity, and efficacy in living organisms. Computational methods, including molecular docking and network pharmacology, may help identify candidate compounds and possible cancer-associated targets. Nevertheless, predicted

interactions require experimental validation and cannot establish anticancer efficacy by themselves. At present, the anticancer potential of N. arbor-tristis should be regarded as an area for further investigation rather than evidence that the plant can be used as a cancer treatment.

8. Immunomodulatory Activity

The immune system protects the body against infectious agents and contributes to the recognition of damaged or abnormal cells. Immunomodulation refers to changes in immune-system activity, which may involve either enhancement or suppression of particular responses.

Nyctanthes arbor-tristis has been investigated for possible effects on biological processes associated with immunity and inflammation. Its phytochemicals may provide useful candidates for studying interactions between immune cells, inflammatory mediators, and cellular signalling pathways.

The immunomodulatory effects of a plant extract cannot be determined solely by its phytochemical composition. Researchers must examine its biological effects using suitable experimental systems. Relevant investigations may include the measurement of cytokines, immune-cell activity, and other indicators of immune responses. The relationship between immunomodulation and anti-inflammatory activity is also important. A compound may influence inflammatory signalling without producing a general improvement in immune function. Therefore, these activities should be assessed separately rather than treated as interchangeable. Network pharmacology may help generate hypotheses about interactions between plant-derived compounds and proteins associated with immune signalling. Such analyses can guide the selection of molecular targets for laboratory experiments, but computational predictions should be distinguished from experimentally confirmed results.

Further work is needed to establish the immunological effects, safety, and therapeutic relevance of Harshingar-derived compounds.

9. Antinociceptive Activity

Antinociceptive activity refers to the reduction of responses to potentially harmful stimuli. It is commonly investigated in experimental models designed to study mechanisms associated with pain.

Traditional uses of medicinal plants for discomfort have encouraged researchers to investigate their possible pain-related effects. In the case of Nyctanthes arbor-tristis, any reported antinociceptive activity must be interpreted in relation to the specific plant part, preparation, dose, and experimental model used. Potential explanations for pain-related effects may involve interactions with inflammatory processes or other biological pathways associated with nociception. However, it is important not to assume that the plant acts through a particular pain pathway unless this has been demonstrated experimentally. Animal studies may provide preliminary information about responses to painful stimuli, but they do not directly establish effectiveness in humans. Researchers must also distinguish genuine antinociceptive effects from changes in movement, alertness, or other factors that could influence experimental outcomes.

Further studies are required to identify active constituents, investigate possible mechanisms, and establish an appropriate safety profile. Until adequate clinical evidence is available, the plant should not be regarded as an established treatment for pain.

10. Anthelmintic and Antiparasitic Activity

Anthelmintic agents are substances that act against parasitic worms, whereas antiparasitic activity is a broader term covering effects against different types of parasites. Plants used traditionally for digestive complaints and fever are sometimes investigated for these properties. Nyctanthes arbor-tristis has received attention in research concerning its possible antiparasitic effects. The biological activity of a plant preparation may depend on its chemical composition, extraction method, and the susceptibility of the organism being studied. Laboratory investigations may examine parasite survival, movement, growth, or other indicators of biological activity. These tests can provide preliminary evidence but do not necessarily establish the effectiveness of an extract in an infected person or animal.

Researchers should identify the active constituents, evaluate their selectivity, and determine whether effective concentrations can be achieved without harmful effects on host tissues. Studies should also compare plant-derived preparations with suitable reference treatments.
Although the plant may provide candidates for further antiparasitic research, its therapeutic usefulness requires stronger evidence from appropriately designed studies.

11. Gastroprotective Activity

The gastrointestinal tract is exposed to dietary substances, medicines, and other factors that can contribute to irritation or tissue injury. Gastroprotective agents are investigated for their ability to preserve the integrity of the stomach lining and reduce damage under particular conditions.

The potential gastroprotective properties of Nyctanthes arbor-tristis may be explored through studies examining oxidative stress, inflammatory responses, and changes in gastric tissue. However, claims regarding protection against ulcers or other gastrointestinal conditions must be supported by research specific to the plant preparation being evaluated.

