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REVIEW ARTICLE

Phytochemical Constituents and Pharmacological Activities of *Nyctanthes arbor-tristis*

Sowmyalakshmi Venkataraman*, S. Harinya, David Benefit Chidiuto, R. Richardson Raja
Department of Pharmaceutical Chemistry and Analysis, School of Pharmaceutical Sciences,
Vels Institute of Science, Technology and Advanced Studies (VISTAS), Pallavaram, Chennai 600 117
†Present Address: Department of Pharmaceutical Chemistry, Faculty of Pharmacy (SBMCH campus),
Bharath Institute of Higher Education & Research, Chromepet, Chennai 600 044
*Corresponding Author E-mail: **sowmyamahesh30@gmail.com**

ABSTRACT:
Nyctanthes arbo-tristis is a medicinal plant found in India, South Asia and Southeast Asia. It was revealed that this herbal plant exhibit various pharmacological activities because of the presence of glycosides and phenolic compounds. Different pharmacological activities like hepatoprotective, antileishmanial, antipyretic, antihistaminic, antimalarial, antibacterial, anti-inflammatory, antioxidant, antiviral and antifungal activities have been reported. This present review, compiles the different phytochemical compounds and pharmacological activities reported so far by this plant in a comprehensive manner.

KEYWORDS: *Nyctanthes arbor-tristis*, phytochemical studies, arbortristosides, 6-beta-hydroxy-loganin, antioxidant, antimicrobial.

INTRODUCTION:
Herbal medicine practice plays an important role in the health care system in most of the developing countries. *Nyctanthes arbor-tristis* is also called as *"Harshringar or parijat or Paariijaatham* belonging to the family Oleaceae is one among the various important medicinal plant with diverse range of pharmacological activities. The geographical distribution of this plant is more localized in the South Asian and Southeast Asian regions of the continent. The organic solvent extracts of the dried leaves, fruits, flowers and seeds extract were prepared and used for various biological assays.[1] Notably, all the parts of the plant have shown a wide range of pharmacological activities.[2,3]

According to the Indian mythology, this shrub in general is used for religious purposes and it is also known for its unique fragrance.[4] *Nyctanthes arbor-tristis* grows well on the hilly region up to 1500 feet from sea level as a shrub with maximum height of 3000 feet. Flowering season is during the month of July to October and the shrub grows to the height of 10 m, their leaves have stiff whitish hair and rough leaves.

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Calyx is 6 to 8 mm long and they have glabrous corolla with more than length of 13 mm, and the length of the tube is 6 to 8 mm long and they are orange in color, also they have equal limbs, white lobes and obcordates are unequal and cuneate. The plant also bears simple and opposite leaves which are 6-12cm long. [5-6]

Vernacular names:
Family: Oleaceae, Nyctanthaceae.
Unani: Harasingaar.
Sanskrit: Parijatha.
Siddha: Pavazha mattigai.
Hindi: Harsingar.
Ayurvedic: Paarijaata, Shephaali, Shephaalikaa, Mandaara.
English: Night Jasmine, Coral Jasmine.
Marathi: Parijathak.
Kannada: Parijatha[3]

Traditional uses:
Customarily blossoms are accumulated for the religious contributions to show wreaths.
The white corolla with an orange color is used for coloring cotton as well silk also, the flower of the plant are used in coloring the orange robes of the Buddhist priests.

Chemical Constituents:
Leaves of *Nyctanthes arbor-tristis* contains the following chemical active constituents. Flavanol glycosides, D-mannitol, β-sitosterol, Astragaline, Nicotiflorin, Oleanolic acid, Nyctanthic acid, Ascorbic acid and Tannic acid etc. are few important phytochemical constituents that has been reported so far.[7]

Distribution of the plant
Nyctanthes arbor-tristis are found in India, generally in the Himalayan districts and south of Godhavari. Likewise it is widely distributed in Sub-Tropical South East Asia, Bangladesh, South-East Asia, Indo-Pakistan subcontinent.[8]

Essential oils, Glucose, Nyctanthin, D-mannitol, Tannin, β-monogentiobioside of crocin-3 and crocin 1, β-D monoglucoside ester of α-crocetin and carotenoids. Seeds of this plant consists of palmitic and myristic acids, arbortristoside A&B, Glycerides of linoleic acid, stearic acid, nyctanthic acid, 3-4 secotriterpene acid, oleic acid, lignoceric acid and a water dissolvable polysaccharide made out of D-mannose and D-glucose. The bark of *Nyctanthes arbor-tristis* comprises of alkaloids and glycosides. Naringenin-4-0-β-glucapyranosyl-α-xylopyranoside and β-sitosterol are present, that have been isolated from the stem of the plant. Flower oil consists of different important phytoconstituents like anisaldehyde, phenyl acetaldehyde, terpenoids, and other ketones.[8] It also consists of polysaccharides, phenyl propanoid glycoside, nyctanthoside- A, nyctanthic acid, friedelin and oleanolic acid and iridoid glycosides arbortristosides A, B and C, etc. among other important phytoconstituents.[9]

