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A CONCISE REVIEW: RECENT DEVELOPMENT AND FUTURE PROSPECTS OF PHARMACOLOGICAL ACTIVITIES OF NYCTANTHOUS ARBOR TRISTIS

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ABSTRACT
Nyctanthes arbor-tristis, commonly known as the Night-flowering Jasmine, is a medicinal plant with a rich history in traditional medicine, particularly in India and Southeast Asia. It has garnered significant attention due to its diverse pharmacological properties, including anti-inflammatory, anti-cancer, antioxidant, antimicrobial, and hepatoprotective effects. Recent studies have isolated various bioactive compounds from different parts of the plant, such as alkaloids, flavonoids, glycosides, and essential oils, Crude extracts and refined chemicals from seeds, such as 4-hydroxy-hexahydrobenzofuran-7-one, 6-hydroxyloganin, and Arbortristoside A, a polysaccharide from the leaves, and Naringenin from the stem, may all be sources of active pharmacological agents. In Ayurveda, the plant is used for a variety of pharmacological effects, including anticancer, antiparasitic, antimalarial, immunostimulant, hepatoprotective, antiviral, anti-diabetic, and anti-allergy activity which are believed to contribute to its therapeutic potential. This review synthesizes the latest research on the pharmacological activities of *Nyctanthes arbor-tristis*, emphasizing the molecular mechanisms underlying its effects. Additionally, it explores the plant's future prospects in drug development, particularly in the context of modern pharmaceutical applications and the need for further clinical trials to validate its efficacy. As interest in natural products continues to rise, Nyctanthes arbor-tristis presents a promising candidate for the discovery of new therapeutic agents, although more comprehensive studies are required to fully understand its pharmacodynamics and safety profile.

KEYWORDS: *Nyctanthus arbor tristis*, Parijat, Medicinal Properties, Biocompounds, Pharmacological activity.

INTRODUCTION
Nyctanthes arbor-tristis, commonly known as the Night-flowering Jasmine or "Harsingar," is a tropical plant native to India and Southeast Asia, widely recognized for its therapeutic applications in traditional medicine. Historically, its flowers, leaves, bark, and roots have been utilized in Ayurvedic, Unani, and Siddha medicine for the treatment of various ailments, including fever, pain, inflammation, and liver disorders. The plant is a rich source of bioactive compounds such as alkaloids, flavonoids, glycosides, and essential oils, which contribute to its diverse pharmacological properties. The plant contains several pharmacologically active constituents, including alkaloids, flavonoids, glycosides, essential oils, and terpenoids, all of which play a significant role in its medicinal effects. Among the most prominent compounds are "Nyctanthin" (a flavonoid), "Oleanoic acid" (a triterpenoid), and "Jasminoidin" (a glycoside), which have demonstrated various biological activities. These bioactive compounds have been shown to exhibit anti-inflammatory, antioxidant, antimicrobial, anti-cancer, hepatoprotective, and analgesic effects in a range of preclinical studies. The plant possesses immense biological properties due to the presence of different chemical substances which perform several important physiological functions. Among 4,22,000 flowering plants reported from the whole world, more than 50,000 plants are reported to have medicinal and pharmacological uses. A rich diversity of medicinal plants is found in India.[1] The bioactive components are believed to interact with key molecular pathways, such as the modulation of oxidative stress, inflammatory cytokine suppression, and the induction of apoptosis in cancer cells. It is a shrub or small tree growing to 10 m tall terrestrial woody perennial plant having 5–20 years of lifespan. It is a well-known tree having a wide range of pharmacological activities and is widely cultivated in tropical and subtropical regions all over the world. In India, it is distributed in the outer Himalayas and tracts of Jammu and Kashmir, Nepal to the east of Assam, Bengal, Tripura extended through the central region up to the Godavari in the South.

Fig. No. 1: *Nyctanthes arbor-tristis* or Night jasmine.