Experimental investigations may measure the extent of gastric lesions, changes in tissue structure, and selected biochemical indicators. These observations can help researchers investigate possible protective mechanisms. Further studies should determine which constituents contribute to any observed effects and whether their activity is reproducible across different experimental models. Safety assessment is also essential, particularly when extracts are intended for oral administration.

The possible gastroprotective activity of Harshingar represents a subject for further pharmacological investigation rather than an established clinical benefit.

12. Antipyretic Activity

Antipyretic activity refers to the ability of a substance to reduce an elevated body temperature associated with fever. Harshingar has a history of traditional use in fever-related conditions, which has contributed to interest in its possible antipyretic properties.

Fever can occur in response to infections and other inflammatory conditions. Therefore, an observed reduction in body temperature does not necessarily demonstrate that a substance treats the underlying cause of the fever.

Experimental research may investigate whether specific plant extracts influence fever-related responses. However, the strength of the evidence depends on the quality of the experimental design, the plant preparation used, and the reproducibility of the findings. Future studies should determine the active constituents, examine their mechanisms of action, and assess their safety. It is also important to distinguish antipyretic activity from antimicrobial or antimalarial activity, because these are separate biological effects.

Traditional use provides a useful starting point for research, but clinical studies are needed before the effectiveness and safety of Harshingar as an antipyretic treatment can be established.

13. Potential Role in Network Pharmacology and Drug Discovery

Network pharmacology provides a framework for examining how multiple compounds may interact with several biological targets and signalling pathways. This approach is particularly relevant to medicinal plants because their extracts often contain numerous chemically distinct constituents.

For Nyctanthes arbor-tristis, network pharmacology could be used to investigate experimentally identified leaf constituents and their possible relationships with targets associated with inflammation, oxidative stress, glucose regulation, or immune responses.

A typical investigation begins with the chemical characterization of the extract. Candidate compounds are then evaluated using appropriate databases and computational tools to identify possible protein targets. The resulting compound-target relationships can be combined into networks and examined for biological pathways that may warrant further investigation.

Molecular docking can provide additional information about the possible binding of selected compounds to particular proteins. For example, a compound predicted to interact with an inflammation-related protein may become a candidate for further experimental testing. However, a favourable docking score does not prove that the compound binds under biological conditions or produces a therapeutic effect.

The reliability of these approaches depends on accurate compound identification, suitable protein structures, appropriate computational methods, and independent validation. Predicted interactions should therefore be presented as hypotheses rather than established mechanisms. Integrating phytochemical profiling, pharmacological experiments, network analysis, and molecular docking may help prioritize promising constituents of Harshingar for further research. This combined strategy can support the early stages of drug discovery, although additional studies are necessary to establish efficacy, selectivity, safety, and clinical relevance.

Protein -Protein interaction Analysis

Protein–protein interaction (PPI) analysis is an important bioinformatics technique used to understand the functional relationships between proteins involved in different biological processes. Proteins rarely perform their functions independently; instead, they often interact with other proteins to regulate cellular activities, biochemical reactions, and signalling pathways. Studying these interactions helps researchers understand how proteins work together and how changes in their activity may contribute to disease development. In medicinal plant research, PPI analysis can provide useful information about the possible molecular mechanisms through which plant-derived bioactive compounds may influence biological systems.

In the study of Nyctanthes arbor-tristis (Harshingar), PPI analysis can be used to investigate the relationships among predicted protein targets associated with its identified phytochemicals. The plant contains several reported chemical constituents, including iridoid glycosides, flavonoids, phenolic compounds, and terpenoids. After identifying and verifying the chemical constituents present in a plant extract, researchers can investigate their potential protein targets using appropriate databases and computational methods. The resulting target proteins can then be examined to determine whether they are functionally connected and associated with particular biological pathways.

The STRING database is commonly used to construct and analyse protein–protein interaction networks. It provides information about known and predicted protein associations based on evidence from experimental studies, curated databases, computational predictions, and other sources. In a typical workflow, the identifiers of selected protein targets are entered into STRING, along with the appropriate organism. The database generates a network in which nodes represent proteins and edges represent evidence-supported functional associations. It is important to recognize that an interaction shown in STRING does not always indicate direct physical binding between two proteins.

