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Review article

# Phytochemicals from Nyctanthes arbor-tristis and their biomedical implications

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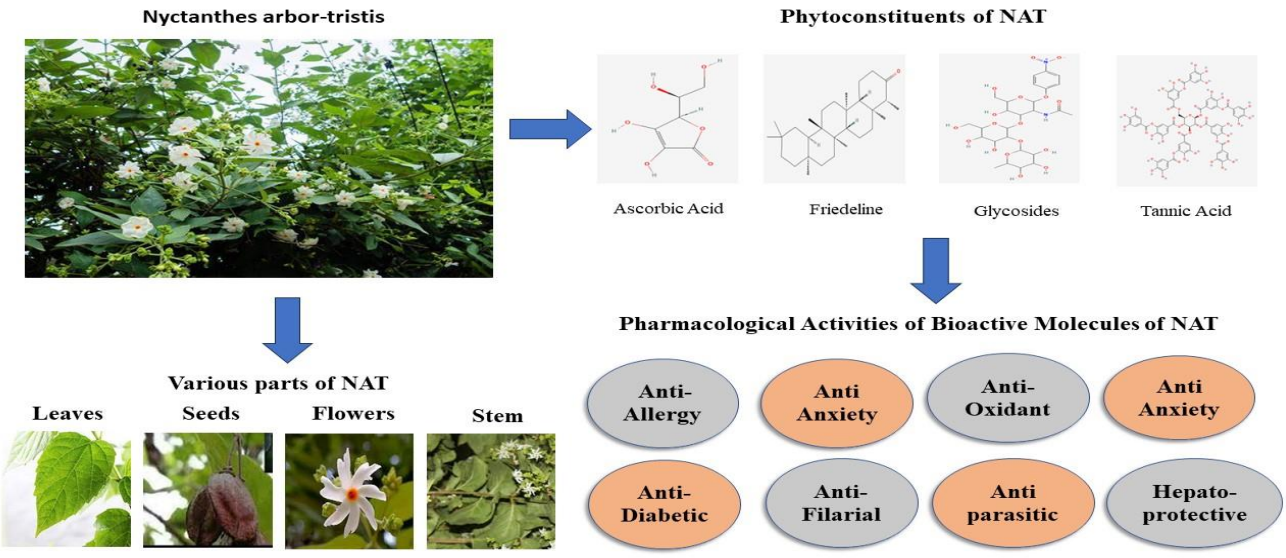
## ABSTRACT

The list of most useful Indian traditional medicinal plants includes Nyctanthes arbor-tristis, popularly known as Night jasmine. It is widely distributed in the sub-Himalayan regions and south of the Godavari.Each component of the plant has some significant medicinal value and can therefore be used for profit. The present review article illustrates an updated account of the analysis of different pharmacophores from the plant, N. arbor-tristis, and their potential biomedical applications. The significant pharmacological activities of different parts of the plant such as seeds, leaves, flowers, bark, and fruits, have been studied. Numerous phytochemicals contained in this plant including glycosides, flavonoids, essential oils, oleanic acid, carotene, tannic acid, lupeol, friedelin, benzoic acid, and glucose, have been studied and tested for their potential anti-inflammatory, hepatoprotective, anti-viral, anti-leishmaniasis, anti-pyretic, anti-fungal, anti-malarial, and anti-histaminic activities of N. arbor-tristis. Further, extensive research is required to unravel their effective medicinal applications against varied serious diseases.

**Keywords:** Night jasmine, Pharmacological activities, Medicinal plants, Phytochemicals.

**Graphical Abstract**



## INTRODUCTION

Plants' capacity to produce a diverse range of secondary metabolites is essential for satisfying human needs [1]. One such plant, "*Nyctanthes arbor-tristis*" (NAT), popularly known as parijat, coral jasmine, harsingar, and queen of the night belongs to the 'Oleaceae' family. It is recognized for its pleasant scent and decorative potential. The scientific botanical name for this plant, Nyctanthes, is derived from the Greek words for night, Nykhta, and flower, Anthos. In part due to the fact that its blossoms only bloom at night and fall off during the day, this plant is often called "the sad tree" or "tree of sorrow." Thus, the plant appears to be completely devoid of life during the day. In both ancient and modern times, "Night jasmine" has been used for its therapeutic properties. Throughout history, people have found practical applications of its leaves, stalks, roots, flowers, fruits, and seeds. Using the leaves of this plant, Ayurveda practitioners have treated many health ailments some of them being sciatica, joint discomfort, cough, persistent fever, arthritis, parasitic worms, rheumatism, constipation etc. [2].