Over recent years, significant scientific interest has emerged regarding the plant's potential in modern pharmacology. Numerous in vitro and in vivo studies have demonstrated its anti-inflammatory, antioxidant, antimicrobial, antidiabetic, anticancer, and hepatoprotective activities. Research has revealed that the plant exerts its therapeutic effects through multiple molecular pathways, such as the modulation of oxidative stress, inhibition of inflammatory cytokines, and regulation of cell cycle and apoptosis in cancer cells. These findings have raised *Nyctanthes arbor-tristis* as a promising candidate for further pharmaceutical development. Numerous research studies reported that extracts from the fowers and leaves of *Nyctanthus arbor-tristis* possess stomachic, carminative, colon astringent, expectorant, anti-bilious, hair tonic, and therapeutic properties.[2]

Despite its traditional use and emerging scientific validation, challenges remain in standardizing its medicinal formulations and conducting extensive human clinical trials. The future prospects of *Nyctanthes arbor-tristis* lie in exploring its full pharmacological potential, optimizing its therapeutic applications, and developing novel drug delivery systems. This review aims to summarize the current developments in pharmacological research on *Nyctanthes arbor-tristis* and highlight the future directions for its clinical utilization.

Taxonomic classification[3]
Kingdom: Plantae
Division: Magnoliophyta
Class: Magnoliopsida
Order: Lamiales
Family: Oleaceae
Genus: *Nyctanthes*
Species: *arbor-tristis*
Botanical Name: *Nyctanthes arbor-tristis*

Vernacular Names[4]
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: Pagadammali, swetasarasa, paghada, karchia, karuchiya
Malayalam: Pavilamalli, parijatam, pavizhamalli, parijatakam
Marathi: Khurasli, Parijataka, Purijat

GEOGRAPHICAL DISTRIBUTION
NAT chiefly grows in India, especially around the forest areas of sub-Himalayan regions and Godavari. Bangladesh, the Indo-Pak subcontinent, and tropical areas of Southeast Asia are also the high growth habitat of NAT, and some varieties are also seen to grow in Thailand, Indo-Malayan Terai tracts, Burma and Ceylon. NAT found growth in high to moderate shade but very few growths in dry deciduous forests. Molecular analysis of NAT has also been done in central and northern India in different regions to estimate genetic diversity that will further help to develop NAT for several traits.

Table 1: Major constituents of *Nyctanthes arbor-tristis* essential oils from various geographical origin.

Geographical Origins	Parts Major	Constituents	References
Sri Lanka	Flowers	Phytol (32.2%), Methyl palmitate (14.7%), cis-9-Tricosene (3.6%), Geranylgeraniol (2.7%), n-Nonadecene (2.2%), Phytone (1.4%), Methyl stearate (1.1%), n-Benzyl salicylate (1.1%), and Heptacosane (0.8%),	[5]
Nepal	Leaves Barks	Hexadecanoic acid (26.4%), phytol (13.6%), Hexenyl benzoate (11%), Linalool (11.3%), Octadecanoic acid (6.2%), Methyl salicylate (5.6%), n-Dodecanol (5.5%), Alpha-Terpineol (4.7%), and Geraniol (3.7%), Hexadecanoic acid (34.3%), Alpha-Eudesmol (8.7%), Beta-Eudesmol (17.1%), Elemol (5.8%), Cryptomeridiol (4.8%), Octadecanoic acid (3.9%), %), n-Dodecanol (6.8%), Methyl palmitate (1.8%), Methyl stearate (1.4%), and 1,8-Cineole (1.3%)	[6]
India (Tamil Nadu	Flowers	1-octanol (74.81%), 2-hexadecen-1-ol, 3,7,11,15-tetra (6.8%), Bis (2-ethylhexyl) phthalate (5.88%), 2,4-cycloheptadiene-1-one, 2,6,6-trimethyl (4.23%), Hexadecanoic acid methyl ester (2.07%), and Benzoic acid (1.21%	[7]

