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THERAPEUTIC POTENTIAL AND PHYTOCHEMICAL PROFILE OF NYCTANTHES ARBOR-TRISTIS LINN: A REVIEW

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ABSTRACT

Nyctanthes arbor-tristis (Oleaceae), a mythical plant, is highly prized inAyurveda for its medicinal properties. Along with being employed as a laxative for rheumatism, and skin conditions, and sedative, this plant is commonly used as an anti-helminthic and antipyretic. Importantly, the locals grow it in their backyard passing on plants and the tradition of using it as medicine to future generations.

The objective of the review is to identify any research gaps and therapeutic possibilities by conducting an ethnopharmacological evaluation that focuses on chemical components, pharmacological effects, and toxicology data.

Keywords: *Nyctanthes arbortristis*, Chemical constituents, pharmacological actions, Bio-prospection.

1. INTRODUCTION

1.1 The Indian traditional system of medicine

Plants have been used as medicine from the beginning of humanity. The first documented usingherbal remedies for disease prevention and treatment "Rigveda," possibly the earliest system of medicine," is credited with curing illnesses. Between 4500 and 4700 B.C., a repository of human knowledge was written. between 1600 BC and 1600 BC The use of the term "Ayurveda"is found in a later work, the "Atherveda" The use of plants as medicine is more diverse, and "Ayurveda" is one of them. The defined qualities of medications and their effects are regardedas "Upveda". More information on the applications has been provided.

Traditional medical systems such as Unani and Ayurveda have provided us with innovative concepts and treatments in the field of healthcare. Traditional medicine's position in the management of many ailments has been widely established since ancient times. The ethnic communities living on the rolling plains' foothills and the world's great forests still employ therapeutic herbs in this way.

1.2 *Nyctanthes arbor-tristis L.*: Taxonomy and synonyms

N. arbor-tristis L. (Oleaceae) are little trees or shrubs with silky white hairs and strongly quadrangular juvenile branches. Leaves are opposite, oval, sharp or acuminate, rough, and covered with short, stiff hairs, border whole or a handful of huge prominent teeth, base round or just cuneate, major nerves visible beneath. Axillary, solitary, or in terminal short trichotomous cymes, the inflorescence is axillary, solitary, or in terminal short trichotomous cymes. Individual flowers open at dusk and close at dawn hands have an orange-red and whiteflower with five to eight lobes core. They are created in groups of two to seven, with individualblooms opening at twilight and closing at dawn. Fruits are compressed and enclosed in a capsule. The seeds are flattened and orbicular.

1.3 Traditional usage

N. arbor-tristis L. is a plant native to southern Asia, according to data from Germplasm Resources International. The plant's geographical distribution stretches from northern Pakistanand southern Nepal through northern India and southeast to Thailand, according to the Resources Information Network, Flora of Pakistan, and Agro-Forestry Tree Database. It's a tiny tree or shrub that grows up to 10 meters tall and has flaky grey bark. **(Chatterjee et al., 2007)** The plant *N. arbor-tristis L.* is reported to offer a diverse array of therapeutic properties. *Nyctanthes arbor-tristis* flowers are used to induce menstruation in India, Indonesia (Java), andMalaysia, the bitter leaves, however, are employed as a cholagogue, laxative, diaphoretic, bothdiuretics (Agroforestry tree database). The plant's leaves are opposite and simple, measuring 6–12 cm long and 2–6.5 cm wide. In children, a leaf's juice I utilized to remove threadworms and roundworms **(Chauhan et al., 1999)** piles, liver and biliary issues, chronic fever, malaria,intractable sciatica, rheumatism, and a lack of appetite diaphoretic are all treated with the leaf juice When administered with honey and common salt, one suggestion is fresh leaf juice as a safe purgative for infants. It is used as a diaphoretic and diuretic in fever and rheumatism in the form of an infusion in doses of two ounces **(Nadkarni, 1982).** The seed powder is used forscalp scurvy, alopecia, and as an anthelmintic. Bronchitis and snakebite are both treated with the bark Various portions that Nyctanthes arbor-tristis are tribal people in central India to treat cough.hiccup, dysentery, snakebite, and sores Scabies and other skin conditions ailments are treated using inflorescence In Nepal, the herb has been utilized as a worm preventative this is nycthanthes arbortristis also known in Indian traditional medicine to have immunotoxic, antiallergic, antihistaminic, purgative, antimicrobial, and ulcerogenic properties, in addition to the functions listed above **(Annonymous, 1997).** It can also be used as a sedative and to treat Bilateral fevers Some elderly Buddhist monks in Sri Lanka uses a hot floral infusion for sedation for diabetes, a 300-500 mL decoction or dry herb in a quantity of 3–6 g is used orally in Myanmar.

Externally, crushed fresh leaves are used to relieve inflammation in ulcers and sores. (Annon.)It is leaf juice as an anthelmintic taken orally by the Jayantia tribes of India who live in Myanmar's borderlands, and the flower is taken as a honey substitute antispasmodic. **(Jaiswal,et al., 2010).** The plant's blooms have long been used as a digestive, astringent, anti-bilious, expectorant, carminative, and hair tonic, as well as to treat piles and numerous skin disorders. Bronchitis and snake bites are treated with the bark **(Aggarwal et al., 2011)**

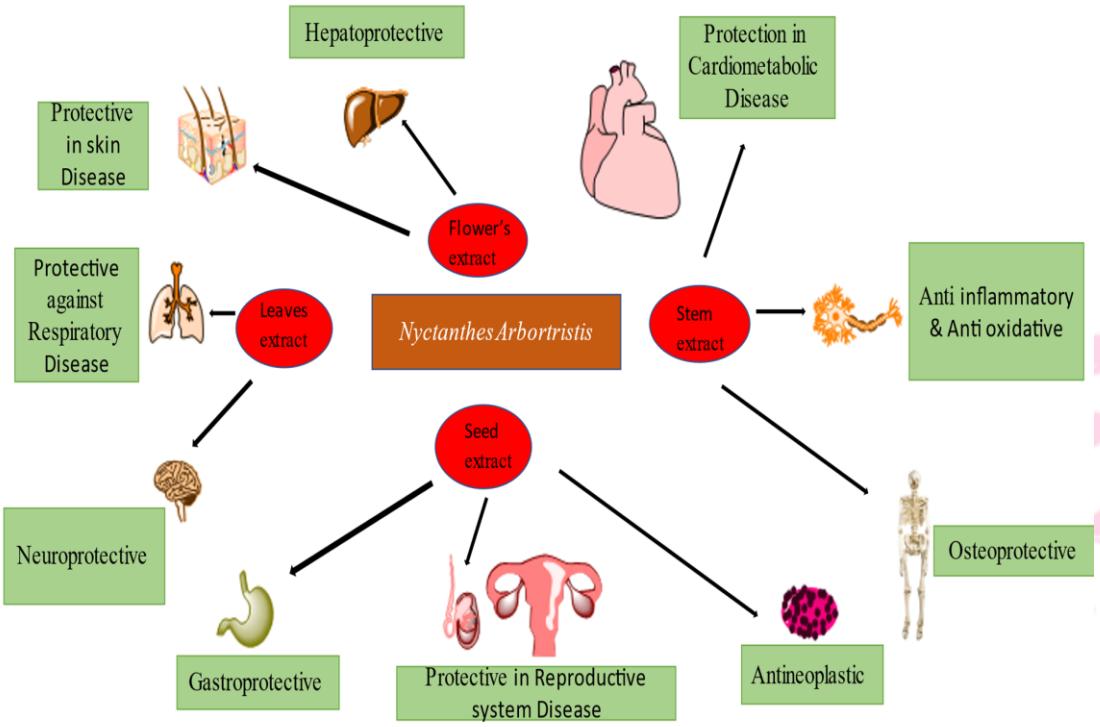
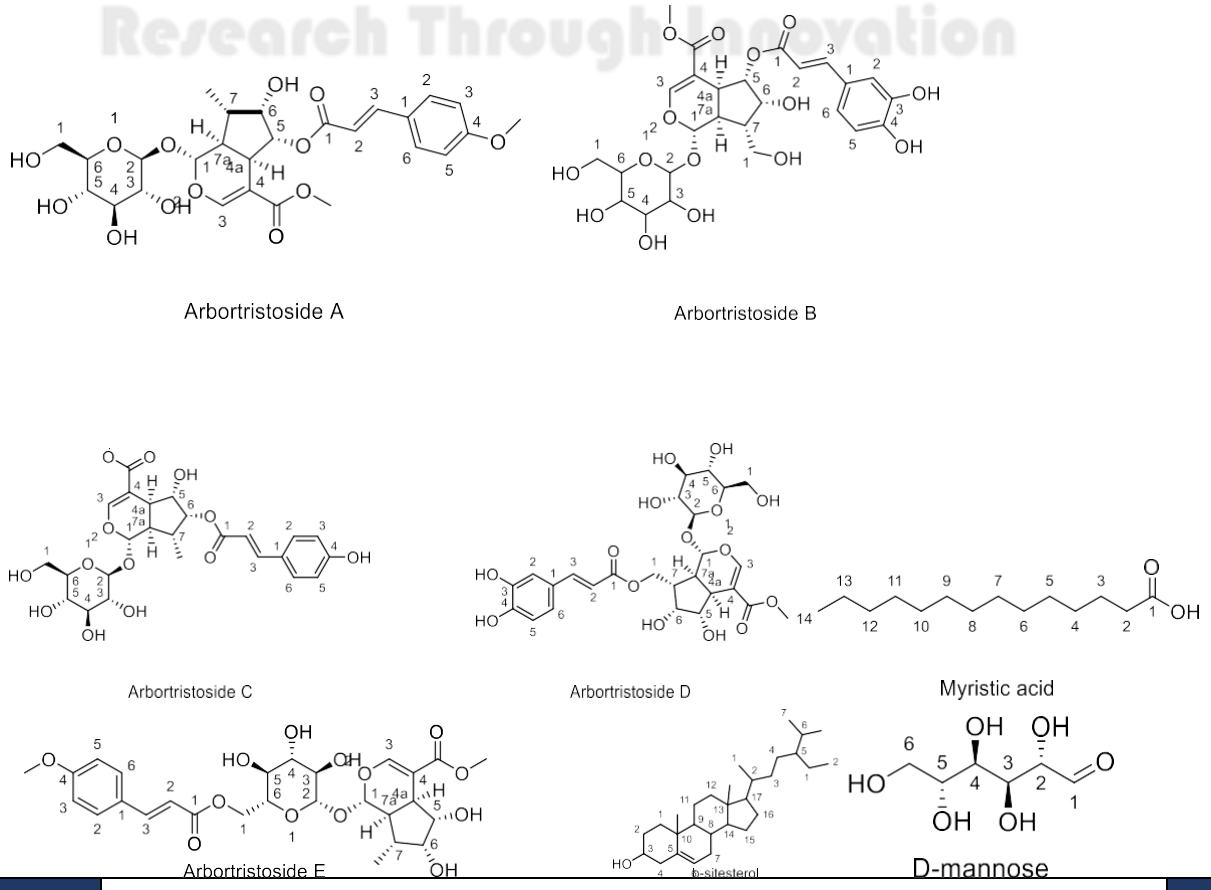


Figure 1: *Nyctanthes arbortristis* medicinal uses

1.4. Scope of the review

The traditional usage of it has been the plant in an assortment of ailments with the scientific studies gyrating this information. The need for a critical review of the gaps in scientific studiesin terms of phytochemical profile, pharmacological or toxicity studies It was felt that they couldbe linked to traditional claims.