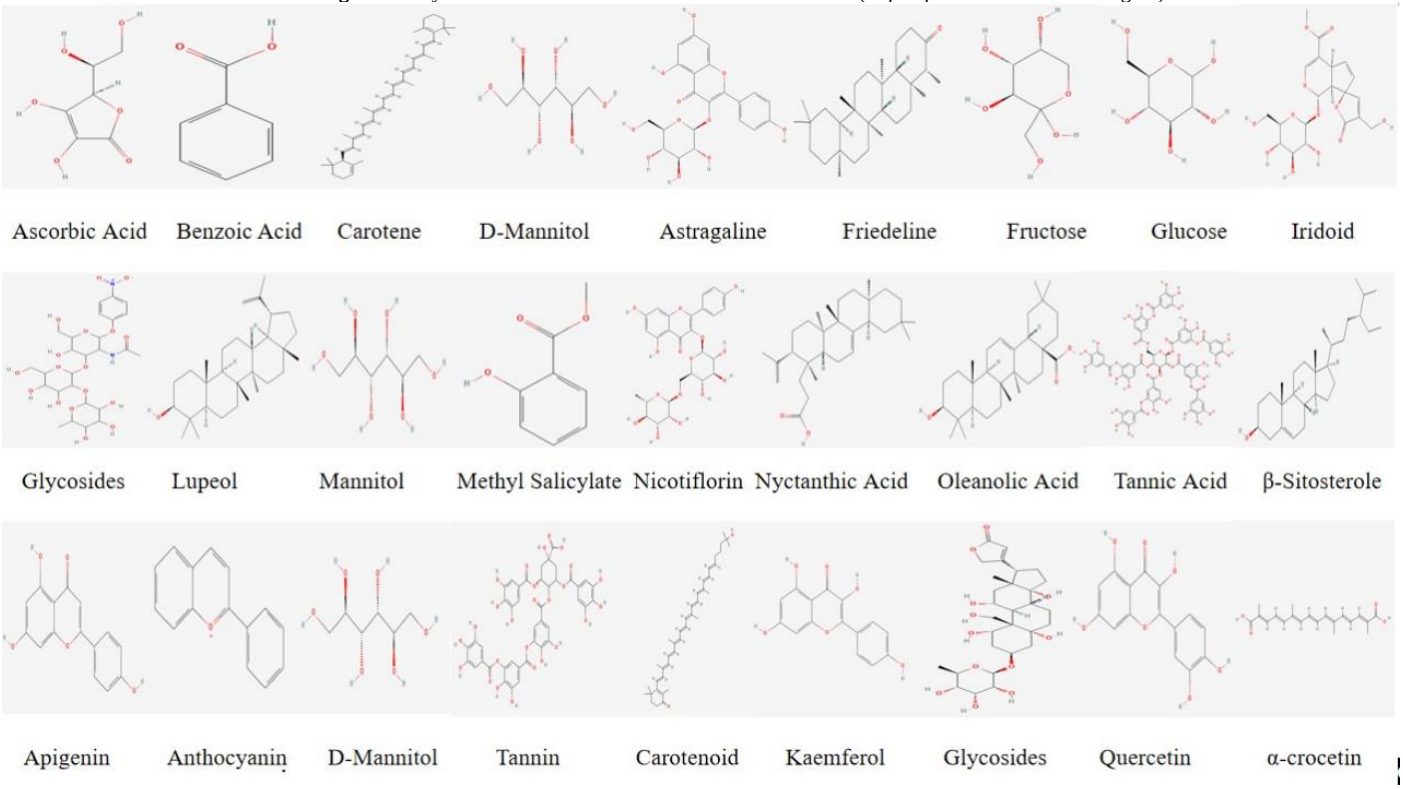
The flowers from the NAT have been employed to treat a variety of health issues including abdominal pain. The healing from chronic cough, gas production, high bile discharge, and irregular bowel movements can also be aided by NAT flowers.The powder made from the NAT tree's stem bark is useful in the treatment of several clinical conditions related to fitness and health, such as rheumatic joint pain, pneumonia, snakebite, malaria, allergic reactions, and biotic toxicity [2]. The information on the pharmacological activity, ethnobotanical applicability of bioactive chemicals, their toxic effects, significance in nanosciences, monetary value, and the knowledge gaps have been addressed in this review.

Ecologically, *Nyctanthes arbor-tristis* is native to India and can be found in different states such as the Andaman and Nicobar Islands, Madhya Pradesh, Uttar Pradesh, and the southernmost state of Rajasthan [3].The Indo-Pakistan peninsula, tropical and subtropical South East Asia, and Bangladesh are just few of the areas you could come across this tree in the wild. Several Indo-Malayan regions, like Burma, the Terai tracts, and Ceylon, have also shown signs of NAT cultivation. In addition to its usual habitat of wet evergreen woods, it has been spotted in dry deciduous forests in Thailand and elsewhere [4]. The plant is versatile, requiring only moderate soil moisture and growing well in either full sun or light shade. A plant's growth and health might be negatively affected by overwatering. Loamy soil is best because of its neutral pH and high-water retention capacity [5], which are conditions ideal for NAT growth.