Botanical Classification
Leaves: The opposite, simple, whole or serrated, petiolate, exstipulate leaves are 5–10 cm in length and 2.5– 6.3 cm in width. They are oblong, acute or acuminate, and have a hairy, 6-cm-long petiole. While the upper surface is dark green with dotted glands, the below surface is light green and softly pubescent. N. arbor-tristis has a reticulate venation.[8]

Flower: The tiny, deliciously scented blooms are grouped at the terminal ends of branches or in the axils of leaves. They are frequently observed in clusters of two to seven.[9]

Seed: Each cell contains a single compressed seed. Exalbuminous seeds contain a high degree of vascularization, a thick testa, and an outer layer of large, transparent cell.[10]

Fruits: The fruit has a single seed within each flat, brown, heart-shaped to spherical capsule that has a diameter of around 2 cm.

Stem and Bark: This large shrub might grow up to ten meters in height. The N. arbor-tristis plant has brown or dark gray bark.[10]

A. Leaves

C. Flower

B. Seeds

D. Fruit

Fig. No. 2: Parts of Plants.

Table 2: Traditional Use.[11]

Plant Parts	Uses
Leaves	Antibilious, expectorant, used in rheumatism and fever, decoction given in sciatica, juice used as a cholagouge, laxative, diaphoretic, diuretic, liver disorder and anthelmintic.
Bark	Expectorant
Seeds	Useful in baldness, scurvy and infections of the scalp.
Flowers	Bitter, ophthalmic, astringent, stomachic, carminative and trichogenous and are useful in inflammations, dyspepsia, flatulence, colic, ophthalmopathy, splenomegaly, greyness of hair and baldness
Corolla tubule	Antileishmanial, Antihistaminic
Orange colored tubular calyx	Carotenoid aglycone Ag-NY1

Table 3: A detailed survey of pharmacological activities of different extracts/compounds from different parts of *Nyctanthes arbor-tristis*.[2]

Plant Part	Active Compound(s)	Method of Isolation	Pharmacological Activity	Type of Activity	Description
Flowers	Nyctanthin, Flavonoids, Phenolic acids	Extraction using solvents like methanol, ethanol, or water; followed by chromatographic techniques (e.g., column chromatography, HPLC) for separation	Anti-inflammatory, Antipyretic, Antioxidant, Anticancer, Antimicrobial	Therapeutic / Antimicrobial / Protective / Anticancer	Nyctanthin and flavonoids exhibit anti-inflammatory and anticancer properties, while phenolic acids show antioxidant and antimicrobial

					activities.
Leaves	Flavonoids, Alkaloids, Saponins	Solvent extraction (methanol, ethanol), followed by fractionation and chromatography (e.g., thin-layer chromatography, HPLC)	Anti-inflammatory, Antidiabetic, Hepatoprotective, Antimicrobial	Therapeutic / Hepatoprotective / Antidiabetic / Protective	Flavonoids and alkaloids reduce inflammation and support liver health, while saponins improve insulin sensitivity and act as antimicrobials.
Bark	Alkaloids, Triterpenoids, Flavonoids	Soxhlet extraction, followed by column chromatography and GC-MS for compound identification	Hepatoprotective, Analgesic, Anticancer	Therapeutic / Pain relief / Liver protection / Anticancer	Alkaloids and triterpenoids are responsible for liver protection and analgesic effects, while flavonoids contribute to anticancer activity.
Roots	Alkaloids, Flavonoids, Tannins	Cold extraction with ethanol or methanol, followed by HPLC and NMR spectroscopy for compound identification	Antimicrobial, Antidiabetic, Antioxidant	Protective / Antimicrobial / Antidiabetic	Alkaloids and flavonoids show antimicrobial effects, tannins possess antioxidant properties, and compounds regulate blood glucose levels.