Following network construction, the interaction data can be examined using network visualization and analysis software such as Cytoscape. This software allows researchers to organize the network, examine the relationships between proteins, and identify proteins that occupy potentially important positions within the network. Several network parameters, including degree centrality, betweenness centrality, and closeness centrality, can be used to assess the structural importance of individual proteins. Degree centrality measures the

number of connections associated with a protein, whereas betweenness centrality reflects how frequently a protein lies along the shortest paths connecting other proteins. These measures can help prioritize candidate proteins for further investigation.

Proteins with a high number of connections are often described as hub proteins. Such proteins may participate in several biological processes and can be useful candidates for studying disease-related mechanisms. For example, depending on the targets identified in the analysis, proteins associated with inflammatory signalling, oxidative stress, immune regulation, or cellular survival may emerge as important network components. However, the biological importance of a hub protein should not be inferred from its connectivity alone. Its relevance must also be evaluated using published experimental evidence and the biological context of the research.

Functional enrichment analysis provides another important component of PPI investigation. Gene Ontology (GO) analysis can classify the identified proteins according to biological processes, molecular functions, and cellular components. Kyoto Encyclopedia of Genes and Genomes (KEGG) pathway enrichment can further identify signalling pathways or biochemical networks in which the target proteins are represented. These analyses may help researchers understand whether the selected targets are associated with common biological mechanisms, such as inflammatory responses, cellular signalling, metabolism, or immune regulation. Statistical significance, multiple-testing correction, and the background gene set should be considered when interpreting enrichment results.

Integrating PPI analysis with network pharmacology and molecular docking may provide a broader understanding of the possible pharmacological effects of N. arbor-tristis. Network pharmacology can help identify relationships between phytochemicals, predicted protein targets, and biological pathways, while molecular docking can be used to explore the possible binding of selected compounds to specific proteins. When combined, these approaches may help prioritize compounds and targets for further laboratory investigation. Nevertheless, the methods provide complementary information and should not be treated as independent proof of biological activity.

For example, if phytochemical analysis identifies a compound that is predicted to interact with a protein involved in inflammatory signalling, PPI analysis may help determine whether that protein is functionally connected to other inflammation-related proteins. Molecular

docking could then be used to examine the possible binding orientation of the compound within the selected protein structure. The proposed relationship would subsequently need to be investigated through appropriate experimental methods, such as biochemical assays, cell-based studies, or direct protein-binding experiments.

From phytochemical to drug discovery

Phytochemicals are naturally occurring compounds found in plants that may provide several health benefits. These compounds include flavonoids, alkaloids, tannins, phenolic compounds, terpenoids, and glycosides. Many medicinal plants contain these substances, which have been studied for their possible antioxidant, anti-inflammatory, antimicrobial, and other biological activities.

The process of drug discovery begins with the identification of useful compounds from natural sources. Researchers first select a medicinal plant and prepare its extract using a suitable solvent. The extract is then examined to identify the different phytochemicals present in it. Further studies help determine which compounds may be responsible for particular biological effects.

Modern research methods, such as chromatography, spectroscopy, network pharmacology, and molecular docking, have made the study of plant-based compounds more effective. Network pharmacology helps researchers understand how different compounds may interact with multiple proteins and biological pathways. Molecular docking is used to predict how a compound may bind to a selected protein target. These methods can help identify promising compounds for further investigation.

In the case of Nyctanthes arbor-tristis (Harshingar), the phytochemicals present in its leaves, flowers, and other plant parts are of interest because of their reported medicinal properties. Studying these compounds may help researchers understand their possible mechanisms of action and identify candidates for future drug development.

However, laboratory findings and computer-based predictions do not establish that a compound is an effective or safe medicine. Further studies, including experimental testing, toxicity assessment, and clinical trials where appropriate, are needed before a plant-derived compound can be developed into a therapeutic drug.

Overall, the journey from phytochemicals to drug discovery combines traditional knowledge with modern scientific techniques. This approach may help researchers identify new drug candidates from medicinal plants and develop a better understanding of their biological effects.