### Phytoconstituents of *N. Arbor-trisitis*

Isolated and reported compounds from *N. arbor-trisitis* include terpenes, steroids, glycosides, flavonoids, alkaloids, and aliphatic chemicals [6]. Most of the plant's chemical constituents consist of secondary metabolites like glycosides and alkaloids [7]. Also, there are some phenylpropanoid glycosides and iridoid glycosides [8]. The iridoid glucosides A, B, D, and E have been isolated from its seeds [9].Researchers have discovered that these bioactive compounds can regulate immune responses and aid in the fight against leishmaniasis as shown in figure 1.

**Figure 1:** Phytoconstituents obtained from the *N. arbor-trisitis*(https://pubchem.ncbi.nlm.nih.gov/)



**Phyto constituents of the leaves of *N. arbor-trisitis***

The leaves of *N. arbor-trisitis* contain numerous astringent, resinous, and coloring chemical components, including mannitol, tannic acid, methyl salicylate, carotene, an amorphous resin, and traces of volatile oil. Twelve to sixteen percent of its seed kernels are converted into the pale-yellow brown fixed oil that contains glucosides of linoleic, oleic, lignoceric, stearic, palmitic acid, and sitosterol [10]. Three unique benzoic esters of Loganin and 6- hydroxyloganin, called arborside-A, arborside-B, and arborside-C, have been isolated from its leaves. Together with mannitol, amyrin beta-sitosterol, astragalin, benzoic acid, hentriacontane, nicotiflorin, friedelin, nyctanthic acid, oleanolic acid, and lupeol, the leaves contain the alkaloid nyctanthine. [11].

**The phytoconstituents from stems of *Nyctanthes arbor-tristis***

The stem of the plant contains a sweetener, sugar, or sugar substitute. The chromatographic separation of a chloroform extract of the stem yielded amyrin, arbortristoside-α, oleanolic acid, nyctoside-α, nyctantic acid, and 6-hydroxyloganin [11].

**The phytoconstituents from seeds of *Nyctanthes arbor-tristis***

The seeds of *Nyctanthes arbor-tristis* containan abundance of sugars such asD-glucose and D-mannose, as well as a polysaccharide, glucomannan. Arbortristoside-A, arbortristoside-B, arbortristoside-C, and 6-hydroxyloganin are all iridoid glucosides that have been found in its seeds. Two more minor iridoid glucosides i.e.arbortristoside-D and arbortristoside-E have been found in *N. arbor-tristis*. Besides iridoid glucosides, only phenyl propanoid glucoside has been identified so far [11].

**The phytoconstituents from flowers of *N. arbor tristis***

Chemically similar to jasmine, N. arbor tristis has an essential oil in its flowers that is high in the 10 modified diterpenoid nyctanthin, anthocyanins, and flavonoids [25]. The carotenoids abound in the tubular calyx of the flower and are often known as the nectary. It contains the antiplasmodialcyclohexylethanoidrengyolone in addition to the well-known iridoid glucosides i.e.arborside-C, 6--hydroxyloganin, and nyctanthoside. *Forsythia suspansa* (Oleaceae) was the first plant to produce rengyolone, a crucial ingredient in the illegal narcotic rengyo. It has been reported that the African medicinal plant, *Halleria lucida* (Scrophulariaceae), contains a cytotoxic ingredient called halleridone (cornaceae). It was discovered that Arborside-C underwent an isomeric structural change over time, changing the benzoate group to C-6-OH, referred to as an isoarborside-C [11].

**The Phytoconstituents from Roots of *N. Arbor Tristis*.**

The roots of the plant contain many active chemical ingredients including alkaloids, tannins, and glucosides. The chloroform extracts of its roots have been used to isolate both beta-sitosterol and oleanolic acid [9]. The presence of several phytoconstituents in various parts of the plant, *N. arbor-tristis*, has been demonstrated in Table 1.

**Anti-Allergic activities of *N. arbor-tristis***

The guinea pigs exposed to histamine aerosol, a water-soluble element of the alcoholic extract of *N. arbor-tristis* leaves, has been reported to significantly reduce the onset of asphyxia. Some workers have reported that arbortristoside A and C, found in *N. arbor-tristis*, are effective against allergies [12].