Pharmacological perspectives of *Nyctanthes arbor tristis*

Hepatoprotective activity

Ethanolic leaf extract of *Nyctanthes arbor-tristis* protects against carbon tetrachloride - induced hepatotoxicity in rat. For this investigation rats were pretreated with extract (1000mg/kg body weight/day, p.o. For 7 days) prior to the administration of a single dose of CCl4 (1.0ml/kg, s.c.). The samples of blood were collected at 48 h after CCl4 administration (9 day) from the abdominal aorta under pentobarbitone anesthesized (350mg/kg i.p.). Silymarin (70mg/kg body weight/day, p.o. For 7 days) were used as a reference standard. In this study the leaf extract of *Nyctanthes arbor-tristis* and silymarin restored all serum and liver parameters which were altered by (CCl4) from the normal level, also prevent loss of body weight; both candidates are also protected against (CCl4) induced increase in liver weight and volume. The mechanism involves the blockade of deactivation of (CCl4) through inhibition of P 450 2E1 activity and or to accelerate the detoxification of (CCl4). These effects may be mediated by the antioxidant present in the plant. In another investigation, the ethanolic and aqueous extract of the leaf of Nyctanthes arbor-tristis (500mg/kg oral route for 10days) reversed the rise in serum AST and total bilirubin in (CCl4) induced hepatotoxicity in animal models

Antioxidant and anti-cancer

Plants have long been recognized as a source of powerful antioxidants, which help eliminate pathogen-causing free radicals. The order of the activity was as folows. The high phenolic and flavonoid content of the ethyl acetate leaf extract of N. arbor-tristis leaves was recently put to the test for its anti-oxidant potential. The hydro-alcoholic extract of the plant's leaves contains anti-lipid peroxidation properties, as well as anti-DPPH radical scavenging and antihydroxyl radical scavenging properties. Butanolic extract showed the greatest percentage of inhibition of the Reactive Oxygen Species (ROS), according to studies on numerous fractionated alcoholic extracts of the plant's leaves. Butanol (95.22%) > ethyl acetate (84.63%) >petroleun ether (82.04%) at 100 µg/ml as compared with reference standard of ascorbic acid at 10 µg/ml. Till date, there has not been much literature regarding the anticancer properties of Nyctanthes arbor-tristis. However, in a major study, it was reported that two iridoid glycoside exhibited anticancer activity against methylcholanthrene produced fibrosarcoma at 2.5 mg/kg in mice.[12]

Anti-trypanosomal and leishmanicidal activity

Similar to other protozoan diseases, trypanosomiasis is also a major cause of suffering in sub Saharan Africa caused by intracellular parasites of trypanosome species Trypanosoma cruzei, Trypanosoma brucei. Anti-trypanosomal potential of a crude 50% ethanol extract of Nyctanthes arbor-tristis leaves exhibited trypanocidal activity at 1000 mg/ml under in-vitro conditions. In-vivo studies revealed that the extract exerted anti-trypanosomal effects at doses of 300 and 1000 mg/kg by prolonging the survival of mice. However, the discontinuation of treatment led to the death of experimental mice.[13]

Leishmaniasis is a widespread tropical disease which can be fatal if left untreated. Recommended first line therapies include pentavalent antimonials but all suffer

from limitations of cost and specific toxicity upon parenteral administration. Biological activity from Nyctanthes lead to the isolation of Arbortristoside A, B, C and 6-b-hydoxyloganin (iridoid glucosides isolated from seeds) which showed high order of activity against Leishmania donovani amastigotes, in vitro, between 30 and 100 mg/ml and in-vivo at 10 and 100 mg/kg. One of the most promising approaches to identify novel anti-leishmanial agent is the analysis of naturally occurring plant derived compounds. In such an effort, bioactivity guided fractionation led to the successful isolation of calceolarioside A from the methanolic extract of *Nyctanthes arbor-tristis* leaves, which exhibited an IC50 of 20 mg/ml, while the in-vivo efficacy was observed at 20 mg/kg in terms of reduced hepatic and splenic parasite burden in an established model of Leishmania donovani in golden hamster.[14]

Larvicidal activity

Eradication of vectors transmitting various tropical diseases through chemical insecticides has intricate problems which has lead to the search for natural sources of vector control strategies. Nyctanthes also has been tried for such activities by some workers.