Toxicity and Safety Considerations

Medicinal plants are widely used in traditional healthcare because they contain various natural compounds with potential therapeutic benefits. However, the natural origin of a plant does not always guarantee its safety. Some plant extracts may cause unwanted effects depending on their chemical composition, dose, duration of use, and method of preparation. Therefore, toxicity and safety evaluation is an important part of medicinal plant research and drug discovery.

In Nyctanthes arbor-tristis (Harshingar), proper safety assessment is necessary before considering its extracts or isolated compounds for therapeutic use. Researchers need to examine whether the plant materials may produce harmful effects on vital organs, such as the liver and kidneys, or cause skin irritation and allergic reactions. The safety of an extract may also vary according to the plant part used, extraction solvent, concentration, and presence of specific bioactive compounds.

Preclinical toxicity studies can help identify possible harmful effects and determine suitable dose ranges for further investigation. Acute toxicity studies generally examine the effects of a single or short-term exposure, whereas repeated-dose toxicity studies investigate the effects of regular exposure over a longer period. Additional tests may be required to assess genotoxicity, reproductive toxicity, and other potential risks, depending on the intended use of the product.

Modern research techniques, including computational toxicity prediction, can provide an early indication of possible safety concerns associated with individual phytochemicals. However, these predictions cannot replace laboratory experiments or appropriate clinical studies. Similarly, molecular docking results indicate possible interactions with selected protein targets but do not establish the safety of a compound in the human body.

Overall, toxicity and safety evaluation is essential for the responsible development of plant-based medicines. Although Nyctanthes arbor-tristis has a history of traditional use, its safety should be established through scientifically designed studies. Careful evaluation of dosage,

adverse effects, interactions, and long-term exposure can help determine whether its extracts or isolated compounds are suitable for future therapeutic applications.

CONCLUSION

Nyctanthes arbor-tristis (Harshingar), commonly known as night-flowering jasmine or parijat, is a medicinal plant with a long history of use in traditional healthcare. Different parts of this plant, including its leaves, flowers, bark, seeds, and roots, have attracted scientific interest because of their diverse phytochemical composition. Compounds such as flavonoids, alkaloids, phenolic compounds, terpenoids, and iridoid glycosides may contribute to the biological activities reported in studies of this plant. Investigating these constituents can help researchers better understand its medicinal properties and identify compounds that may be useful in future drug development.

The integration of phytochemical analysis and pharmacological evaluation provides a systematic approach to studying the therapeutic properties of N. arbor-tristis. Traditional knowledge can guide the selection of plant materials, while modern analytical techniques can help identify and characterize their chemical constituents. Furthermore, network pharmacology offers a way to examine the possible relationships between multiple phytochemicals, protein targets, and biological pathways. Molecular docking can complement this approach by predicting how selected compounds may interact with specific proteins. Together, these methods can help prioritize promising compounds for further investigation and provide possible explanations for the biological effects observed during experimental studies.

Despite these research opportunities, several challenges must be addressed before the plant's constituents can be considered for therapeutic development. The chemical composition of extracts may vary according to the plant part, geographical location, harvesting conditions, and extraction method. Therefore, standardized extraction procedures and reliable analytical methods areimportant for obtaining consistent results. In addition, computational predictions should be supported by laboratory experiments to verify the proposed interactions and biological activities. Detailed studies of toxicity, dosage, absorption, distribution, metabolism, and elimination are also necessary to understand the safety and suitability of potential drug candidates.

Another important area for future research is the identification of individual bioactive compounds responsible for specific pharmacological effects. Researchers should investigate their mechanisms of action, possible interactions with other compounds, and effectiveness in appropriate experimental models. Well-designed clinical studies may eventually be required to determine their benefits and risks in humans. Traditional use alone is not sufficient to establish clinical effectiveness or guarantee safety.

Overall, Nyctanthes arbor-tristis represents a valuable subject for further phytochemical and pharmacological research. Combining traditional medicinal knowledge with modern drug discovery tools may improve our understanding of its bioactive constituents and their possible therapeutic applications. Although additional experimental and clinical evidence is needed, an integrated approach involving phytochemical profiling, network pharmacology, molecular docking, and safety assessment may help identify promising plant-derived drug candidates. Such research could contribute to the scientific evaluation of Harshingar and support the future development of evidence-based herbal medicines.