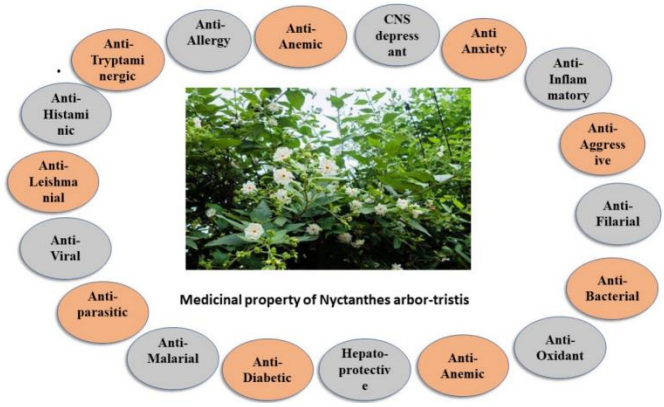
**Table 1:** The phytoconstituents present in various parts of the plant, *N. arbor tristis*

| Plant parts | Phyto-constituents |
|---|---|
| Flower oil | Anisaldehyde, Phenyl acetaldehyde, p-cymene, 1-deconol, 1- hexanol methyl heptanone, α-pinene. |
| Seeds | 3-4 Secotriterpene Acid, a Pale Yellow Brown Oil (15%), Arbortristoside A & B, Nyctanthic Acid, Lignoceric, Myristic Acids, Glycerides of Linoleic Oleic, Palmitic, Stearic. |
| Leaves | Nicotiflorin, D-Mannitol, Flavanol Glycosides-Astragaline, Friedeline, Fructose, Oleanolic Acid, Iridoid Glycosides, Tannic Acid, Mannitol, Methyl Salicylate, Carotene, Nyctanthic Acid, Glucose, Lupeol, β-Sitosterole, Ascorbic Acid, Benzoic Acid. |
| Bark | Glycosides, Alkaloids. |
| Stem | Glycoside-naringenin-4'-0-β-glucapyranosyl-α-Xylopyranoside,β-sitosterol. |
| Flowers | Apigenin, Essential Oil, β-monogentiobioside, D-Mannitol, Tanninm, Glucose, Carotenoid, Anthocyanin, Rengylone, Nyctanthin, Glycosides, Quercetin, Kaemferol, α-crocetin (or crocin-3), β-monogentiobioside-β-D, β-digentiobioside. |

**The pharmacological activities of bioactive molecules isolated from *n. Arbor tristis***

The NAT has been acknowledged as a promising therapeutic or curative treatment source in the Ayurvedic, Siddha, and Unani medical traditions. Furthermore, its metabolic analysis has recently encouraged its extensive use in therapeutic pharmacological applications (Figure 2).

**Figure 2:** The medicinal properties of *Nyctanthes arbor-tristis*




**The anti-anxiety property of the extract of *N. arbor-tristis***

Anxiety can be alleviated with the use of *N. arbor tristis* (NAT) hydroalcoholic extracts. A hydroalcoholic mixture was used to extract the *N. arbor tristis* plant parts, which were then concentrated by distilling off the solvent, dried by evaporation on a water bath, and stored in an airtight container in the fridge until needed [13].

**The anti-inflammatory activity of *N. arbor-tristis***

Acute and subacute anti-inflammatory activity was found in the water-soluble fraction of the alcoholic extract of *N. arbor-tristis* leaves, as well as in the extracts of the stem and seeds. Acute anti-

inflammatory activity on inflammatory models in the rat's hind paw was tested using phlogistic agents like carrageenan, formalin, histamine, 5-hydroxytryptamine, and hyaluronidase.Using the cotton pellet tests and granulomapouch, researchers discovered that *N. arbor-tristis* dramatically reduced granulation tissue 42 development in the sub-acute animals. In addition, it has been observed that *N. arbor-tristis* can mitigate the redness and swelling caused by the purified tuberculin reaction and Freund's adjuvant arthritis immunological procedures [14].

**The anti-aggressive activity of *N. arbor-tristis***

The fresh juice extracted from the plant's leaves was found to be effective against malaria. The anti-amoebic and anti-allergic properties of the 50% ethanolic extract from the seeds, leaves, roots, flowers, and stems have been demonstrated. The extracts from the plant showed anti-inflammatory, analgesic, antipyretic, and ulcerogenic properties. The flowers, seeds, and leaves of the plant have been studied for their immunostimulant effects. *In vitro* and *in vivo* studies have shown that the water-soluble fraction of an ethanolic extract has anxiolytic, antihistamine, purgative, and tumor necrosis factor-suppressing effects. It has been found that the extracts from the seeds of *N. arbor-tristis* may exhibit antitumor activity [15].

**The anti-filarial activity of *N. arbor-tristis***

The larvicidal activity against the common filarial vector, *Culex quinquefasciatus*, has been observed with both the pure compound isolated from the *N. arbor tristis* and a chloroform extract of its flowers [16].