The evaluation of chloroform extract and its isolated compound NCS-2 from flowers of Nyctanthes have been reported to be larvicidal against common filarial vector, Culex quinquefasciatus with LC50 of 25.67–72.60 ppm and 73.31–99.02 ppm. It was also observed that the late instar larvae were more resistant to the extract than those of early instars (585). Leaves of *Nyctanthes arbor -tristis* possess larvicidal activity as well. The LC50 values of chloroform extract of *Nyctanthes arbor -tristis* leaves were 303.2, 518.2, and 420.2 ppm against Aenopheles aegypti, Anopheles stephensi, and Culex quinquefasciatus, respectively. The methanol and chloroform extracts of flowers of *Nyctanthes arbor -tristis* showed larvicidal activity as well against larvae of Anopheles stephensiwith the respective LC50 values of 244.4 and 747.7 ppm. In a study related to the toxicological properties of several medicinal plants, the larvicidal activity (LC50 values) of petroleum ether extract of leaves of *Nyctanthes arbor-tristis* was 185 ppm against Anopheles stephensi.[15]

Antimicrobial Activity

Nyctanthes are explored for antimicrobial activity amongst many other ethnomedicinal plants. Flower petals have antibacterial activity against Escherichia coli. Besides, chloroform and ethyl acetate fractions from flowers were also effective against gram-positive strains Bacillus megaterium, Bacillus cereus, Bacillus subtilis, Streptococcus sp., Staphylococcus aureus, and Sarcina lutea and gramnegative strains such as Shigella dysentriae, Escherichia coli, Shigella boydii, Pseudomonas aeruginosa, Shigella shiga, and Shigella sonnei. The leaf ethanol extract also demonstrated antibacterial activity against Salmonella paratyphi and Staphylococcus aureus. Ethanol fraction of the stems and leaves have been reported to be active against Staphylococcus epidermidis, Staphylococcus aureus, Candida albicans and yeast , whereas the aqueous extract was moderately effective against Pseudomonas testosterone. The aqueous and methanol extracts demonstrated antibacterial effects against Bacillus subtilis, Staphylococcus aureus, and Escherichia coli by disk diffusion method. Furthermore, study showed that the methanol leaf extract was also active against other pathogens like Salmonella typhi, Staphylococcus epidermidis, Staphylococcus aureus, and Salmonella paratyphi.[16]