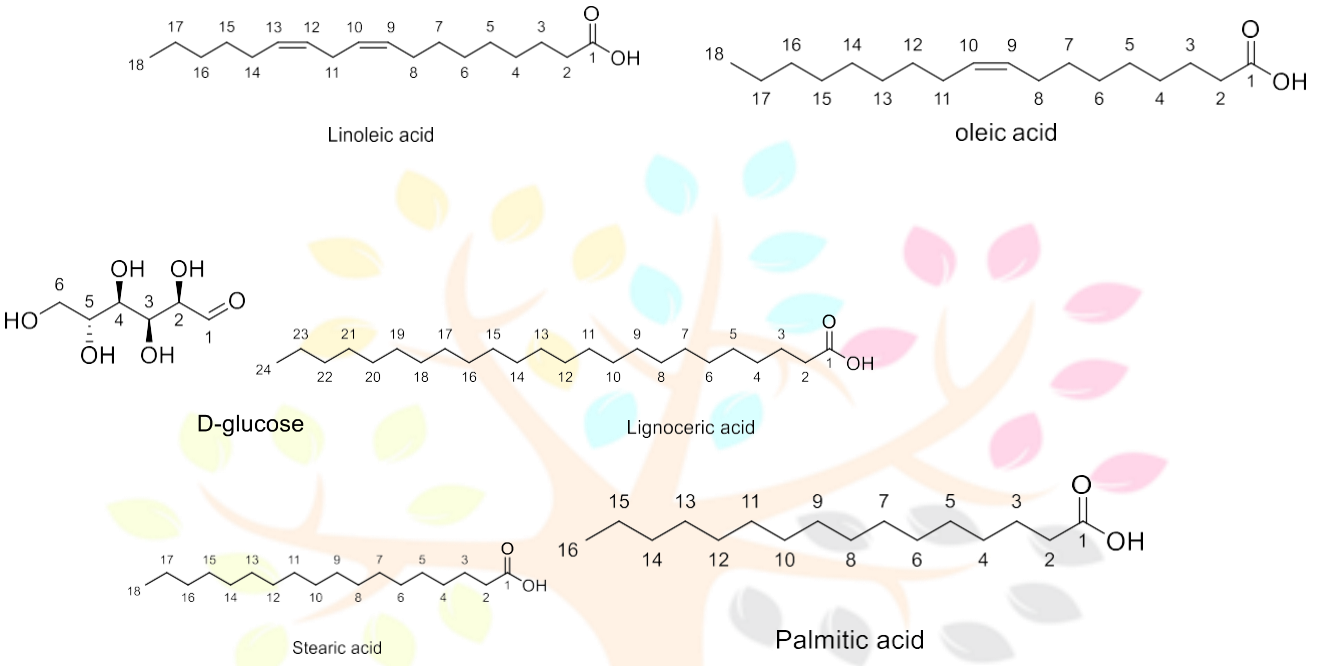
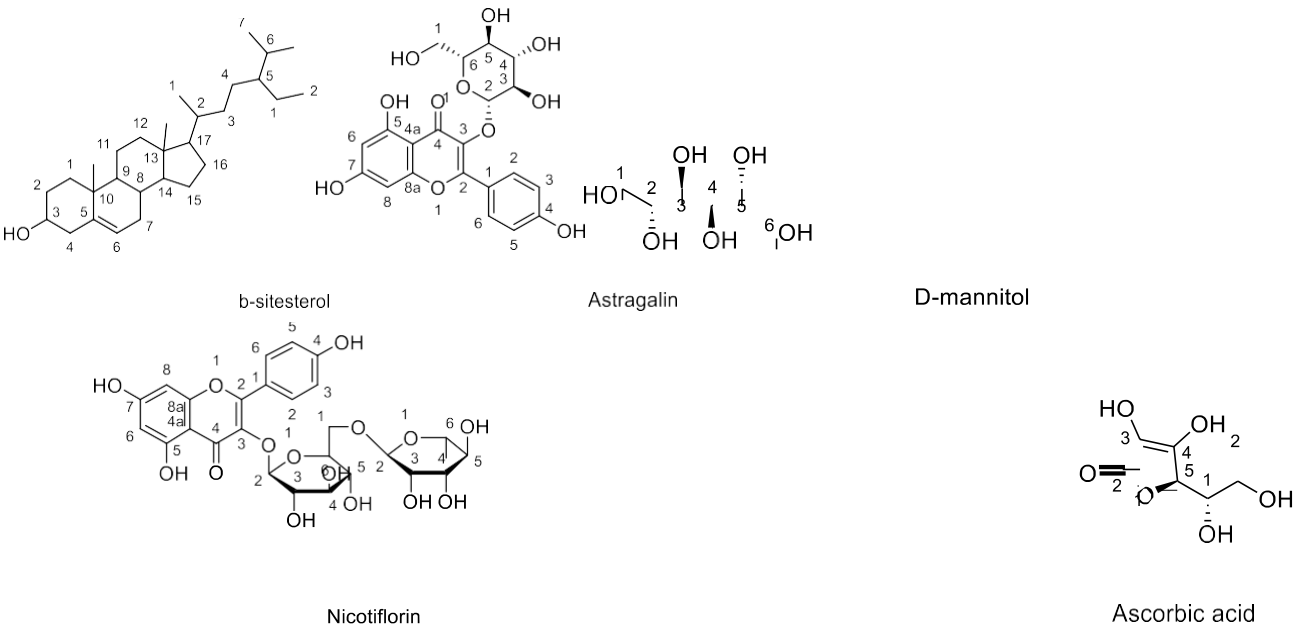


Figure 2. Compound isolated from seeds of *Nycthanthes arbortristis*

This review aims to bring together all of the existing material to conclude the therapeutic value of plants and the research gaps that need to be filled. **(Sasmal et al., 2007)** published a prior compilation that focused on the chemical makeup of the plant and its pharmacological actions. This review seeks to point researchers in the right way if they wouldlike to research the plant further the biological activities of the entities separated from various portions of the plant have been tabulated, and a separate table listing the biological activities has been created for the readers' convenience.

The numerous biological activities that were carried out for the scientific validation of the plant have been described in detail, along with any chemical constituents that were isolated. **(Anirban et al., 2013)**



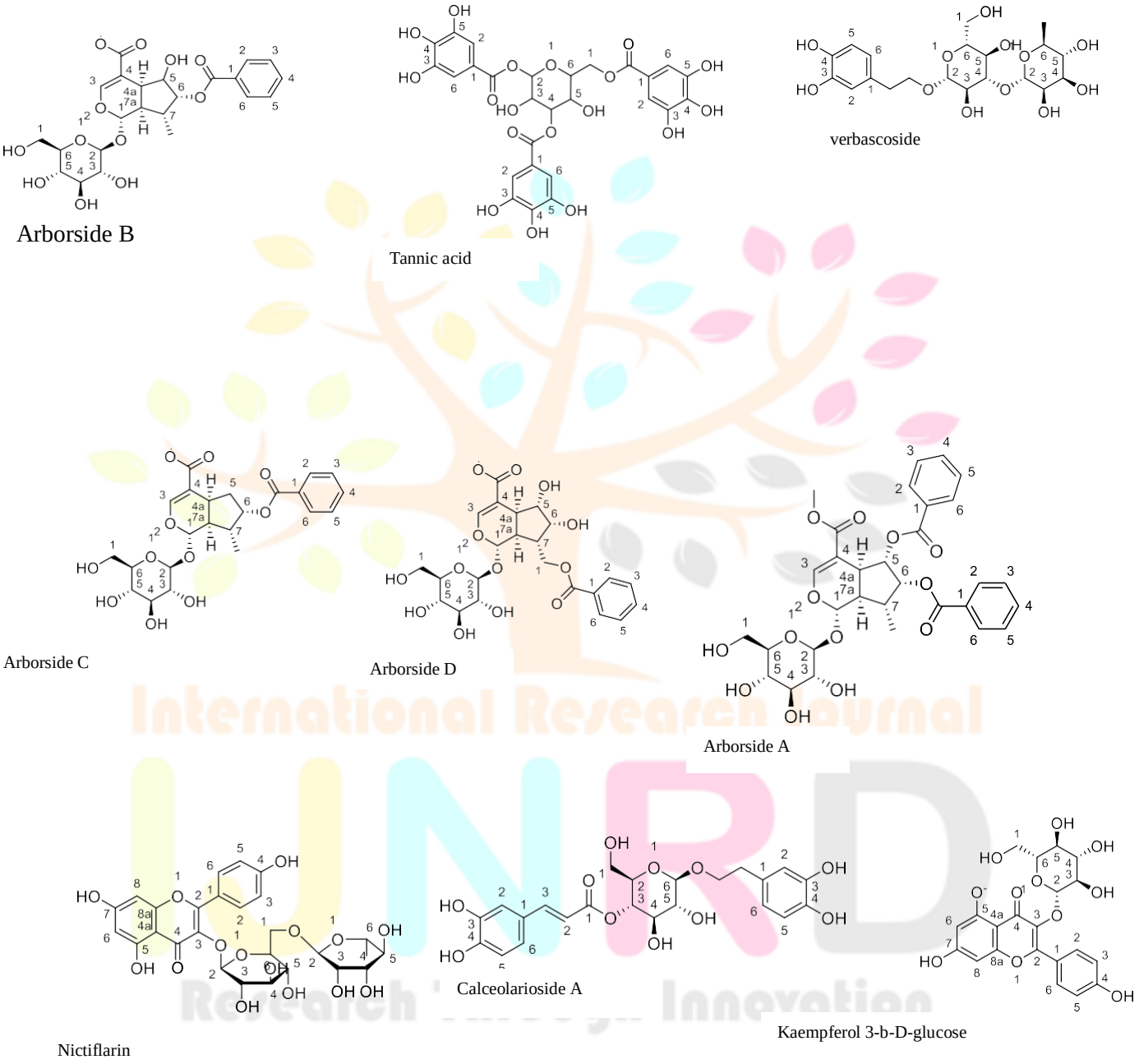


Figure 3. Compound isolated from the leaves and flower of *Nycthanthes arbortristis*