**The antibacterial activity of *N. arbor-tristis***

Across the world, infectious diseases contribute to the leading causes of premature death. Multiple drug resistance is increasingly widespread in many species, including *Staphylococcus aureus, Staphylococcus epidermis, Salmonella typhi*, and *Salmonella paratyphiA.* This is because many different types of pathogens are turning to be resistant to antimicrobial drugs. The minimum inhibition concentration (MIC) values for *Staphylococcus aureus, Staphylococcus epidermis, Salmonella typhi*, and *Salmonella paratyphiA* were found to range between 1 and 8 mg/ml when exposed to a methanolic extract of *N. arbor tristis* leaf. The MIC and zone of inhibition values for the extracts were determined and compared to those for the commonly used drugs fluconazole and ciprofloxacin. It has been observed that there was only antibacterial action with the petroleum ether and ethanol extracts, but there was only antibacterial and antifungal activity in the chloroform extract [17].

**The anti-oxidant activity of *N. arbor-tristis***

Some workers have used the diphenyl-picryl-hydrazyl (DPPH) assay *in vitro* to test the antioxidant capacity of the various *N. arbor tristis leaves* extracts. The formation of 1, 1-diphenyl-1, 2-picrylhydrazine was detected at 517 nm. It was generated when plant extracts reacted with DPPH, a stable free radical. Two popular plant extracts, ascorbic acid and beta-hydroxytoluene (BHT), have been reported to inhibit the scavenging power of the DPPH radical through the following mechanisms: The percentage of ascorbic acid was found to be 93.88% at a dose of 10 mg, while the levels of BHT, butanol, ethyl acetate, and petroleum ether were found to be 97.42%, 95.22%, 84.63%, and 82.04% at a dose of 100 mg, respectively. Depending on their concentration, the *N. arbor tristis* leaf extracts exhibited free radicals scavenging potential [18].

**The anti-cancer activity of *N. arbor-tristis***

Extracts of fruit, leaves, and stems of N. arbor tristis were soaked in methanol and examined for their anticancer properties. At a concentration of 30 mg/ml, the methanol extract of dried *N. arbor tristis* leaves inhibited pathogen-free breast cancer cell lines by 71%; at a concentration of 10 mg/ml, it inhibited them by 86%. The $IC_{50}$ values for a methanolic extract of *N. arbor tristis* dried fruit were 9.72 mg and 13.8 mg, respectively, against human breast cancer cell lines (MDA-MB 231) [19]. Its anticancer activity is thought to be caused by the phytochemicals like glycosides, tannins, phenols, and steroids, all of which can be detected in the dried fruit methanol of *N. arbor tristis* [20].

**The anti-diabetic activity of *N. arbor-tristis***

The anti-diabetic efficacy of the methanolic extract of *N. arbor tristis* root has been shown by some workers to be at par with that of diabetic control mice. The anti-diabetic activities of the extract were strong and reliable. For this extraction, they used 50g of root powder and 400 ml of methanol in a hot continuous extraction process that lasted 18h. The methanolic extract was filtered and partitioned with petroleum ether to remove contaminants. The solvent evaporated under high pressure, and the material was dried in a hover. The hypoglycemic efficacy of the *N. arbor-tristis* dried extract was evaluated. After seven days of treatment at 500 mg/Kg, it reduces blood glucose levels in rats more effectively than normal medicine. It has been shown that a methanolic extract of the roots of *N. arbor-tristis* was more efficient than conventional treatment for reducing blood sugar levels [19].

**The anti-malarial activity of *Nyctanthes arbor-tristis***

Some workers have used a fresh paste produced from medium-sized *N. arbor-tristis* leaves to test its antimalarial activity. They used it three times daily for 7-10 days and healed the condition in 92 (76.7%) patients within 7 days. They observed that 20 out of 30 patients were cured in less than a week, while the other 8 did not respond to the treatment. The paste was well-accepted and had no significant adverse effects. The methanolic and chloroform extracts of leaves killed *Anopheles stephensi* larvae with $LC_{50}$ values of 244.4 and 747.7 ppm, respectively, when tested against three important mosquito vectors, *Aedes aegypti*, *Culex quinquefasciatus*, and *Anopheles stephensi*[14].

**The anti-parasitic activity of *Nyctanthes arbor-tristis***

A crude leaf extract in 50% ethanol is trypanocidal at a concentration of 1000 g/ml. The *in vivo* tests revealed that 300 and 1000 mg/Kg body weight considerably increased the median survival time of mice infected with *Trypanosoma evansi*. The potential anti-leishmanial activity of *N. arbor tristis* extract was also observed in the hamsters infected with *Leishmania donovani*. The extracts of seeds, leaves, roots, flowers, and stem from *N. arbor-tristis* were found to be effective against *Entamoeba histolytica* infections in the caecum of rats when used in a 50% ethanolic solution. However, the *in vitro* testing revealed that the extracts had no effect. The flowers, bark, seeds, and leaves of *N. arbor-tristis* were discovered to have anthelminthic activity [20]. This activity is assumed to be due to the plant's ability to restrict motility by relaxing and decreasing response to acetylcholine's contractile effect.