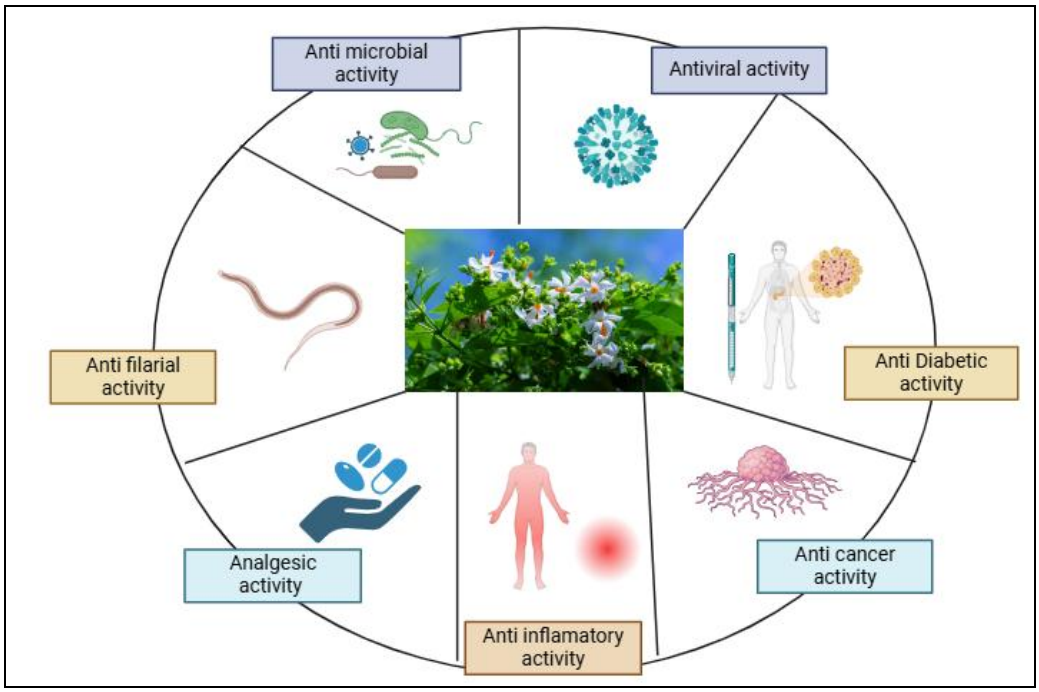

Fig. No. 3: Diagrammatic illustration of the pharmacological potential of *Nyctanthus arbor-tristi.*

Anti-inflammatory activity

A water soluble ethanolic extract of NAT leaves was used in a study to determine the presence of anti-inflammatory activity. NAT inhibited acute inflammatory edoema in the hind paw of rats induced by several phlogistic agents, including carrageenin, formalin, histamine, 5-hydroxytryptamine, and hyaluronidase. Turpentine oil was shown to be effective in reducing acute inflammatory edoema in rats' knee joints.[17]

Immunostimulant activity

Oral administration of ethanolic extract of NAT at dosages of 50, 100, 150, and 200 mg/kg significantly enhanced circulating antibody titres when challenged with SRCs and heat-killed Salmonella antigens. Chronic therapy raised the overall WBC count and significantly enhanced the DTH response. The extract was found to include 21 immune-bioactive chemicals.[4]

Antihyperglycemic and antihyperlipidemic

Diabetes is a disease caused by disorders of the endocrine system. This damage causes an increase in glucose levels because of the disturbance in insulin secretion. Diabetes in the long term will affect an increase in low-density lipoprotein (LDL), a decrease in high-density lipoprotein (HDL), which causes lipid dysregulation, reactive oxygen species production, and reduction of antioxidant status Lipid disorders also trigger the occurrence of coronary heart disease. The ethanol extract of NAT leaves demonstrated antihyperglycemic and antihyperlipidemic activities in albino rats. It decreased blood sugar levels at the dose of 400 mg/kg given for 28 days in highfat-diet (HFD) and streptozotocin (STZ) induced rats. The extract significantly reduced the blood sugar level from 437.4 ± 21.18 mg/dl to 191.3 ± 21.51 mg/dl ($p < 0.001$). Interestingly, the lipid profile was also significantly improved. The total cholesterol triglyceride, vLDL, and LDL decreased by 36.3%, 21.6%, 21.6%, and 60.3%, respectively, whereas HDL increased compared with the control group (HFD–STZ-induced diabetic rats). The ethanol extract of NAT also decreased the malondialdehyde (MDA) level and increased the superoxide dismutase (SOD), catalase, and glutathione reductase enzyme levels. MDA is a marker of lipid peroxidase and can cause cross-linking of the polymerization of proteins, nucleic acids, and other macromolecules. Meanwhile, SOD, catalase, and glutathione reductase are enzymatic antioxidants that have an important role in the defense of the immune system. Although the active compound responsible for the antihyperglycemic and antihyperlipidemic activities remains unknown, previous studies showed that the ethanol extract of NAT leaves was able to suppress hyperglycemia-mediated oxidative stress and to inhibit inflammatory pathways upon nuclear factor kappa B activation that are crucial in diabetes and hyperlipidemia.[18]

Central nervous system modulatory

In Indian system of medicine selected plants have long been classified as medhya rasayanas from Sanskrit word medhya meaning intellect or cognition, and rasayana meaning rejuvenation. Though there has not been any mention of this plant in treating conditions related to central nervous system, few of the groups have tried to monitor the effect of the plant on the central nervous system reported that the aqueous extract from the leaves of the plant could antagonize the effect of malathion on acetylcholine esterase activity which is an essential component for the metabolism of acetylcholine. In another study, the water soluble portion of the alcoholic extract of the leaves had no effect on righting reflex but in doses of 4.0 and 8.0 g/kg, it significantly (po0.05 and o0.01, respectively) prolonged the pentobarbitone sleeping time. Tests for tranquilizing activity exhibited that the extract in identical doses inhibited CAR activity significantly.[1]