REFERENCES

1. Agrawal J, Pal A. Nyctanthes arbor-tristis Linn—a critical ethnopharmacological review. J Ethnopharmacol, 2013; 146(3): 645-58. doi:10.1016/j.jep.2013.01.024.
2. Meshram MM, Rangari SB, Kshirsagar SB, Gajbhiye S, Trivedi MR, Sahane RS. Nyctanthes arbor-tristis: a herbal panacea. Int J Pharm Sci Res, 2012; 3(8): 2432-40.
3. Tuntiwachwuttikul P, Rayanil K, Taylor WC. Chemical constituents from the flowers of Nyctanthes arbor-tristis. Sci Asia, 2003; 29: 21-30. doi:10.2306/scienceasia1513-1874.2003.29.021.
4. Rathore A, Rivastava V, Srivastava KC, Tandon JS. Iridoid glucosides from Nyctanthes arbor-tristis. Phytochemistry, 1990; 29(6): 1917-20. doi:10.1016/0031-9422(90)85040-M.
5. Priya K, Ganjewala D. Antibacterial activities and phytochemical analysis of different plant parts of Nyctanthes arbor-tristis (Linn.). Res J Phytochem, 2007; 1(2): 61-7. doi:10.3923/rjphyto.2007.61.67.
6. Kannan M, Singh AR. An immuno-pharmacological investigation of Indian medicinal plant Nyctanthes arbor-tristis Linn. World Appl Sci J, 2010; 11(5): 495-503.
7. Gond SK, Mishra A, Sharma VK, Verma SK, Kumar J, Singh DK, et al. Diversity and antimicrobial activity of endophytic fungi isolated from Nyctanthes arbor-tristis, a well-

known medicinal plant of India. Mycoscience, 2012; 53(2): 113-21. doi:10.1007/S10267-011-0146-Z.

8. Gahtori R, Tripathi AH, Chand G, Pande A, Joshi P, Rai RC, et al. Phytochemical screening of Nyctanthes arbor-tristis plant extracts and their antioxidant and antibacterial activity analysis. Appl Biochem Biotechnol, 2024; 196(1): 436-56. doi:10.1007/s12010-023-04552-4.
9. Venkataraman S, Harinya S, Chidiuto DB, Raja RR. Phytochemical constituents and pharmacological activities of Nyctanthes arbor-tristis. Res J Pharm Technol, 2019; 12(10): 4639-43. doi:10.5958/0974-360X.2019.00798.4.
10. Pundir S, Gautam GK, Zaidi S. A review on pharmacological activity of Nyctanthes arbor-tristis. Res J Pharmacogn Phytochem, 2022; 14(2): 69-72. doi:10.52711/0975-4385.2022.00014.
11. Nyctanthes arbor-tristis Linn.: a review on its traditional uses, phytochemistry, pharmacological activities, and toxicity. Curr Tradit Med, 2023; 9(1). doi:10.2174/2215083808666220512141937.
12. Nagarajan SS, Velmurugan B, Ravichandran S, Tiruppathi S, Mariyappan S, Murali V. A comprehensive review of Nyctanthes arbor-tristis Linn phytochemical diversity and its pharmacological activities. J Pharmacogn Phytochem, 2025; 14(6): 129-32. doi:10.22271/phyto.2025.v14.i6b.15651.
13. Tipugade O, Sawale J, Jadhav N. Nyctanthes arbor-tristis Linn.: comprehensive insights into its medicinal, phytochemical and safety profiles. Nat Prod Res, 2026; 40(11): 3338-51. doi:10.1080/14786419.2025.2456086. ◆
14. Nyctanthes arbor-tristis bioactive extract ameliorates LPS-induced inflammation through the inhibition of NF-κB signalling pathway. PubMed record available under PMID 37925001. Note: Retrieve the full author list, journal, year, volume, and page numbers from PubMed before citing this study.
15. Katre SG, Chhangani JKA. Therapeutic insights and pharmacological evaluation of Nyctanthes arbor-tristis Linn.: a comprehensive review. Asian J Res Pharm Sci, 2026; 16(3): 265. doi:10.52711/2231-5659.2026.00039. ◆
16. ewman DJ, Cragg GM. Natural products as sources of new drugs over the nearly four decades from 01/1981 to 09/2019. J Nat Prod, 2020; 83(3): 770-803. doi:10.1021/acs.jnatprod.9b01285.