2. Nyctanthes arbortristis L. Pharmacological activity

2.1Anti-inflammatoryatory and analgesic effects

Ayurvedic practitioners have utilized the plant's leaves to treat arthritis and stubborn sciatica. The juices of its leaves have been used to treat acute, chronic, and intermittent fevers of various kinds **(Chopra et al., 1958).** reported an ethanol (absolute) extract of thehas anti-inflammatory properties in its water-soluble part plant's leaves in rats utilizing both immunogenic and non-immunogenic inflammatory models in experimental research caused by different phlogistic agents, such as carrageenan, formalin, histamine, 5- hydroxytryptamine hyaluronidase, and Freund's adjuvant. The doses that were considered ranged from 1–8 gm/kgbd. wt. The ethanolic extract's water-soluble portion was shown tohave anti-nociceptive effects similar to aspirin but not analgesia similar to morphine. Toxicity tests on the same fraction at five doses ranging from 2.0 to 32 gm/kg revealed a fatal dose (LD50) of 16 gm/kg. **(Saxena et al. 1984)**

Table 1. Biological activity of *nycthanthes arbortristis*

Plant part	Compound	Activity
Leaves	*Calceolariose*A 4-hydroxy hexahydrobenzofuran-7-one b sitosterol	AntileishmanialAnticancer Analgesic and anti-inflammatory
Flower	Rengyolone and its acetateNCS-2	AntimalarialLarvicidal
Seed	*A and B arbortristoside* *Arbortristoside* A, B, C And 6b-hydroxyloganin *Arbortristoside* A and C arbortristoside	Anticancer and hepatotoxicity Antileishmanial Anti-inflammatory Antiallergic ImmunomodulatoryAntiviral
Seed kernel	Iridoid glucosides (a, b and c)	Antileishmanial

Additionally, the same fraction showed an antipyretic effect but also caused a stomach ulcer inrats after being administered orally for six days in a row at concentrations b/w 0.5 to 8.0 gm/kg**(Saxena et al., 1987).**

Studies on the orange tubular calyx's pure carotenoid and ethanol (absolute) extract showed significant anti-inflammatory efficacy at 200 mg/kg in carrageenan-induced rat

Table 2. Chemical ingredients were extracted from various *Nyctanthes arbor-tristis* parts

Seed	Glycerides of palmitic, myristic, linoleic, oleic, lignoceric, stearic, and sterol, parasitosterol, vitamin A, and 3,4-secotriterpene acid (nycosterol) Terpene tetracycline (nyctanthic acid) Glycerides (trisaturated, disaturated, mono, di, and tri unsaturatedacid. A and B arbortristoside 4-O-b-D-mannopyranosyl-D-mannopyranose and O-b-D-glucopyranosyl-(1-4)-O-b-D- mannopyranosyl- (1-4)–O-b-D-mannopyranose Iridoid glycoside (Arbortristoside A) (I), *nyctanthic acid*, oleanic acid, friedelin, b-sitosterol glucoside, and 6 b- hydroxyloganin Arbortristoside D and E Water-soluble polysaccharides composed of D-glucose and D mannose *Arbortristoside* A and C Phenylpropanoid glycoside (*nyctoside A)* Stearic acid, lauric acid, linoleic acid, and oleic acid
Flower	Flowers Essential oil, nyctanthin, D-mannitol *Arborside* C, 6-b-hydroxyloganin, *nyctanthoside* D-mannitol and flavanoids (astraglin and nicotiflorin) Carotenoid glycoside (b-monogentiobioside ester of a-crocetin (or crocin-3), b-monogentiobioside-b-D monoglucoside ester of a-crocetin (crocin 2), b-digentiobioside ester ofa-crocetin (or crocin-1) Cyclohexylethanoid rengyolone; a new iridoid glucoside (6-O-trans-cinnamoyl-7-O-acetyl-6b-hydroxylaganin) Sugars and carotenoids Carotenoid aglycone (crocetin)
Leaves	Mannitol, an amorphous resin, glucoside, glucose, and essential oil Vitamin C and carotene Mannitol, b-amyrin, b-sitosterol, hentriacontane, and benzoic acid Flavanol glycosides- Astragaline (Kaempferol 3-glucoside), Nicotiflorin (kaempferol 3-rhamnoglucoside) Triterpenoid (oleanolic acid, *nyctanthic acid*, Friedline, lupeol tannic acid, ascorbic acid,methyl salicylate, an amorphous glycoside) Iridoid glycosides (*arborsides* A, B, C) Iridoid glycoside (6,7-di-O-benzonylnyctanthoside (I) and 6-O-trans-cinnamoyl-6-b- hydoxyloganin (II), 7-O-trans-cinnamoyl-6-b-hydroxyloganin) Phenylpropanoid glucoside (desrhamnosylverbascoside5) Iridoid glucoside (*arborside* D) Calceolarioside A Polyacetylenes and flavanol glycoside (quercetin-3,30-dimethoxy-7-O-rhamnoglucopyranose) Octacosane and 10-hydroxyl-30,4-dimethyl-1,10-bi (cyclohex-3-en)-2 oneb-sitosterol
Bark	Glycosides and alkaloids
Stem	Glycoside-naringenin-40-O-b-glucapyranosyl-a-xylopyranoside and b-sitosterol Flower oil a-pinene, p-cymene, 1-hexanol methyl heptanone, phenylacetaldehyde, 1-decanol,and anisaldehyde.

paw swelling **(Omkar et al., 2006).** The ethanolic extract's LD50 has been determined to be 1500 mg/kg. **(Saxena and Paul 1997)** found that oral treatment of the water-soluble part of theleaf ethanolic extract to arthritic mice at a dose of 100 mg/kg consistently reduced host plasmalevels of tumour necrosis factor (TNF-a) and interferon (IFN-g) in arthritic and Balb/cmice treated with soluble protein A (SpA) did not change the immunoglobulin (Ig)G

and IgMlevels,indicating the potential for its use about the TNF-a in clinical diseases. In a different study, **(Paul et al.,2002)** showed that-treating animals exposed to silica with leaf extract at 50 mg significantly reduced the amount of TNF-alpha that accumulated in the mice'sbronchoalveolarr lavage (BAL) fluid. A similar study **(Rathore et al., 2007)** that used bd. w t of the water- soluble component ethanolic extract of leaf and fruit to treat Freund's complete adjuvant- induced arthritis in mice suggested that it may function as a modulator of the balance betweenpro-and anti-inflammatory cytokines. The extracts were given an acute oral NOAEL (no observed adverse effect level) of 2000 mg/kg.

They discovered that an iridoid glycoside called *arbortristoside*-A had considerable (50 and 75mg/kg) and dose-dependent anti-inflammatory and antinociceptive activity, and they hypothesized that this activity may have been caused by the inhibition of prostaglandins **(Das et al., 2008a, b).** The substance's LD50 was determined to be 500 mg/kg. A recent study compared a standard medicine, pentazocine, at 10 mg/kg and paracetamol, at 50 mg/kg and thesame dose, to a percent petroleum ether extract of leaves 50 mg/kg and b-sitosterol derived fromthesame extract in a hot plate and acetic acid-induced Mouse writhing test comparative anti- inflammatory efficacy to ibuprofen at 50 mg/kg **(Nirmal et al., 2012a, 2012b).**

From the aforementioned studies, it can be inferred that the majority of research has focused on the ethanolic extract's water-soluble fraction for anti-inflammatory efficacy. Concerningly,the experiment doses ranged from 0.5 g to 8 g/kg. The studied extract and the separated *Arbortristoside* A are both harmless, according to the toxicity studies. Additionally, there is potential to investigate seeds for comparable biological activities, and Bioactivity-guided fractionation may produce active fractions or compounds with respectable biological activity.

2.2Anti-allergic properties

Many secondary metabolites and botanical extracts have been demonstrated to diminish eosinophilia and/or eosinophil recruitment, suggesting that they could be used instead of allopathic antihistaminics. There are three reports on *Nyctanthes*, all from the same group, in which a 50 percent alcoholic extract of the plant's flower, root, seed, and leaf was tested for anti-PCA (passive cutaneous anaphylaxis) and showed significant inhibition of PCA at 50 mg/kg in both mice and rats, indicating that it can inhibit the anaphylactic reaction in the skin comparable to the standard drug disodium cromoglycate (DSCG) **(Gupta and colleagues, 1993).** Furthermore, when the Separation of *arbortristosides* A and C from the seed was tested at 25and50 mg/kg, they produced significant inhibition of PCA at 25 and 50 mg/kg, as well as significant protection of Degranulation of mast c,e as are brought on by compound 48/80at 10mg/kg, dueto their action stabilizeslises mast cells, when compared to DSCG. When given orally, both compounds showed strong anti-PCA and mast cell stabilizing activity in rats, although DSCGis poorly absorbed when given orally **(Gupta et al., 1995).**

Anti-histaminic action has also been tested in the plant's bark. **(Nirmal et al., 2012)** examinedpetroleum ether, chloroform, ethyl acetate, ethanol, and *Nyctanthes arbor-tristis* aqueous extracts bark, finding that the best resistance to mast cell degranulation by clonidine and resistedconstriction (bronchodilation) produced by histamine at 50 and 100 mg/kg was demonstrated by petroleumether extract.

The ability of the extracts to reduce histamine release appears to be obvious from the studies done by several

groups above, at doses that are within acceptable limits. Though no toxicity tests have been reported in any of these trials, other reports of toxicity in similar extracts suggest a considerably lower degree of toxicity**. (Mohammed S et al.,2021)**

2.3 Anti-cancer properties

Over 60% of today's anticancer medications are produced using natural resources in some fashion. Dietary flavonoids and other polyphenols derived from medicinal plants are expected to play a key role in cancer prevention. The anticancer *Nyctanthes arbortristis* characteristics have not been thoroughly investigated. **(Susan et al., 1986)** found that two iridoid glycosides, *Arbortristoside* A and B, have anticancer efficacy against methylcholanthrene-induced fibrosarcoma in mice at 2.5 mg/kg.