**The ability of the *Nyctanthes arbor-tristis* extractsto block Trypanosomes**

Researchers have found that a *Nyctanthes arbor-tristis* methanolic extract may inhibit the activities of Trypanosomes. The anti-trypanosomal activity *in vitro* and *in vivo* was evaluated using a leaf extract of *Nyctanthes arbor-tristis* that was produced in 50% ethanol. The extract was found to be trypanocidal in the study. The extract, when given intraperitoneally to sick mice at doses of 300 and 1000 mg/Kg body weight, dramatically prolonged their survival time, as shown by in vivo studies. However, the parasitaemia rapidly increased and ultimately proved fatal in the test animals soon after the extract administration was discontinued [21].

**The anti-viral activity of *Nyctanthes arbor-tristis***

Arbortristiside A and arbortristiside C, two pure substances isolated from *N. arbor-tristis*, have potent antiviral properties against Encephalo myocarditis virus (EMCV) and Semliki forest virus (SFV). The *in-vivo* ethanolic extract and n-butanol fraction at daily doses of 125 mg/Kg body weight, respectively, inhibited SFV infection in EMCV-infected mice [22]. The biological activity of *Nyctanthes arbor-tristis* extracts produced from various plant sections are summarized in Table 2.

**The anti-leishmanial activity of *Nyctanthes arbor-tristis***

Several researchers believe that arbortristosides A, B, and C, as well as 6-β-hydroxyloganin, do correctly responsible for the anti-leishmanial action of *N. arbor-tristis* [11]. Anti-leishmanial action against amastigotes in macrophage cultures and hamster test systems [52] was demonstrated by arbortristosides A, B, C, and 6- β -hydroxyloganin.

**The anti-histaminic and anti-Tryptaminergic activity of *Nyctanthes arbor-tristis***

Some workers have shown that the heavily protecting guinea pigs from asphyxiation brought on by histamine aerosols (2% at 300 mm Hg) were the alcoholic and aqueous soluble extracts of *N. arbor-tristis* leaves (4.0 and 8.0g/Kg oral). The anti-allergic chemicals like arbortristosid A and arbortristosid C were found present in the *N. arbor-tristis*[11].

**The anti-cholinesterase activity of *Nyctanthes arbor-tristis* extracts**

The effects on the activity of cholinesterase in the serum are more noticeable than that in the brain. There is little evidence of anti-muscarinic activity in acetylcholine-induced contractions of isolated rabbit ileum, as previously reported [53,54].

**Table 2:** Biological activities of the extracts derived from different parts of *Nyctanthes arbor-tristis*

| Biological Activity | Plant part used | Extract | Reference |
|---|---|---|---|
| Pain and inflammation | Flower, Leaf, and Fruit | Water soluble portion of ethanol extract, Petroleum-Ethanol, Ethanol | [23] |
| | Leaf, Seed and Fruit | Water soluble portion of ethanolic extract | [24] |
| Anti-oxidant | Leaf | Methanol, Acetone soluble portion of ethyl acetate extract, Ea-As, Aqueous, E-bf,Me-fl, | [25,26] |
| | Flower | Aqueous, Methanol and Aqueous | [27] |
| | Leaf and stem | Ethanol | [28] |
| | Flower, Calyx and Petal | Aqueous | [27] |
| Immunomodulation | Leaf | Aqueous, Ethanol | [29,30] |
| | Seed | Chloroform | [31] |
| | Leaf, Seed and Flower | 50% Ethanol and af | [32] |
| Anti-cancer | Leaf | 50% Ethanol, | [33] |
| Anti-diabetic | Leaf, Root, Leaf and Flower | 50% Ethanol, Methanol Chloroform | [34,35] |
| CNS modulatory | Leaf | Water soluble portion of ethanol extract Aqueous, 50% Ethanol, Ethanol and Aqueous | [36,37] |
| | Flower, Leaf, Seed, Flower and Bark | Infusion/ Ethanol | [6] |
| Hepato-protection | Leaf | Ethanol and Aqueous, Methanol | [38,39] |
| Anti-allergic | Stem-Bark, Flower, Root, Seed and Leaf | Petroleum, 50% Ethanol, | [23] |
| Diuretic | Flower, Leaf, Seed and Fruit | Ethanol | [6,40] |
| Wound Healing | Leaf | An ointment prepared from Methanol extract. | [19] |
| Anti-microbial | Leaf, Stem-Bark | Ethanol, Aqueous | [41] |
| Anti-bacterial | Leaf | Aqueous Methanol, Aqueous and Methanol, Ethanol | [42] |
| | Flower, Root-Bark | Chloroform, Ethyl acetate /Pe, Ethanol and Aqueous | [43] |
| | Leaf, Seed and Fruit | Chloroform and Ethyl acetate | [14] |
| | Flower and Seed | Chloroform and Ethyl acetate | [44] |
| Anti-fungal | Stem-Bark, Leaf and Stem | Chloroform, Ethanol | [45] |
| Antiviral | Seed | Ethanol | [46] |
| Anti-helminthic | Leaf, Leaf, Stem, Bark | 50% Ethanol, Juice/ Ethanol and Aqueous | [47] |
| Antiamoebic | Leaf, Seed, Flower, Fruit and Stem | 50% Ethanol, | [48] |
| Antimalarial | Leaf | 50% Ethanol, /Juice/ Decoction /Paste | [49] |