17. Atanasov AG, Waltenberger B, Pferschy-Wenzig EM, Linder T, Wawrosch C, Uhrin P, et al. Discovery and resupply of pharmacologically active plant-derived natural products: a review. Biotechnol Adv, 2015; 33(8): 1582-614. doi:10.1016/j.biotechadv.2015.08.001.
18. Cragg GM, Newman DJ. Natural products: a continuing source of novel drug leads. Biochim Biophys Acta, 2013; 1830(6): 3670-95. doi:10.1016/j.bbagen.2012.11.008.
19. Harvey AL, Edrada-Ebel R, Quinn RJ. The re-emergence of natural products for drug discovery in the genomics era. Nat Rev Drug Discov, 2015; 14(2): 111-29. doi:10.1038/nrd4510.
20. Fabricant DS, Farnsworth NR. The value of plants used in traditional medicine for drug discovery. Environ Health Perspect, 2001; 109 Suppl 1: 69-75.
21. Rates SMK. Plants as source of drugs. Toxicon, 2001; 39(5): 603-13. doi:10.1016/S0041-0101(00)00154-9.
22. Efferth T, Koch E. Complex interactions between phytochemicals: the multi-target therapeutic concept of phytotherapy. Curr Drug Targets, 2011; 12(1): 122-32.
23. Heinrich M, Barnes J, Gibbons S, Williamson EM. Fundamentals of pharmacognosy and phytotherapy. 2nd ed. Edinburgh: Churchill Livingstone Elsevier; 2012.
24. Evans WC. Trease and Evans pharmacognosy. 16th ed. Edinburgh: Saunders Elsevier; 2009.
25. World Health Organization. WHO guidelines on good agricultural and collection practices (GACP) for medicinal plants. Geneva: World Health Organization; 2003.
26. Harborne JB. Phytochemical methods: a guide to modern techniques of plant analysis. 3rd ed. London: Chapman & Hall; 1998.
27. *-8Sofowora A. Medicinal plants and traditional medicine in Africa. 3rd ed. Ibadan: Spectrum Books; 2008.
28. Evans WC. Pharmacognosy. In: Trease and Evans pharmacognosy. 16th ed. Edinburgh: Saunders Elsevier; 2009.
29. Dai J, Mumper RJ. Plant phenolics: extraction, analysis and their antioxidant and anticancer properties. Molecules, 2010; 15(10): 7313-52. doi:10.3390/molecules15107313.
30. Azmir J, Zaidul ISM, Rahman MM, Sharif KM, Mohamed A, Sahena F, et al. Techniques for extraction of bioactive compounds from plant materials: a review. J Food Eng, 2013; 117(4): 426-36. doi:10.1016/j.jfoodeng.2013.01.014.