At 20 mg/kg, a derivative of benzofuran Isolated from the leaves, 4-hydroxy-hexahydro benzofuran-7-onereduced cell proliferation by 43.27 percent and had no lethal effect on Ehrlich ascites cancer cells **(Khatune et al., 2003).** The hydroalcoholic tincture of leaves was also found to be chemopreventive against dimethyl benzanthracene (DMBA)-induced skin carcinogenesis at a dose of 250 mg/kg **(Dinamani et al., 2009).**

When it comes to anticancer action, it's worth noting that there hasn't been any thorough investigation done in the sector. Rather than evaluating immediately in animal models, the extracts or fractions should have been examined for in-vitro study against various cell lines, andpositive leads should have been taken up in in-vivo models. During the anticancer activity, theselectivity index should have been calculated as well. **(Patil Javesh K et al.,2016)**

2.4 Anti-diabetic properties

for diabetes, insulin and several types of hypoglycemic drugs such as biguanides and sulphonylureas, both old and novel, are available. However, none of these drugs are optimal because of their toxic side effects and, in some circumstances, a decrease in responsiveness after lengthy use at the end of the activity. Despite reports of antidiabetic effectiveness, *Nyctanthes arbor*-tristis lacks scientific validity because it has not been thoroughly investigated.

When given orally to alloxan-induced diabetic rats, a methanolic extract of root at 500 mg/kg was efficient in reversing the symptoms **(Sharma and Marwaha, 2011**). In rats, the extract was determined to be safe up to 3000 mg/kg when administered orally.

In another study, **(Rathod et al., 2009)** discovered that chloroform extract from leaves at 100,200, and 50 mg/kg significantly reduced serum glucose and insulin levels.

Insulin resistance was developed in rats by a high fructose diet. They did not, however, prove the extract's safety and effectiveness. In a similar study, **(Rathod et al., 2010)** found that givingSTZ diabetic rats chloroform extract from the flower and leaves 27 days at the same dosage ledto a notable reduction in lipid peroxidation, liver enzymes, aspartate aminotransferase (SGOT), alanine transaminase (SGPT), alkaline phosphatase (ALKP), cholesterol, and triglyceride levels, indicating that the qualitative tests have been completed. Alkaloids and flavonoids havebeen discovered by analytical analyses.

In a study involving diabetic rats produced by streptozotocin (STZ), a 50 percent ethanolic extract from the leaves significantly boosted superoxide dismutase, catalase, and glutathione peroxidase in the blood at doses of each 200 and 100 mg/kg **(Husain et al., 2010).** The extractsignificantly reduced thiobarbituric acid-reducing substances

(TBARS) in the liver, which decreased lipid peroxidation.

With these results on hypoglycemia potential, it appears that a full study using various components of the plant against various antidiabetic models is possible.

2.5Anti-helmintic activity

Antihelminthic medications like albendazole and praziquantel, which are now in use, have drawbacks, prompting a return to alternative therapies.

In a dose-dependent reduction of spontaneous movement in adult earthworms, 0.1 to 1 percenthydroalcoholic extracts of the leaves of Nyctanthes arbor-tristis showed modest antihelminthicefficacy, and the endeavor is comparable to standard medication For1 percent extract, the paralytic effect was noticed at 0.44070.033 minutes, with death occurring at 1.15070.230 minutes. At the same concentration, albendazole caused paralysis after 0.32470.028 minutes and death after 0.42670.035 minutes. Apart from aqueous and hydroalcoholic extracts, fresh juice has also been reported with the same function **(Verma et al., 2011a, 2011b)**.

On Pheretima Posthuma, Alcohol and aqueous bark extracts of *Nyctanthes arbor-tristis* at 20, 40, and 60 mg/kg have been tested based on either period of paralysis or worm death. The findings were similar to those obtained with albendazole. Furthermore, because the alcoholic extract kills worms faster than albendazole, it is more effective **(Suresh et al., 2011).** because the helminth studied in the preceding investigations was solely earthworm, the work on anti- helminthic activity is quite preliminary. Other important human models, such as Ascarida spp.,Haemonchus concertsCaenorhabditis elegans, Hymenolepsis sp., Ascaris sp., Taenia sp., Fasciola sp., or Strongylus sp. should be considered. It might be determined the fact that sufficient amount of There is a lot of room for evaluating this plant's antihelminthic activity.

2.6Antimalarial activity

Resistance to practically every antiplasmodial medicine now available has been discovered in laboratory investigations, highlighting the need for a new antimalarial drug. Some researchershave studied *Nyctanthes arbor-tristis* for its action with stem bark, leaf, root, seed, and flowers.the first scientific proof in fresh leaf juice against chloroquine-resistant Plasmodium falciparum. The factory is reportedly used by tribals in Orissa (India) to treat malarial fever bymaking a decoction from seven leaves that have been filtered and combined with honey and taken for three to four days **(Aminuddin et al., 1993).** Only at 100 mg/ml does a 50 percent ethanolic extract of root and seed show in vitro action.

Leaf extract, on the other hand, has antimalarial efficacy against Plasmodium falciparum and Plasmodium berghei as well as in vivo. (NK 65) **(Misra et al., 1991).** The alcoholic extracts ofthe fruit and leaf have reportedly also been efficacious against chloroquine-resistant strains of the human malaria parasite Plasmodium falciparum, with IC50 values of 54 and 38 mg/ml, respectively **(Simonsen et al., 2001).**

an ethanolic floral extract was subjected to activity-guided fractionation, which resulted in the isolation of rengylone and a derivative of it a cyclohexylethanoid having antiplasmodial activity, and an IC50 and 4.6 mg/ml respectively, against Plasmodium falciparum.

By giving patients a fresh paste made from five fresh *Nyctanthes arbor-tristis* leaves three times daily for seven to ten days, **(Karnik et al., 2008)** demonstrated a therapeutic result (76.17%) in curing malaria. They also

recommended the creation of an established formula.

125 patients (15–70 years old, excluding pregnant women) who had a positive test for Plasmodiumvivax, Plasmodium falciparum, or both participated in the clinical trial. Other antimalarial or antipyretic medications were not administered. Tepid sponging and a coldwater enema were administered in cases of severe fever. According to traditional ayurvedic texts, patients were daily checked for temperature and rigors Moreover, as the severity of 35 malaria-related signs andsymptoms.

When making counts at the time of admission and on the third and seventh days after treatment, blood smears were taken into consideration for parasite identification. For those who had improved clinically but had no parasite count after 7 days, the medication was continued. Boththe early and late full groups Moreover, the early partial group of treatment response categoriesdemonstrated parasite eradication. As a result, 92 out of 120 patients (76.7%) experienced a therapeutic response. The fresh leaf juice contains also been used in studies to treat diseases similar to malaria, this time from the Indian state of Orissa **(Kantamreddi et al., 2009)**.

Only *Nyctanthes* has had its ethnopharmacological usage clinically confirmed, albeit in a limited way, out of all the studies done on this plant. The findings described above imply that at higher baseline parasitemia, the typical *Nyctanthes arbor-tristis Linn's* dosage might not always besufficient. To enable linking the treatment's effectiveness with the level of parasitemia, future research will require a standardized formulation in addition to a predetermined flexible dosingregimen. Since each piece of the task has been finished independently, the leaf and fruit can beexamined for detailed chemistry and biological activity using the currently available scientifically certified lead. **(Anshuman Singh et al., 2014)**

2.7 Antimicrobial activity

The antibacterial potential of *Nyctanthes* and numerous other ethnomedicinal plants has been investigated. The juice from fresh leaves has antibacterial action, according to **(Badam et al., 1987).** Escherichia coli was discovered to be resistant to this plant's flower petals' antibacterialproperties. **(Dakar and others, 1998)** The Gram-positive and Gram-negative bacteria Bacillus subtilis, Bacillus cereus, Bacillus megaterium, Staphylococcus aureus, Streptococcus sp.,Sarcina lutea, Escherichia coli, Shigella dysentriae, Shigella Shiga, Shigella boydii, Shigella sonnei, and Pseudomonas aeruginosa have all shown promising activity when **(Khatun et al., 2001a, 2001b)**. For pet ether, chloroform, ethyl acetate, and gallic acid, the LC50 values in thebrine shrimp experiment were 14.80, 12.62, 12.79, and 4.53 ppm, respectively.

Staphylococcus aureus and Salmonella paratyphi, two germs that can't be killed by antibiotics,are both killed by the alcohol-based extracts of the leaves **(Ahmad and Beg, 2001).** According to **(Bhatt et al., 2005)**, Staphylococcus aureus, Staphylococcus epidermidis, yeast, and Candida albicans are all susceptible to the ethanolic extract of the stem and leaves Leaf extracthas been discovered to have moderate activity against Pseudomonas testosterone Staphylococcus aureus, Bacillus subtilis, and Escherichia coli are all susceptible to the bactericidal effects of the leaf's aqueous and methanol extracts Additionally, **Mahida and Mohan's (2007)** research demonstrated that the leaves' methanolic extract was effective againstbacterial strains that were multi-drug resistant, including Staphylococcus aureus, and Staphylococcus epidermis, Salmonella typhi, and Salmonella paratyphi.

According to a study on root bark extracts (Pet ether, chloroform, ethanolic, and aqueous extracts), at concentrations ranging from 10 to 60 mg/ml, disc diffusion assay results showed activity against Escherichia coli, Bacillus subtilis, Pseudomonas aeruginosa, Staphylococcus aureus, and Streptococcus faecalis. The aqueous, methanolic, and ethanolic extracts displayedbactericidal action in order of polarity at dosages ranging from 10 to 40 mg under in-vitro conditions against medically significant Gm—ve and Gm—ve strains, according to a study thatwas marginally better organized by **(Sathiya et al., 2008)**. The erythrosine B dye exclusion assay-based cell viability assay results showed that all of the extracts were most viable at 100 mg.