| | | | |
|---|---|---|---|
| | Leaf and Fruit, Root and Seed | Et / 50% Ethanol | [50] |
| Anti-trypanosomal | Leaf | 50% Ethanol, | [21] |
| Larvicidal | Leaf | Dcm | [51] |
| | Flower | Chloroform / Methanol and Chloroform / Petroleum | [52] |

**The anti-pyretic and anti-nociceptive activity of *Nyctanthes arbor-tristis***

The antipyretic properties of the extract have been demonstrated in a rat model of pyrexia caused by brewer's yeast. When administered orally to rats for six consecutive days, it resulted in stomach ulcers of varying severity depending on the dose. When tested using the rat tail flick and mouse tail-clip methods, the aqueous soluble fraction of the ethanolic extract of the leaves failed to elicit morphine-like analgesia but did show significant aspirin-like anti-nociceptive activity, as evidenced by the inhibition of acetic acid-induced writhing in albino mice [2].

**The anti-anemic activity of *Nyctanthes arbor-tristis***

According to the results of a hematological study conducted on ethanolic extracts of the plant's flowers, barks, seeds, and leaves, the hemoglobin content and red blood cell count were found to increase in rats in a dose-dependent manner. The hemogram profile of anemic rats was found to be maintained using the extracts [11].

**The CNS depressant activity of *Nyctanthes arbor-tristis***

Evidence suggests that a decrease in dopamine and an increase in serotonin level underlie the CNS depressant activity of ethanolic extracts of *N. arbor-tristis* leaves, flowers, seeds, and bark (600 mg/kg), as observed by significantly and dose-dependently extending the onset and duration of sleep. [11].

**The membrane stabilizing activity of *Nyctanthes arbor-tristis***

Ag-NY1, a carotenoid aglycone, isolated from the tubular calyx of *N. arbor-tristis* flowers has been shown to offer membrane stabilizing activity. After further study, the carotenoid molecule was determined to be crocetin, the primary aglycone in the stigma of *Crocus sativus*. This molecule exhibited a greater capacity for stabilizing membranes compared to its counterpart, glycoside and crocin[11].

**The hepato-protective activity of *Nyctanthes arbor-tristis***

Against $CCl_4$-induced hepatotoxicity, aqueous extracts of *N. arbor-tristis* leaves and seeds were found to have an anti-hepatotoxic effect [55,56]. Both the alcoholic and aqueous extracts were found to have significant hepatoprotective action by reducing blood levels of SGPT (serum glutamic pyruvic transaminase), SGOT (serum glutamic oxaloacetic transaminase), and serum bilirubin (total and direct). These results were supported by histopathological examinations of liver tissue, which demonstrated the extracts' ability to regenerate hepatocytes [57].