31. Sasidharan S, Chen Y, Saravanan D, Sundram KM, Latha LY. Extraction, isolation and characterization of bioactive compounds from plants' extracts. Afr J Tradit Complement Altern Med, 2011; 8(1): 1-10.
32. Sarker SD, Nahar L. An introduction to natural products isolation. In: Sarker SD, Nahar L, editors. Natural products isolation. 3rd ed. Totowa (NJ): Humana Press; 2012.
33. Cos P, Vlietinck AJ, Berghe DV, Maes L. Anti-infective potential of natural products: how to develop a stronger in vitro proof-of-concept. J Ethnopharmacol, 2006; 106(3): 290-302. doi:10.1016/j.jep.2006.04.003.
34. Eloff JN. A sensitive and quick microplate method to determine the minimal inhibitory concentration of plant extracts for bacteria. Planta Med., 1998; 64(8): 711-3. doi:10.1055/s-2006-957563.
35. Balunas MJ, Kinghorn AD. Drug discovery from medicinal plants. Life Sci, 2005; 78(5): 431-41. doi:10.1016/j.lfs.2005.09.012.
36. Hopkins AL. Network pharmacology: the next paradigm in drug discovery. Nat Chem Biol, 2008; 4(11): 682-90. doi:10.1038/nchembio.118.
37. Li S, Zhang B. Traditional Chinese medicine network pharmacology: theory, methodology and application. Chin J Nat Med, 2013; 11(2): 110-20. doi:10.1016/S1875-5364(13)60037-0.
38. Nogales C, Mamdouh ZM, List M, Kiel C, Casas AI, Schmidt HHHW. Network pharmacology: curing causal mechanisms instead of treating symptoms. Trends Pharmacol Sci, 2022; 43(2): 136-50.
39. Chandran U, Mehendale N, Tillu G, Patwardhan B. Network pharmacology of Ayurveda formulation Triphala with special reference to anti-cancer property. Comb Chem High Throughput Screen, 2015; 18(9): 846-54.
40. Ru J, Li P, Wang J, Zhou W, Li B, Huang C, et al. TCMSP: a database of systems pharmacology for drug discovery from herbal medicines. J Cheminform, 2014; 6: 13. doi:10.1186/1758-2946-6-13.
41. Wishart DS, Feunang YD, Guo AC, Lo EJ, Marcu A, Grant JR, et al. DrugBank 5.0: a major update to the DrugBank database for 2018. Nucleic Acids Res, 2018; 46(D1): D1074-82. doi:10.1093/nar/gkx1037.
42. Szklarczyk D, Gable AL, Nastou KC, Lyon D, Kirsch R, Pyysalo S, et al. The STRING database in 2021: customizable protein-protein networks, and functional characterization of user-uploaded gene/measurement sets. Nucleic Acids Res, 2021; 49(D1): D605-12. doi:10.1093/nar/gkaa1074.

43. Shannon P, Markiel A, Ozier O, Baliga NS, Wang JT, Ramage D, et al. Cytoscape: a software environment for integrated models of biomolecular interaction networks. Genome Res, 2003; 13(11): 2498-504. doi:10.1101/gr.1239303.
44. UniProt Consortium. UniProt: the universal protein knowledgebase in 2023. Nucleic Acids Res, 2023; 51(D1): D523-31.
45. Trott O, Olson AJ. AutoDock Vina: improving the speed and accuracy of docking with a new scoring function, efficient optimization, and multithreading. J Comput Chem, 2010; 31(2): 455-61. doi:10.1002/jcc.21334.
46. Morris GM, Huey R, Lindstrom W, Sanner MF, Belew RK, Goodsell DS, et al. AutoDock4 and AutoDockTools4: automated docking with selective receptor flexibility. J Comput Chem, 2009; 30(16): 2785-91. doi:10.1002/jcc.21256.
47. Kitchen DB, Decornez H, Furr JR, Bajorath J. Docking and scoring in virtual screening for drug discovery: methods and applications. Nat Rev Drug Discov, 2004; 3(11): 935-49. doi:10.1038/nrd1549.
48. Ferreira LG, dos Santos RN, Oliva G, Andricopulo AD. Molecular docking and structure-based drug design strategies. Molecules, 2015, 20(7): 13384-421. doi:10.3390/molecules200713384.
49. Pinzi L, Rastelli G. Molecular docking: shifting paradigms in drug discovery. Int J Mol Sci, 2019, 20(18): 4331. doi:10.3390/ijms20184331.
50. Pagadala NS, Syed K, Tuszynski J. Software for molecular docking: a review. Biophys Rev, 2017; 9(2): 91-102. doi:10.1007/s12551-016-0247-1.
51. Ashokkumar K, Dharshini M, Janani T, Shrravani Sri V, Subhasidha R, et al. Nyctanthes arbor-tristis Linn. (Night Jasmine): extraction techniques, phytochemical constituents, and biological impacts of extracts and essential oil. Future J Pharm Sci, 2024; 10: 117. doi:10.1186/s43094-024-00694-2.
52. Nagarajan SS, Velmurugan B, Ravichandran S, Tiruppathi S, Mariyappan S, Murali V. A comprehensive review of Nyctanthes arbor-tristis Linn phytochemical diversity and its pharmacological activities. J Pharmacogn Phytochem, 2025; 14(6): 129-132. doi:10.22271/phyto.2025.v14.i6b.15651.
53. Sit R, Tamang S, Das R, Mohanty JP, Banik B. Pharmacognostic and therapeutic insights into Nyctanthes arbor-tristis Linn: an extensive review. J Pharmacogn Phytochem, 2025; 14(4): 13-22. doi:10.22271/phyto.2025.v14.i4a.15444. ◆