In a thorough investigation, dried leaf, flower, fruit, and seed extracts with substantial action against Gm—ve bacteria when compared to Give bacteria were extracted using ethyl acetate and chloroform **(Priya and Ganjewala, 2007).** Additionally, they underlined that the action ismore pronounced when plant material is ingested in fresh form and that combining extracts that have been dried did not produce any synergistic effects. Yeast (Candida albicans), mold (Aspergillus niger), and bacteria (Gm-ve and — ve) were also found to be susceptible to the stem bark extract (petroleum ether, chloroform, and ethanol) in a different early investigation **(Manisha et al., 2009).**

They suggested as well that chloroform extract from the plant's stem bark be used instead of petroleum ether and ethanolic extracts, which were proven to merely have antibacterial activity.A single study using this plant's bark describes how an aqueous extract of it prevented the development of one yeast, Candida krusei, as well as pathogenic and non-pathogenic bacteria in a disc diffusion assay using 200 ml of crude extract **(Thatoi et al., 2008).** A recent study found that fresh leaf, seed, and fruit extracts of chloroform and ethyl acetate greatly slowed theexpansion of Escherichia coli, Klebsiella pneumonia, and Staphylococcus aureus, while dried extracts of the same compounds dramatically slowed Pseudomonas aeruginosa growth **(Balasubramanian., 2012).**

Only two reports of n-butanol fraction, *arbortristosides* A and C, and ethanolic extract, whichwere extracted from the plant's seed, have been linked to anti-viral activity against Encepha-Semlinki forest virus and the myocarditis virus have both been observed in vivo. The ineffectiveness of *Arbortristosides* B, D, and E against these viruses has also been mentioned. When analyzing the antibacterial activity described in the literature, it can be seen that none ofthe research used the broth dilution method to determine the least effective inhibitory concentration(MIC), which provides a clear picture of the activity. There are very few reports on the antibacterial properties of pure molecules or Bioactivity-guided fractions, which could be thetopic of further research. Various in-vivo models of bacterial or fungal infection can be used totest any promising discovery. The lack of antiviral literature calls for at least a preliminary testagainst different virus families. **(Champa Rani et al., 2012)**

2.8 Antioxidant activity

Strong antioxidants are produced by plants, and the anti-oxidant activity of classes of chemicalsthat help scavenge the free radicals primarily responsible for the pathophysiology can be connected to the use of *Nyctanthes* leaves as a decoction for various maladies in ayurvedic medicine.

In their initial study, **Sunil Kumar and Muller (1999)** used bovine brain phos- pholipid liposomes to test the effect of a methanolic extract from *Nyctanthes* leaves on free radical-induced lipid peroxidation and discovered good activity with an IC50 value of 20 mg/ml. However, the total flavonoid and it was discovered that phenolic

content was very low, which was correlated to the lowest antioxidant activity in comparison to other leafy vegetables. The water-based extracts of the plant's leaves have previously been cited as having DPPH radical, hydroxyl radical scavenging activity, and lipid peroxidation preventive properties **(Dasgupta and De., 2007).**

Through assays like the di-phenyl picryl hydroxyl reducing power (DPPH) radical scavenging assay ability, hydrogen peroxide scavenging assay, and total antioxidant assay, **Thangavelu and Thomas (2010)** demonstrated that ethanolic extracts of the plant's leaves and stem are an achievable source of antioxidants. According to a study on the antioxidant activity of aqueous extract from the flower and its components, the order of the active components for scavengingDPPH radicals is calyx4flower4petals **(Vankar., 2008).**

According to a subsequent investigation on the alcoholic fractionated extract of leaves, butanol(95.22 percent), 4-ethyl acetate (84.63 percent), and 4-petroleum ether (82.04 percent) all had more antioxidant activity at 100 mg/ml than ascorbic acid (93.88 percent) did at 10 mg/ml DPPH, hydroxyl, and superoxide radicals, as well as H2O2 scavenging assays, were used in a study by **(Rathee et al., 2007)** on the acetone soluble fraction of ethyl acetate extract from leaves. The fractions have been evaluated and found to be equivalent to well-known antioxidants such as a-tocopherol, BHT, and mannitol.

Gamma ray-induced DNA damage and Fe (II)-induced liposome lipid peroxidation were usedas additional proof. Aqueous extracts of the flowers revealed higher levels of enzymatic antioxidants, while methanolic extracts of the flowers also have high phenolic antioxidant activity and substance **(Nagavani et al., 2010**). With IC50 values of 63.670.29 and 61.970.15 mg/ml, respectively, methanol extract and the flavonoid fraction of the leaves demonstrated DPPH scavenging activity and high ferric reducing activity. **(Sasikumar., 2010)**

When Antioxidant function is considered collectively, it can be said that leaf, stem, and flowerextracts containing phenolic and flavonoids are what cause the antioxidant activity, which wasgenerally found in extracts derived from solvents of lower polarity. Lower antioxidant activitywas revealed by the study on aqueous extract (greater polarity).

2.9 Leishmanicidal and anti-trypanosomal activities

Trypanosomiasis is a major source of suffering in sub-Saharan Africa, and it is caused by intracellular parasites of the trypanosome species Trypanosoma cruzeiro. Trypanosoma brucei,like other protozoan diseases. The crude 50 percent ethanol leaf extract from *Nyctanthes arbor-tristis* had anti-trypanosomal potential and showed trypan-genocidal activity at a concentration of 1000 mg/ml in vitro testing. Through extending mouse longevity, in-vivo experiments showed that the extract has anti-trypanosomal properties at dosages of 300 and 1000 mg/kg. However, experimental mice died once the medication was stopped **(Talakal et al., 2000**).

Leishmaniasis is a common tropical disease that, if neglected, can be lethal. Pentavalent antimonials are among the first-line treatments that are advised, but they all have financial restrictions and particular toxicity when administered parenterally. *Arbortristoside* A, B, C, and6-b-hydoxyloganin (iridoid glucosides obtained from seeds) were isolated through biological activity from *Nyctanthes* and demonstrated potent action against Leishmania donovani amastigotes in vitro between 30 and 100 mg/ml and in vivo at 10 mg/kg. 100 mg/kgand **(Tandon et al., 1991).** Analyzing naturally occurring chemicals generated from plants is among the most promising methods for discovering new anti-leishmanial agents. In this endeavor, calceolarioside A was

successfully isolated from Nyctanthes' methanolic extract using Bioactivity-guided fractionation.

IC50 values for arbor-tristis leaves were 20 mg/ml, while in well-established in golden hamsters with the Leishmania donovani model, the in-vivo efficacy was observed at 20 mg/kgin terms of reduced hepatic and splenic parasite burden. load **(Poddar et al., 2008a., 2008b**). Isolated iridoid glucosides from the seed kernel were first reported as inhibitors of trypanothione reductase, which is a validated drug target enzyme of the Leishmania parasite; the compounds a, b, and c showed significant inhibitory activity with IC50 values of 2.29, 2.65, and 4.74 mM, respectively. This finding is similar to the above observations. According to **Shukla et al. (2012)** who continued the previous investigation, these iridoid glucosides are amastigotes. The growth of Leishmania donovani promastigotes and axenic amastigotes was therefore inhibited by compound(s) a, b, and c, with IC50 values of 3.264, 3.5, 5.016, 7.26, 7.63, and 9 mM. Due to the inhibition of trypanothione reductase, these substances had aconsiderable impact on the parasite's redox balance, increasing the levels of reactive oxygen species. As a result, the elevated reactive oxygen species cause oxidative stress, cell membrane damage, and Leishmania parasite death. the iridoid glucosides at 4 and 100 mM demonstrated 90-95 percent and 50-71 percent viability, respectively, and are safe and can thus be used for human administration, according to cytotoxicity experiments on HEK 293 and mouse macrophages. It should be noted that the given research has been done over the previous ten years, with a focus on chemicals isolated from leaves and seeds whose in vitro cytotoxicity results in safety. Leishmania Donovan has been the subject of well-organized investigations, but bioactivity on Leishmania major, Leishmaniaamazonensis, Leishmania infantum, and Leishmania aethiopica might show the uniqueness ofthe molecules isolated from *Nyctanthes arbor-tristis.*

2.10 Central nervous system frequency modulation

With the Sanskrit words media, which means intellect or cognition, and Rasayana, which means rejuvenation, certain plants have long been categorized as media rasayanas in the Indianmedical system. A few research teams have attempted to track the plant's centralnervous system effects, even though it has not been mentioned about the disorders related tothe central nervous system.

According to **(Verma et al., 2001)**, the aqueous extract from the plant's leaves could counteractmalathion's impact on acetylcholine esterase activity, which is crucial for the metabolism of acetylcholine. In a further trial, the water-soluble component of the alcoholic leaf extract did not affect the righting reflex, but at dosages of 4.0 and 8.0 g/kg, it markedly (p o0.05 and p o0.01, respectively) increased the pentobarbitone sleeping period. The extract significantly decreased CAR activity at identical doses, according to tests for sedative activity (p o0.05) **(Saxena et al., 2002).**

The sedative potential of a steaming floral brew has also been tested for sedative effect in rats ina different study. Surprisingly, female rats were not affected by the infusion's mild dose-dependent (3.7 to 18.7 mg/kg) conscious sedative effect. Even after subchronic doses, the infusion was accepted successfully. and did not exhibit any overt signs of dependence using leaf ethanolic extracts, flowers, seeds, and bark at a dose of 600 mg/kg, a comparable investigation found that the onset and duration of substantial dose-dependent adverse effects were prolonged possibly as a result of the elevated serotonin and decreased dopamine levels, sleep **(Das et al., 2008a, b).** At dosages of 500, 1000, and 1500 mg/kg, *Nyctanthes* leaf ethanolic and aqueous extracts have an anti-convulsant

action against MES-induced seizures, but they also cause drowsiness and motor deficits. Although the precise chemicals or the mechanism were Not completely comprehended, the ethanolic extract showed to be more efficient against maximum electroshock **(Singh et al., 2010).** The extracts' LD50 was discovered to be 45000 mg/kg. Significant antidepressant efficacy was seen in rodents in a related investigationusing the hydroalcoholic extract of the leaves at 250 and 500 mg/kg **(Tripathi et al., 2010).** Additionally, the anti-aggressive characteristics of the same extract at the same dosage have been documented by the same group. **(Tripathi et al., 2011).**

The nervous system or CNS effects of *Nyctanthes arbor-tristis* can be summarised as a sedative,and this fact should be taken into account During the plant's utilization to treat various conditions. When researching other pharmacological processes, researchers should also plan their studies with the important effects of the extracts on the brain and spinal cord in mind.