Biological activities:
The whole plant of *Nyctanthes arbor-tristis* exhibits wide pharmacological effects. For instance, the leaves shows antibacterial, anti-fungal, anti-inflammatory and anti-pyretic effects. They are also utilized as purgative, diaphoretic, diuretic and cholagogue. The leaf decoction is generally utilized to treat hepatic ailments, biliary scatters and constant fever. Leaf decoction is also used for the treatment of intestinal sickness and joint inflammation in Ayurvedic treatment. The other parts of the plants, namely flowers display a potent anti-filarial, antioxidant, diuretic effects and also used in perfumery industry. The seeds exhibit antifungal, antibacterial, immunomodulatory activities while the Stem and bark shows excellent antimicrobial, antipyretic and antioxidant activities.[4]

Antioxidant activity:
The *in vitro* antioxidant activity of *N. arbor-tristis* was carried out using 1,1-diphenyl-2-picrlyhydrazyl (DPPH), hydroxyl and superoxide radicals and hydrogen peroxide scavenging assays. The plant has a reducing power which is attributed to high phenolics and flavonoid contents. Leaves show concentration dependent free radical scavenging activity in *in vitro* DPPH assay assessment of free radicals. In another study, the total phenolic content in the methanolic extract of the leaves was also analysed using other *in vitro* antioxidant studies and was established as the important chemical component for the antioxidant activity.[10-13]

Anti-diabetic activity:
Chloroform extracts of crude drug when given orally and the leaf extract which contain 50% ethanolic extract notably increase in the levels of superoxide dismutase (SOD) and catalase (CAT) and causes a remarkable decrease in liver homogenate. Stem and bark of *N. arbor-tristis* exhibits anti-diabetic activity in streptozotcin- nicotinamide administered diabetic rats. In addition, a dose-dependent decrease was also seen in the levels of blood glucose.[14-15] The aqueous concentrate of flowers showed significant inhibition of the absorption of glucose from the intestine and decrease the total cholesterol levels and triglycerides. The flower extracts showed remarkable hypoglycemic and hypolipidemic activities and thus can be considered as an alternative method of therapy for the treatment of diabetes.[16]

Immuno-Stimulant Effect:
The alcoholic extracts of various parts of *N. arbor-tristis* exhibited enhanced antigen specific and non-specific immunity through an enhancement in the delayed and humoral and hypersensitivity. Flower has shown to possess immuno-stimulant activity. They activates the cell mediated immune system, while the aqueous leaves extract activate both humoral and cell mediated responses.[17] In another study, the aqueous extract of the flower had shown promising effect in the induction of cytokines and proliferation of splenocytes and thus exhibited a profound immunomodulatory effect in Swiss albino mice and Wistar rats.[18]

Antiviral Effect:
Alcoholic fractions of *N. arbor-tristis* showed promising activity against Encephalomyocarditis and Semliki Forest virus which are known to cause encephalitis. In addition, Arbortristoside A and C, the two important constituents that were isolated from the plant had shown remarkable cytopathogenic effect against these viruses.[19]

Antispasmodic and Anthelmintic Activity:
Ethanolic extracts from various parts of the plant was examined for antispasmodic activity using ileum of guinea pig which works in opposition to acetylcholine. Anthelmintic action was done using the technique reported earlier utilizing night crawler (*Pheretima*

posthuma). The concentrates shows antispasmodic movement, which was not as much as piperazine citrate, the standard drug used for the study. The ethanolic extracts of the flowers and seeds showed good antispasmodic effect by inhibiting the motility by relaxing the responses to contractile activity of acetyl choline.[20] In another study, the acetone extract of the leaves have shown a dose dependent anthelmintic activity using *Pheretima posthuma* as the model worm.[21]

Anti-Leishmanial Activity:

Among the folk lore herbs, *Nyctanthes arbor-tristis* have shown significant activity against *Leishmania donovani*.[22] The anti-Leishmanicidal activity of *N. arbor-tristis* has been attributed because of arbortristosides A, B, and C and 6-β-hydroxyloganin.[23] These iridoid glucosides have shown significant inhibition against trypanothione reductase (TryR), which is a notable enzyme present in the parasite.[24].

Anti-histaminic Activity:

The alcoholic extracts of the plant was found to exhibit positive effect during allergic conditions. The phytochemical constituents like arbortristoside A & C have shown notable anti-passive cutaneous anaphylaxis and mast cells stabilizing effect.[25] In a similar study, Nirmal et al. reported the antihistaminic activity using the bark of the plant. Among the extracts tested, petroleum ether extract significantly reduced the clonidine-induced and haloperidol-induced catalepsies, thus established the antihistaminic effect and its usefulness in the treatment of asthma.[26]

CNS Activity:

Saxena and coworkers studied the tranquilizing and purgative action of the aqueous soluble portion of the ethanolic concentrates of the leaves. It was observed that the extract exhibited remarkable improvement in the sleeping time and thus depressed the spontaneous motor activity. In addition, the extract showed notable purgative action.[27]

Anti-inflammatory and Analgesic activity:

Saxena et al, studied on the aqueous portion of the alcoholic concentrate for the anti-inflammatory activity. It was reported that the extract inhibited the oedema formation and also significantly reduced the acute and chronic phases of arthritis in mouse models.[28] In another study, the ethanolic extract showed a dose dependent analgesic activity in rodents.[29] Interestingly, it is believed that the flavonoids present in the plant is known to inhibit the pain mediators like prostaglandins, to exert the analgesic and anti-inflammatory activity in the animal models.[30] In another study, it was reported that β-sitosterol which was present in the petroleum ether fraction was responsible for the analgesic and anti-inflammatory activities.[31]

Antibacterial activity:

Organic solvent extracts of various parts of the plant were subjected to antibacterial studies using different Gram positive and Gram negative organisms. The antimicrobial activities were exhibited due to the presence of different phenolic and glycosidic constituents.[10] In addition, the petroleum ether extracts of flowers also showed cytotoxic activity.[32] In a similar study, the aqueous extract showed better sensitivity against *Pseudomonas testosteroni*.[33] Chouhan et al. reported the antibacterial efficacy of different extracts of *Nyctanthes arbotristis* against *Pseudomonas aeruginosa*, *Listeria monocytogenes*, *Staphylococcus aureus*, *Klebsiella pneumonia*, *Staphylococcus epidermidis.*[34]

Geetha et al. studied the antimicrobial effect of alcoholic and water extracts of the leaves against different pathogenic bacteria. It was observed that the ethanolic fractions showed enhanced antibacterial activity compared to the aqueous the aqueous fractions.[35] In a similar study, different organic solvent extracts of leaves and seeds exhibited remarkable effect against different Gram positive and Gram negative bacteria.[36,37,38] Gogoi et al. prepared silver nanoparticles utilising the alcoholic extracts of flowers and reported the effectiveness on *E. coli* MTCC 443 for antibacterial activity and cytotoxic activity on mouse fibroblastic cell line (L929).[39] Sathiya et al. demonstrated the antibacterial studies of the ethanolic extracts of the plant against different microorganisms like *Salmonella typimurium*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Escherichia coli*, *Streptococcus* sp., *Bacillus subtilis* etc. [40]

Antifungal Activity

Jamdagni et al. synthesized zinc nanoparticles using the flower extract of the plant. The antifungal efficacy of the synthesized nanoparticles were studied using different pathogenic fungal strains namely *A. niger* (ITCC 7122), *A. alternata* (ITCC 6531), *B. cinerea* (ITCC 6192), *F. oxysporum* (ITCC 55) and *P. expansum* (ITCC 6755) and good activity was observed against the fungal pathogens.[41]

Hepatoprotective activity:

The aqueous and alcoholic extract of *N. arbor-tristis* leaves was studied for the hepatoprotective action against carbon tetrachloride induced hepatic damage. The extracts markedly reduced the increased levels of the biochemical parameters.[42] Deshmukh et al. on a similar study reported the hepatoprotective action of the ethanolic extract of the leaves. It was reported that the extract exhibited hepatoprotectivity by inhibiting the

reactive oxygen species that were involved in the hepatotoxicity.[43]

Anticancer Activity:

Pandeti et al. isolated few iridoid derivatives from *N. arbor-tristis* and studied the cytotoxic efficacy against different cancer cell lines. Among them, 7-O-trans-cinnamoyl 6β-hydroxyloganin and its derivatives showed moderate activity against MCF-7 and Hep G2 cell lines *via* a caspase dependent apoptosis.[44] Benzofuranone compound was isolated from the *N. arbor-tristis* flowers and studied the cytotoxic activity against brine shrimp lethality assay and the benzofuranone also exhibited promising antimicrobial activity towards various Gram positive and Gram negative organisms.[45]

Miscellaneous Activity:

Gupta et al. studied the efficacy of methanolic concentrate of the bark of *N. arbor-tristis* on the spermatogenesis of male albino rats. It was reported that the extract significantly suppressed the motility and density of the sperm. In addition, it altered the diameter of the seminiferous tubules as well as decrease in the Sertoli cells.[46] In a different work, the chloroform and methanol extracts *N. arbor-tristis* exhibited larvicidal activity against *A. aegypti, C. quinquefasciatus, and A. stephens.*[47] The chloroform extract and NCS-2, a compound isolated from the flowers were studied for their larvicidal activity against *Culex quinquefasciatus* and the results showed significant activity against the vector.[48]

CONCLUSION:

It has been found that *Nyctanthes arbor-tristis* contains important phytochemical constituents and the same has been explored for its medicinal uses. The present study compiles the different phytochemical constituents reported so far and also the different pharmacological activities exhibited by different parts of the *Nyctanthes arbor-tristis.* This review seems to help the researchers to acquire more insights about the important phyto-constituents and the important biological activities exhibited so far by *N. arbor-tristis.* Thus, it is observed that the plant can thus be considered as an important traditional remedy for different pathological conditions. Further, researches may be carried out to isolate the biologically important phytochemicals and thus paves way for new drug discovery.

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CONFLICTS OF INTEREST:

The authors declare that they have no conflicts of interest.

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