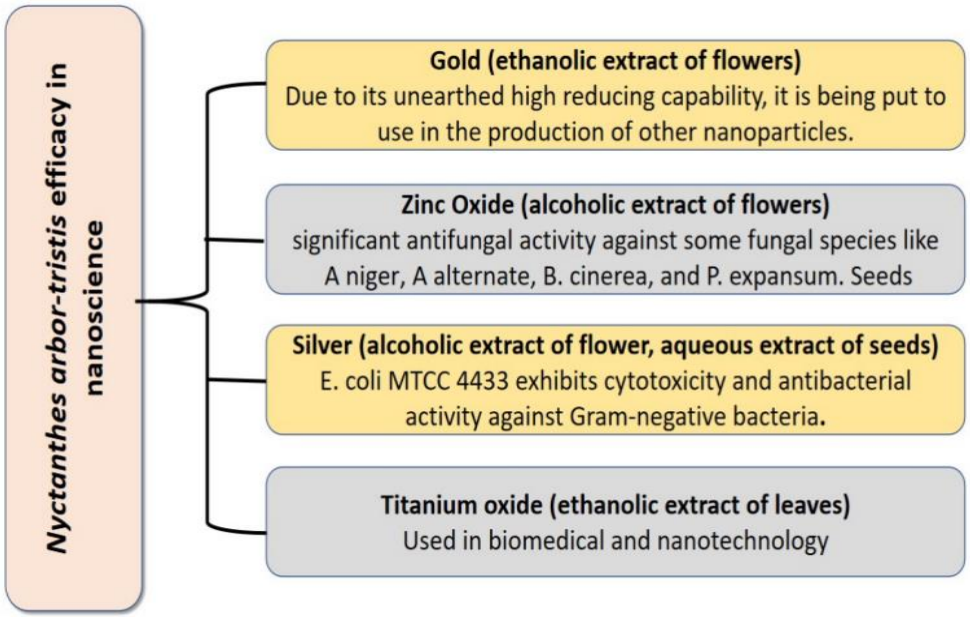
**The sedative activity of *Nyctanthes arbor-tristis***

The sedative effects of a hot infusion of the flowers were tested by some workers on rats. In this study, conscious sedative behavior was observed in male rats as a function of a certain dose but not in female rats. The blood sugar levels, muscle strength, and motor skills were not affected by these doses, even at the maximum amount. Nevertheless, glucose absorption from the gut was drastically decreased. Sedation was attributed in part to the extract's antioxidant and membrane-stabilizing activities [6].

**The biomedical application of *Nyctanthes arbor-tristis* for the treatment of gout, dry cough, and piles**

The seeds of the *N. arbor-tristis* are employed in the treatment of piles. *N. arbor-tristis* flower decoction is used to treat gout. To alleviate a dry cough, drinking some tea made from its leaves has been recommended. To treat skin disorders, especially ringworm, an aqueous paste made from the leaves is applied topically. Women take the young leaves as a tonic. In addition to its hypoglycemic impact, *N. arbor-tristis* has been shown to improve the efficacy of exogenous insulin in the streptozotocin-induced diabetic rat model.

**Figure 3:** Application and the efficacy of *Nyctanthes arbor-tristis* in nanoscience




**Application of *nyctanthes arbor-tristis* in nanoscience**

The synthesis of nanoparticles (NPs) has received enough attention in the recent past because of the lasting significance of their biological, optical, and chemical features. There is a lack of knowledge on the potential of various NAT plant parts for NPs production. The ethanolic extract of the NAT flower is utilized to synthesize gold nanoparticles and other nanoparticles due to its recently revealed strong reduction capability. The cytotoxicity and antibacterial activity of synthetic silver nanoparticles derived from alcoholic flower extract have been effectively evaluated against the Gram-negative bacteria *E. coli* MTCC 443. Zinc oxide nanoparticles (NPs) were also synthesized using the aqueous floral extract of NAT, and these NPs showed significant antifungal efficacy against several other types of fungi, including *Aspergillus niger, Alternaria alternate, Botrytis cinerea*, and *P. expansum.* Studies have demonstrated that the seeds of NAT (an aqueous extract) can be utilized to synthesize silver nanoparticles, which have applications in the biomedical field with catalytic capabilities [9]. It has been indicated that NAT is a viable source of metals and metal oxides for NP synthesis (Figure 3).

## CONCLUSION

The information available on the research carried out by several workers on *Nyctanthes arbor-tristis* has indicated that almost all the parts of this plant possess enormous therapeutic potential with enough pharmacological properties. *N. arbor-tristis* thus serves as a key source of many herbals and ayurvedic medicines for the successful treatment of numerous ailments. *N. arbor-tristis* is a widely cultivated shrub that can be used to treat bronchitis, sciatica, and fungal skin infections. The antibacterial, anti-inflammatory, anti-rheumatoid arthritis, and anthelmintic properties of leaves are noteworthy [58]. The flowers of *N. arbor-tristis* are bitter, astringent, ophthalmic, stomachic, and carminative. It exhibits febrifuge, tonic, bitter, mild purgative, and expectorant properties. The antipyretic, antibacterial, antiviral, anti-inflammatory, hepatoprotective, antihistaminic, anti-filarial, anti-oxidant, and immune-protective properties of phytochemicals contained in this plant have been revealed by several studies. *N. arbor-tristis* has shown a wide range of effectiveness against several pathogenic bacteria and viruses. However, still, more research is required to explore the biomedical implications of several other bioactive molecules isolated from *Nyctanthes arbor-tristis* to treat many severe diseases including cancer and bacterial/viral infections.

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## CONFLICT OF INTEREST

Authors have no conflict of interest

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