2.11 Diuretic activity

Natural products have recently concentrated on scientific and clinical research for new diureticmedications that are primarily supported by empirical use. The majority of these new diuretic pharmaceuticals have shown significant efficacy in animal models, albeit the mechanisms of action have largely not been explored. **(R.S.Gupta et al., 2006)**

In terms of *Nyctanthes*' diuretic properties, hot flower infusions with dosages varying from 3.7to 18.7 mg/kg of the plant significantly reduced urine output and retained K+ ions in the bodiesof rats treated with 13 mg/kg of furosemide. A significant (po0.05) dosage-dependent fast but persistent diuresis was brought on by the flower infusion. Additionally, the flower infusion significantly reduced the levels of Na and K in the urine and slightly but significantly increasedits alkalinity. However, neither the urine-specific gravity nor the Na/K ratio was significantly impacted by the infusion. Additionally, subchronic treatment of the infusion in rats demonstrates safety **(Ratnasooriya and Jayakody, 2004).** Through quantification of variableslike urine volume and electrolyte excretion, similar observations have also been made on the ethanolic extract of the leaves, seeds, and flowers at concentrations between 200 to 600 mg/kg. the extract is also determined to be safe at 2 g/kg in a temporary toxicity investigation **(Sasmal et al., 2007)**. Overall, it can be said that flowers have a promising future as a reliable, affordablediuretic.

2.12 Hepatoprotective activity

A significant obstacle for twentieth-century medicine is liver disease. The liver has a large capacity for regeneration, and damage is typically severe before it becomes apparent. Based on conventional wisdom, *Nyctanthes arbor-tristis* has also been tested for its hepatoprotective properties.

The extracts of leaves in alcohol and water were efficient in lowering the high levels of enzymes, according to early research by **(Hukkeri et al., 2006)** on carbon tetrachloride-induced liver injury. **(Deshmukh et al., 2007)** reported that the ethanolic extract at a concentration of 1 g/kg may selectively suppress reactive oxygen species, hence blocking P450-mediated CCl4 bioactivation.

In a separate experiment, rats treated by combining methanolic extracts of leaves after being given 1 g/kg of acetaminophen recovered by preventing glutathione levels from rising **(Vishwanathanand Juvekar, 2010).** Similar to other pursuits, ethanolic and in rats with galactosamine-induced liver injury, an aqueous extract of the

plant's leaves were found to be efficient as a hepatoprotective at 500 mg/kg (Mayee et al., 2010). According to **(Kashaw et al., 2011)**, the plant's leaves and seeds contain *nyctanthesin*, which may be the cause of its hepatoprotective effects.

Hepatoprotective activity studies have been conducted using early conventional models. The initial findings in particular models of phalloidin-induced liver damage or drug-inducedhepatotoxicity (Rifampicin, Isoniazid, Ethambutol, etc.) appear to have room for furtherexpansion.

2.13 Immunomodulatory function

Some medicinal plants are thought to boost the body's innate immune system, which is thoughtto increase the body's natural resistance to infections. The manipulation of immune response with the help of different bioactive to alleviate particular diseases is an active field of research.The index of macrophage migration (MMI)and the humoral and delayed-type hypersensitivityreaction to red blood cells from sheep (SRBC) both increased in response to 50% ethanolic extracts from seeds and 50% ethanolic extracts from leaves and flowers, respectively **(Puri et al., 1994)**.

Additionally, Swiss mice were significantly protected against systemic infection with Candidaalbicans following prophylactic treatment with ethanol (50 percent) extracts of the seed at 50 mg/kg, root at 25 mg/kg, and isolated *arbortristosides* A and C from the seed. This protection was a result of the potentiation of immunostimulant activity, which was demonstrated by an increase in humoral and delayed-type reaction (DTH) of hypersensitivity to sheep red blood cells(SRBC) **(Khan et al., 1995).** In mice exposed to malathion, treated or untreated, extract of theleaves in water was found to counteract the immunotoxic effects of chemical pesticides by strengthening immune systems through an increase in humoral, cell-mediated immunological, immunocyte numbers, and phagocyte activities **(Bhatia and Kaur., 2001).**

When challenged with the use of sheep red blood cells (SRBC) and heat-killed Salmonella antigens, the ethanolic extract from leaves, at concentrations between 50 to 200 mg/kg, not onlystimulated the cell-mediated immune response but also enhanced the humoral immune response. In a study that did not use a mammalian system, it was discovered that feeding tilapia, Oreochromis mossambicus, feed supplemented with chloroform extract of the seed at 0.1 and 1percent level provided disease resistance against live, virulent Aeromonas hydrophila by stimulating an unspecific immune one reaction significantly enhancing non-specific immune response, including serum lysozyme and alternate complement hemolytic (ACH50) activities **(Kirubaran et al., 2010).**

From an ethanolic extract of leaves, Kannan and Singh (2010) confirmed the presence of the methoxylated flavonoid quercetin-3,30-dimethoxy-7-0-rhamnoglucopyranoside and polyacetylene. They also correlated the activity with an improvement in mice's immune status by increasing the phagocytic index regarding the reticuloendothelial system (RES), white bloodcell count, spleen weight, and leukocyte

The plant has immunostimulating properties, according to every report on the immune system.According to the report on antagonistic pesticide activity, the extracts have the ability to both be effective in aquatic systems and capable of reversing the immunosuppressive activity.

2.14 Larvicidal activity

The investigation for natural sources of vector control measures has arisen as a result of complex issues with the

chemical insecticides used to eradicate the vectors that transmit different tropical diseases. Some employees have also tried *Nyctanthes* for these purposes.

LC50 values range from 25.67-72.60 ppm and 73.31-99.02 ppm, respectively, the assessment has shown that the isolated chemical NCS-2 from *Nyctanthes* flowers and chloroform extract artist larvicidal against Culex, the common filarial vector, quinquefasciatus. Additionally, it was shown that the extract was less effective on late instar larvae than on earlon instar larvae**(Khatun et al., 2001a, 2001b).** Additionally, *Nyctanthes arbor-leaves ttristis*have larvicidal properties. The LC50 values of the leaves of *Nyctanthes arbor-tristis* against Anopheles aegypti, Anopheles stephensi, and Culex quinquefasciatus were 303.2, 518.2, and 420.2 ppm, respectively. The *Nyctanthes arbor-tristis* flower extracts in methanol and chloroform also exhibited larvicidal efficacy the LC50 values for this compound against Anopheles stephensi larvae are 244.4 and 747.7 ppm. respectively **(Mathew et al., 2009).** The leaves of *Nyctanthesarbor-tristis* were extracted with petroleum ether hadand a larvicidal activity (LC50 values) of 185 ppm against Anopheles stephensi in a study on the toxicological qualities of different medicinalplants **(Alam et al., 2011).** With LC50 values of 114.5 and 260.72 mg/l, crude dichloromethaneextract of leaves exhibits the most larvicidal activity against Anopheles aegypti and Anophelesstephensi among the aforementioned extracts **(Patil et al., 2010).**

According to all four investigations, the leaves and flowers have larvicidal action and may provide effective natural vector control methods. However, it's also important to take into account the safety research on aquatic life.

3. Study on phytochemicals and pharmaceuticals for quality assurance

The research on *Nyctanthes arbor-tristis* has been pretty thorough, but strangely, there is a paucity of data on the pharmacognosy. The exomorphology, macro and microscopic qualities, powder characteristics, fluorescence observations, physicochemical parameters, and preliminary phytochemical screening are all reported in one study on the plant's bark **(Suresh and Arunachalam., 2012**). According to reports, the bark's surface is described as being rough, deep, and irregularly fissured under a microscope. It is a yellowish-white color on the inside.

In the inner bark, the fractures are fibrous and short. The barks total thickness is 8.2 mm, and it can be divided into inner bark and periderm (secondary phloem). The tiny fissures that are present on the periderm surface are uneven. Small, tubular phellem cells with black stripes make up the periderm. In regions where there is heterogeneity in the phellem, composed of broader, thin-walled, squarish, or tubular cells and thin, continuous phelloidal (sclereid)tangential lines. **(Sasmal D et al., 2008)** There is no sign of phelloderm. Secondary phloem immediately follows periderm.the outer zone of the unbroken phloem and the inner zone of collapsed phloem make up the secondary phloem The largest portion is of the bark of the collapsed phloem. Circular, less compact parenchyma cells, slender phloem rays, and conspicuous, circular masses of sclereidsmake up the area below the periderm. Additionally, there are obliquely radial black thin lines that are located inside the phloem. These lines reflectcrushed and destroyed sieve elements or collapsed phloem. **(Shekhar S et al., 2014)** Phloem that isn't collapsed measures 450 mm. It is composed of one unbrokensieve-tube member, thin,less noticeable rays, and axial parenchyma. The tiny, randomly, or radially oriented sieve tubecomponents. The sieve-tube members have a diameter between 20 and 30 mm. The collapsed and non-collapsed phloems are visible in the TLS view. The

collapsed phloem displays significantly wider rays that are three to several short and broad, serratehomocellular, and madeup entirely of undamaged polygonal compact cells. Sclereids are arranged in dense vertical bands. **(Haque ME et al., 2001)**

The crushed sieve-tube members are visible as thick, black vertical lines. The rays have a widthof 200–250 mm. Sclereids are missing and the phloem light is lower in size in the non-collapsedphloem area. Members of the sieve tube are compact and slender. They stand 250 mm tall. Itis the sieve plate straightforward and angled. Wide simple pits can be seen in the phloem parenchyma cells. The RLS view shows a strip of cells that resembles a horizontal ribbon. These cells are either square or oblong. They are homocellular, the rays. Some of the rays are heterocellular, with slightly upright and horizontally procumbent cells. **(Kusum S Akki et al.,2009)**

Phylloid cells are visible in the powdered bark, and when the periderm is broken up into minutepieces, sclerotic phylloid cells and thin-walled phloem cells are visible. The powder contains calcium oxalate crystals of two different forms. Both rectangular and spindle-shaped prismaticcrystals can be found in abundance. The stone cells or branchy sclereids make up the sclerenchyma that makes up the bark. They have large lumens and thick lignified walls. The sclereids include several small, round pits. **(Rangari SB et al., 2012)**

All of the various bark extracts have also undergone HPTLC profiling. Petroleum ether, chloroform, ethanolic, and aqueous extracts, in that order, each displayed 10, 7, 10, and 8 phytoconstituents at 254 nm.