Medicinal Importance of *Nyctanthus arbor tristis*

Nyctanthes arbor-tristis, is a plant renowned for its wide range of medicinal properties, making it highly valuable in traditional medicine systems like Ayurveda and Unani. The plant's flowers, leaves, bark, and roots are all used for their therapeutic effects. Anti-inflammatory and antipyretic properties make it effective in treating conditions like arthritis, gout, and fever. The plant is also rich in antioxidants, particularly flavonoids and phenolic compounds, which help protect the body from oxidative stress and related diseases such as cardiovascular issues and neurodegenerative disorders. Additionally, *Nyctanthes arbor-tristis* has strong antimicrobial activity against both bacterial and fungal pathogens, making it useful in treating infections and wounds. The plant's antidiabetic properties help regulate blood sugar levels, offering benefits for those with diabetes. Furthermore, its hepatoprotective effects support liver health by detoxifying the liver and protecting it from damage caused by toxins or infections. It also has analgesic properties, providing relief from pain and inflammation, particularly in conditions like headaches, muscle pain, and arthritis. The plant's anticancer potential is another notable aspect, as compounds in the plant have shown the ability to inhibit the growth of cancer cells, particularly in breast and lung cancers. Additionally, its role in improving respiratory health, reducing anxiety, and promoting skin health further enhances its medicinal value. Overall, Nyctanthes arbor-tristis is a versatile plant with significant therapeutic potential, offering solutions for a wide variety of health issues.

FUTURE PROSPECTIVE

The current study on *Nyctanthes arbor-tristis* showed its significance in herbal and ayurvedic traditional uses for the treatment of various diseases with its effective potential pharmacological activities. It is a readily available plant, and its collection and cultivation need no special conditions with a rich source of biologically active compounds that will draw drug development

groups' attention to discover new bioactive molecules to treat different diseases more safely and effectively. Further investigations are required on the whole plant extracts and chemical components. Preliminary experiments of pharmacological studies are related to metabolic conditions such as diabetes, inflammation, diuresis, allergy, immunomodulation, and hepatoprotection activity with toxicity assessment. Furthermore, detailed investigations are needed to determine more biological activities from crude plant fractions or pure natural constituents for their proper safety and toxic assessment. However, while preclinical evidence is promising, further research is essential to explore its mechanisms of action, establish its clinical safety and efficacy, and standardize dosages for human use. Future prospects for *Nyctanthes arbor-tristis* involve further clinical trials, the development of phytopharmaceuticals, and the integration of its benefits into modern medicine. Additionally, sustainable cultivation and harvesting practices will be critical to ensuring that this valuable plant can meet growing demand. With continued research and development, *Nyctanthes arbor-tristis* could become a key player in the treatment of various chronic and lifestyle-related diseases.

CONCLUSION

In conclusion, *Nyctanthes arbor-tristis* (Night-flowering Jasmine) emerges as a plant with remarkable pharmacological potential, exhibiting diverse therapeutic properties such as antioxidant, anti-inflammatory, antimicrobial, anticancer, antidiabetic, and neuroprotective effects. Its bioactive compounds offer promising solutions for treating a wide range of ailments, including chronic diseases like diabetes, liver disorders, and cancer. Despite the promising results from preclinical studies, further clinical trials and detailed research into its mechanisms of action are essential for translating these benefits into safe and effective therapies. Future developments should focus on optimizing its pharmacological applications, ensuring safety through toxicity studies, and exploring its role in integrative medicine. Additionally, sustainable cultivation practices will be key to supporting its widespread use. Overall, *Nyctanthes arbor-tristis* holds significant promise for future pharmaceutical development and the advancement of natural medicine.

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