54. Pundir S, Gautam GK, Zaidi S. A review on pharmacological activity of Nyctanthes arbor-tristis. Res J Pharmacogn Phytochem, 2022; 14(2): 69-72. doi:10.52711/0975-4385.2022.00014.
55. Aggarwal A, Mehta DK, Bhardwaj A, Das R. Nyctanthes arbor-tristis: a multifaceted medicinal plant in traditional and contemporary medicine. Planta Med, 2026; 92(4): 440-464. doi:10.1055/a-2706-7358.
56. Tipugade O, Sawale J, Jadhav N. Nyctanthes arbor-tristis Linn.: comprehensive insights into its medicinal, phytochemical and safety profiles. Nat Prod Res, 2026; 40(11): 3338-3351. doi:10.1080/14786419.2025.2456086. ◆
57. Priya K, Ganjewala D. Antibacterial activities and phytochemical analysis of different plant parts of Nyctanthes arbor-tristis (Linn.). Res J Phytochem, 2007; 1(2): 61-67. doi:10.3923/rjphyto.2007.61.67. ◆
58. Tuntiwachwuttikul P, Rayanil K, Taylor WC. Chemical constituents from the flowers of Nyctanthes arbor-tristis. Sci Asia, 2003; 29(1): 21-30. doi:10.2306/scienceasia1513-1874.2003.29.021.
59. Agrawal J, Pal A. Nyctanthes arbor-tristis Linn—a critical ethnopharmacological review. J Ethnopharmacol, 2013; 146(3): 645-658. doi:10.1016/j.jep.2013.01.024.
60. Meshram MM, Rangari SB, Kshirsagar SB, Gajbhiye S, Trivedi MR, Sahane RS. Nyctanthes arbor-tristis: a herbal panacea. Int J Pharm Sci Res, 2012; 3(8): 2432-2440.
61. Hopkins AL. Network pharmacology: the next paradigm in drug discovery. Nat Chem Biol, 2008; 4(11): 682-690.
62. Berger SI, Iyengar R. Network analyses in systems pharmacology. Bioinformatics, 2009; 25(19): 2466-2472.
63. Barabási AL, Gulbahce N, Loscalzo J. Network medicine: a network-based approach to human disease. Nat Rev Genet, 2011; 12(1): 56-68.
64. Li S, Zhang B. Traditional Chinese medicine network pharmacology: theory, methodology and application. Chin J Nat Med, 2013; 11(2): 110-120.
65. Zhang R, Zhu X, Bai H, Ning K. Network pharmacology databases for traditional Chinese medicine: review and assessment. Front Pharmacol, 2019; 10: 123.
66. Ru J, Li P, Wang J, Zhou W, Li B, Huang C, et al. TCMSP: a database of systems pharmacology for drug discovery from herbal medicines. J Cheminform, 2014; 6: 13.

67. Wang X, Shen Y, Wang S, Li S, Zhang W, Liu X, et al. PharmMapper 2017 update: a web server for potential drug target identification with a comprehensive target pharmacophore database. Nucleic Acids Res, 2017; 45(W1): W356-W360.
68. Szklarczyk D, Gable AL, Nastou KC, Lyon D, Kirsch R, Pyysalo S, et al. The STRING database in 2021: customizable protein-protein networks, and functional characterization of user-uploaded gene/measurement sets. Nucleic Acids Res, 2021; 49(D1): D605-D612.
69. Trott O, Olson AJ. AutoDock Vina: improving the speed and accuracy of docking with a new scoring function, efficient optimization, and multithreading. J Comput Chem, 2010; 31(2): 455-461.
70. Daina A, Michielin O, Zoete V. SwissADME: a free web tool to evaluate pharmacokinetics, drug-likeness and medicinal chemistry friendliness of small molecules. Sci Rep, 2017; 7: 42717.