When analyzing the results of the pharmacognostic research on the plant, it becomes clear thatonly the bark has undergone extensive investigation. The research on leaves and seeds, which make up the majority of the herbal ingredients used in conventional medicine, is still in its infancy and requires careful investigation. **(Pattanayak C et al., 2012)**

4. *Nyctanthes arbor-tristis* toxicity

Although the herb has been utilized traditionally for many years, toxicity tests using isolates and extracts of substances have also been conducted to support scientific investigations. The LD50 of petroleum ether, chloroform, and ethyl acetate extract from the flower were determined to be 14.80, 12.62, and 12.79 respectively when compared to 4.53 ppm of gallic acid in a preliminary brine shrimp lethality assay **(Khatune et al., 2001).** When researching the anti-inflammatory properties of the water-soluble component of the ethanolic extract of leaves, found that in albino rats, a dose of 2.0 g/kg did not result in any mortality whereas 32 g/kg resulted in 75% mortality. **(Chaya Gadgoli et al., 2010)**

The LD50 was determined using the probit log dose-response curve to be 16 g/kg. **Bhatia andKaur (2001)** discovered that the leaf extract in water can counteract the immunotoxic effects of chemical pesticides in treated or untreated mice exposed to malathion while researching theplant's immunomodulatory activities. Working with the flowers, **(Omkar et al., 2006)** found that the ethanolic extract's LD50 was 1500 mg/kg. This observation was madeusing the orange tubular calyx of the flower. The ethanol extract of leaves, seeds, and flowers was similarly shown to be safe at 2 g/kg when administered intraperitoneally to rats in a comparable acute toxicity trial **(Sasmal et al., 2007)**. The LD50 of *arbortristoside*-A extracted from the seeds was found to be 500 mg/kg.and cause 100% death at 1 gm/kg in mice when administered intra-peritoneally, in addition to crude extracts. In mice, the compound reduces locomotor activity, as evidenced **(Das et al., 2008a, b)**. Research on HEK 293's

cytotcytotoxicity ande macrophages revealed that the iridoid glucosides at 4 and 100 mM showed90%and 50% viability, respectively, and are harmless and can therefore be used employed for administration to humans **(Shukla et al., 2012).** When the information on toxicity studies is summarised, it can be seen that only preliminary research that concentrates on acute studies hasbeen undertaken. The avenues for thorough safety research relating to many organs become necessary whenever any biological activity is proven, but there aren't any on the extracts or active fractions of this plant.

5. SUMMARY AND CONCLUSIONS

In some cases, the early research of biomedical investigations on metabolic disorders includinginflammation, allergies, diabetes, diuresis, hepatoprotection, or immunomodulation has been useful in demonstrating the relationship between biological activity and chemical ingredient nature with toxicity. In line with the aforementioned finding, research on infectious diseases including malaria, trypanosomiasis, leishmaniasis, or those caused by microbial pathogens hasrevealed that the actions are more apparent in crude extracts than in pure molecules, with generally encouraging toxicological data. Efforts toward combination therapy including therapeutic entities prone to resistance development could be one of the future possibilities as the Bioactivity-guided fractionation studies in the majority of conditions have decreased efficacy. Studies on the mechanisms of action would also bolster the therapeutic claims.

A high-level analysis of the examined literature reveals a gap in the body of research that requires filling to support claims made by the conventional medical system. In addition to pilesand gynecological investigations, some of the validation studies, such as those on antiviral, ophthalmic, bronchitis, and snake venom antidotes, have not been covered. However, some studies show an indirect relationship with biological processes, such as the suppression of intestinal worms through anti-helminthic activity, the treatment of gout through analgesic and anti-inflammatory activity, and the modulation of the brain and spinal cord in the case of anxiety and restlessness. Some of the stated scientific data that was taken from online journalsand provided may not have been verified, which is a flaw of the review.

REFERENCE

1) AGRAWAL, Jyoti; PAL, Anirban. Nyctanthes arbor-tristis Linn—A critical ethnopharmacologicalreview. Journal of ethnopharmacology, 2013, 146.3: 645-658.

2) ALQAHTANI, Mohammed S., et al. Preparation, characterization, and in vitro-in silico biological activities of Jatropha pelargoniifolia extract loaded chitosan nanoparticles. International Journal ofPharmaceutics, 2021, 606: 120867.

3) SOLANKI, Mansi, et al. NYCTANTHES ARBOR-TRISTIS LINN: A SHORT REVIEW. 2021.

4) Bhosale AV, Abhyankar MM, Pawar SJ, Shoaib K, and Patil N., Nyctanthes arbor-tristis: A Pharmacognostic review, Research Journal of Pharmacognosy and Phytochemistry, 1(2): 91-97.

5) Ansari Imtiyaz Ahmed, Patil Javesh K., Kamora Kunal Rajeshlal, Mandhan Priyanka Mahesh, Poptani Taruna Hareshlal and Grease Ananda Narayan, Anthelmintic activity of Nyctanthes arbor-tristis leaves on Indian earthworms, Indian Journal of Drugs, 2016; 4(2): 63-68

6) Anshuman Singh and Bhupendra Vyas Night Jasmine (Nyctanthes arbor-tristis), Research Journal of Pharmacognosy and Phytochemistry, 2018; 10(4): 324-330.

7) Bansal S, Bharati AJ, and Bansal YK, In vitro callogenesis and Phytochemical Screening of Harsingar (Nyctanthes arbor-tristis) a Multipotent Medicinal Tree, International Journal of PharmTech Research, 2013; 74(3): 243-246.

8) Champa Rani, Sunaina Chawla, Manish Mangal, AK Mangal, Subhash Kajla and AK Dhawan, Nyctanthes arbor-tristis Linn. (Night Jasmine) A sacred ornamental plant with medicinal potential, Indian Journal of traditional knowledge, 2012; 11(3): 427-435.

9) Chaya Gadgoli and Sandeep Shelke, Crocetin from the tubular calyx of Nyctanthes arbortristis,Natural Product Research, 2010; 24(17): 1610-1615.

10) D.Sasmal, Sanjita Das and S.P.Basu, Phytoconstituents and therapeutic potential of Nyctanthes arbor-tristis Linn. , Pharmacognosy Reviews, 2007; 1(2): 344-349.

11) Das S, Sasmal D and Basu SP, Anti-inflammatory and antinociceptive activity of arbortristoside-A,Journal of Ethnopharmacology, 2008; 116(1): 198-203.

12) David Benefit, Anticancer activity of Nyctanthes arbor-tristis, International Journal of AdvanceResearch, Ideas and Innovation in Technology, 2019; 5(3): 84-87.

13) Irani Biswas, Sushobhan Ukil and Ambarish Mukharjee A., Determination of n-alkane constituentsand their phenological variation in the epicuticular wax of mature leaves of Nyctanthes arbor-tristisL., Natural Product Research, 2014; 28(5): 330-332.

14) Jain PK and Pandey A, The wonder of Ayurvedic medicine - Nyctanthes arbor-tristis, InternationalJournal of Herbal Medicine, 2016; 4(4): 09-17.

15) Khatunne NA, Haque ME, and Mosaddik MA, Laboratory evaluation of Nyctanthes arbortristis Linn.Flower extract and its isolated compound against common filarial vector, Culex quinquefasciatus say(Diptera: Culicidae) Larvae, Pakistan Journal of Biology Sciences, 2001; 4(5): 585-587.

16) Khatunne NA, Islam ME, Abdur Rahman MA, Mosaddik MA and Haque ME, Invivo cytotoxic evaluation of new Benzofuran derivative isolated from Nyctanthes arbor-tristis L. on Ehrlich AscitesCarcinoma Cells (EAC) in mice, Journal of medicinal sciences, 2003; 3(2): 169-173.

17) Kusum S Akki, Phytochemical investigation and in vitro evaluation of Nyctanthes arbortristis leafextract for antioxidant property, Journal of Pharmacy Research, 2009; 2(4): 752-755.

18) Kusum S. Akki, Hepatoprotective activity of the leaves of Nyctnathes arbor-tristis Linn.,Pharmaceutical Sciences, 2006; 68(4): 542-543.

19) Madhuri Kumari, V.bhagyalakshmi, V.sravanthi, K.Nagajyothi, R.B.Desi Reddy and K.Sravanthi, AReview on Nyctanthes arbor-tristis, World Journal of Pharmaceutical Research, 2018; 7(7): 429-435.Mathuram V and Kundu AB, Occurrence of two new esters of 6-hydroxyloganini in Nyctanthes arbor-tristis, Journal of the Indian Chemical Society, 1991; 68 (10): 581-584.

20) Meshram MM, Rangari SB, Kshirsagar SB, Gajbiye S, Trivedi MR, and Sahane RS, Nyctanthes arbortristis: A herbal panacea. International Journal of Pharmaceutical Sciences and Research, 2012;3(8): 2432-2440.

21) Pattanayak C, Datta PP, Chauhan AS, Firdoush KA, Prasad A, and Panda P, Hypoglycaemic effect of Nyctanthes arbor-tristis leaf extract on alloxan-induced diabetic rats, American Journal of PharmTechResearch, 2012; 2(6): 380-387.

22) Paul BN, Saxena AK, Depletion of tumor necrosis factor-□ in mice by Nyctanthes arbor-tristis,Journal of Ethnopharmacology, 1997; 56(2): 153-158.

23) Prasad MP and Shekhar S, In-Vitro Phytochemical and Antimicrobial activity of Nyctanthes arbor- tristis Linn against human pathogens, International Journal of Pure & Applied Bioscience, 2014; 2(1):1-5.

24) R.Indira Iyer, V.Mathuram and P.M.Gopinath, Establishment of callus cultures of Nyctanthesarbor-tristis from juvenile explants and detection of secondary metabolites in the callus, Current Science, 1998; 74(3): 243-246. R.S.Gupta, J.B.S.Kachhawa and Rakhi Sharma, Antispermatogenic effects of Nyctanthes arbor-tristisin male albino rats, Pharmacologyonline, 2006; 2(1): 261-273.

25) Rathee JS, Hassarajani SA and Chattopadhyay S, Antioxidant activity of Nyctanthes arbor-tristis leafextract, Food Chemistry, 2007; 103 (4): 1350-1357.

26) Rout GR, Mahato A, and Senapati SK, Invitro clonal propagation of Nyctanthes arbortristis, Biologia Plantarum, 2008; 52(3): 521-524.

27) Ruchita Shrivastava and Ajay Kumar Bhardwaj, Nyctanthes arbor-tristis an Important Medicinal Plantof Madhya Pradesh State – A Review, UK Journal of Pharmaceutical and Biosciences, 2018; 6(6): 10-11.

28) Sah AK and Verma VK., Phytochemicals and Pharmacological potential of Nyctanthes arbor-tristis: A comprehensive review, International Journal of Research in Pharmaceutical and Biomedical Sciences, 2012; 3(1): 420-426.

29) Sandhar HK, Kaur M, Kumar B, and Prasher S., An update on Nyctanthes arbor-tristis Linn,Internationale Pharmaceutica Sciencia, 2011; 1(1): 77-86

30) Sandip Pal, Study of variation in petal number and relative abundance of Nyctanthes arbor-tristis L.flowers, Current Life sciences, 2019; 5(1): 15-18.

31) Saxena RS, Gupta B, and Lata S., Tranquilizing, the antihistaminic and purgative activity of Nyctanthes arbor-tristis leaf extract. Journal of Ethnopharmacology, 2002; 81(3): 321-325.

32) Sharma V, Pooja and Marwaha A., Hypoglycaemic activity of methanolic extract of Nyctanthesarbor-tristis Linn. root in Alloxan induced diabetic rats, International Journal of Pharmacy and Pharmaceutical Sciences, 2011; 3(3): 210-212.

33) Siddiqui, Anis M and Jahan AA., Rapid multiplication of Nyctanthes arbor-tristis through in-vitroauxiliary shoots proliferation, World Journal of Agricultural Sciences, 2006; 2(2): 188–192.

34) Sumeet Gupta, Priyanka Kashyap, Mohammed Asad, Ipshita Chattopadhyaya, and Randhir Dahiya,Anti-depressant activity of Nyctanthes arbor-tristis in mice, Bangladesh Journal of Pharmacology, 2016; 11(3): 634-645.

35) Sunil Ashokrao Nirmal, Subodh Chandra Pal and Subhash Chandra Mandal, Pharmacognostic Evaluation of Nyctanthes arbor-tristis bark, Asian Pacific Journal of Tropical Biomedicine, 2012;2(2); 494-500.

36) Sunil Kumar Sen and Lalit Mohan Behera, Ethno –medicinal uses of Nyctanthes arbortristis L. inBargarh

district, Odisha, International Journal of Herbal Medicine, 2020; 8(2): 22-24.

37) Suresh V, Arunachalam V, and Jaikumar S., Anticancer activity of ethanol extract of stem bark ofNyctanthes arbor-tristis Linn., Research Journal of Pharmaceutical, Biological and Chemical Sciences, 2010; 1(4): 306-311.

38) Talakal TS, Dwivedi SK, and Sharma SR., In vitro and In Vivo Antitrypanosomal Potential ofNyctanthes arbor-tristis Leaves, Pharmaceutical Biology, 2000; 38(5): 326- 329.

39) Tim Mosmann, Rapid colorimetric assay for cellular growth and survival: Application to proliferationand cytotoxicity assays, Journal of immunological Methods, 1983; 65(1-2): 55-63.

40) Vats M, Sharma N, and Sardana S., Antimicrobial activity of stem bark extracts of Nyctanthes arbor-tristis Linn. (Oleaceae). International Journal of Pharmacognosy and Phytochemical Research, 2009;1(1): 12-14.

41) Ahmad, I., Beg, A.Z., 2001. Antimicrobial and phytochemical studies on 45 Indian medicinal plants against multi-drug resistant human pathogens. Journal of Ethnopharmacology 74, 113–123.

42) Akki, K.S., Krishnamurthy, G., Bhoja naik, H.S., 2009. Phytochemical investigations and in vitro evaluation of Nyctanthes arbor-tristis leaf extracts for the antioxidant property. Journal of Pharmacy Research 2, 752–759.

43) Alam, M.F., Mohammed, M.S., Chopra, A.K., Dua, V.K., 2011. Toxicological properties of several medicinal plants from the Himalayas (India) against malaria, filariasis, and dengue vectors. Tropical Biomedicine 28, 343–350.

44) Aminuddin, R.D., Girach, A., Khan, S., 1993. Treatment of malaria through herbal drugs from Orissa, India. Fitoterapia 64, 545–548.

45) Anjaneyulu, A.S.R., Murty, Y.L.N., 1981. The triterpenoid constituents of the leaves of Nycthanthes arbor-tristis Linn. Journal of the Indian Chemical Society 58, 817–818.

46) Anonymous 1997. A wealth of India, A Dictionary of India Raw Materials and Industrial Products, vol. VII, (National Institute of Science Communication, CSIR, New Delhi, 1997) pp. 69–70.

47) Badam, L., Rao, T.L.G., Wagh, U.V., Antarkar, A.D., 1987. Antimicrobial activity of fresh leaf juice of Nyctanthes arbor-tristis Linn. Indian Journal of Parasitology 11, 13–14.

48) Badami, L., Rao, T.L.G., Wagh, U.V., Antarkar, A.D., 1987. Antimalarial activity of fresh leaf juice of Nyctanthes arbor-tristis, Linn ‘‘in-vitro’’. Indian Journal of Parasitology 11, 13–14.

49) Balasubramanian, M., 2012. Study on phytochemical screening and antibacterial activity of Nyctanthes arbor-tristis. Journal of Chemical and Pharmaceutical Research 4, 1686–1695.

50) Bandi, B., Venkatesan, K., Mannarapu, U., Keerthi, M., 2011. Isolation and partial characterization of alkaloids from the stem bark of Nyctanthes arbor- tristis. International Journal of Pharmaceutical and Biomedical Research 2, 149–152.

51) Banerjee, A., Poddar, A., Ghanta, S., Chakraborty, A., Chattopadhyay, S., 2007. Nyctanthes arbor-tristis Linn—spectrum of its bioactivity potential. Planta Medica, 73.

52) Basu, N.M., Ray, G.K., De, N.K., 1947. The vitamin C and carotene contents of several herbs and flowers are used in the ayurvedic system of medicine. Journal ofthe Indian Chemical Society 24, 358–360.

53) Bharti, M., Saxena, R.C., Baghel, O.S., Saxena, R., Apte, K.G., 2011. Wound healing activity of leaf of Nyctanthes arbor-tristis (Linn). International Journal of Pharmaceutical Sciences and Research

2, 2694–2698.

54) Bhatia, A., Kaur, J., 2001. Nyctanthes arbor-tristis leaves extract as antagonizer of immunotoxic effects of chemical pesticides (experimental study). International Journal of Environmental Studies 58, 197–215.

55) Bhatt, L.R., Lim, J.A., Baek, S.H., 2005. Antimicrobial activity of Nepalese medicinal plants on skin microbial inflammation pathogens. Journal of Cosmetics and PublicHealth 1, 6–9.

56) Bhattarai, N.K., 1992. Folk anthelmintic drugs of Central Nepal. Pharmaceutical Biology 30, 145–150. Chandra, G., 1970. Chemical composition of the flower oil of Nyctanthes arbor-tristis. Indian Perfumer 14, 19–20.

57) Chatterjee, S.K., Bhattacharjee, I., Chandra, G., 2007. Bactericidal activities of somecommon herbs in India. Pharmaceutical Biology 45, 350–354.

58) Chauhan, J.S., Saraswat, M., 1978. A new glycoside from the stem of Nyctanthesarbor-tristis. Journal of the Indian Chemical Society 55, 1049–1051.

59) Chauhan, N.S., 1999. Medicinal and Aromatic Plants of Himachal Pradesh. GidwaniPublishing Company, New Delhi, P 288.

60) Chitravanshi, V.C., Singh, A.P., Ghoshal, S., Krishna Prasad, B.N., Srivastava, V., Tandon, J.S., 1992. The therapeutic action of Nyctanthes arbor-tristis against caecal amoebiasis of the rat. International Journal of Pharmacognosy 30, 71–75.

61) Chopra, R.N., Chopra, I.C., Handa, K.K., Kapur, L.D., 1958. Chopra's Indigenous Drugsof India, second ed. U.N.Dhar and Sons Private Ltd, Calcutta 408.

62) Darokar, M.P., Mathur, A., Dwivedi, S., Bhalla, R., Khanuja, S.P.S., Kumar, S., 1998.Detection of antibacterial activity in the floral petals of some higher plants. Current Science 75, 187–189.

63) Das, S., Basu, S.P., Sasmal, D., 2006. The anti-inflammatory activity of the different parts of Nyctanthes arbor-tristis Linn. Ethiopian Pharmaceutical Journal 24, 125–129.

64) Das, S., Sasmal, D., Basu, S.P., 2008a. Anti-inflammatory and antinociceptive activity of arbortristoside-A. Journal of Ethnopharmacology 116, 198–203.

65) Das, S., Sasmal, D., Basu, S.P., 2008b. Evaluation of CNS depressant activity ofdifferent plant parts of Nyctanthes arbor-tristis Linn. Indian Journal of Pharmaceutical Sciences 70, 803–806.

66) Dasgupta, N., De, B., 2007. Antioxidant activity of some leafy vegetables of India: a comparative study. Food Chemistry 101, 471–474.

67) Deshmukh, R.D., Pokharkar, R.D., Takata, S.B., Gite, V.N., 2007. Amelioration of CCl_4-induced heat suppression by Nyctanthes arbor-tristis Linn leaves in Wistar albino rats. Pharmacologyonline 1, 203–208.

68) Dhingra, V.K., Seshadri, T.R., Mukerjee, S.K., 1976. Carotenoid glycosides of Nyctanthes arbor-tristis Linn. Indian Journal of Chemistry, Section B: Organic Chemistry Including Medicinal Chemistry 14B, 231–232.

69) Dinamani, M., Savaiah, S., Rao, A.R., 2009. Chemoprevention of DMBA induced skin tumorigenesis in Swiss albino mice: a study with Nyctanthes arbor-tristis leaf extract. The Bioscan 4, 295–299.

70) Gadgoli, C., Shelke, S., 2010. Crocetin from the tubular calyx of Nyctanthes arbor- tristis.

Natural Product Research 24, 1610–1615.

71) Gupta, P., Bajpai, S.K., Chandra, K., Singh, K.L., Tandon, J.S., 2005. Antiviral profile of Nyctanthes arbor-tristis L. against encephalitis causing viruses. Indian Journal of Experimental Biology 43, 1156–1160.

72) Gupta, P.P., Srimal, R.C., Srivastava, M., Singh, K.L., Tandon, J.S., 1995. Anti-allergicactivity of arbortristosides from Nyctanthes arbor-tristis. International Journal of Pharmacognosy 33, 70–72.

73) Gupta, P.P., Srimal, R.C., Tandon, J.S., 1993. Antiallergic activity of some traditional Indian medicinal plants. International Journal of Pharmacognosy 31, 15–18.

74) Gupta, S.K., Bokadia, M.M., 1976. Flavanoids from the flowers of Nyctanthes arbor-tristis Linn. Vijnana Parishad Anusandhan Patrika 19, 377–380.

75) Hukkeri, V.I., Akki, K.S., Sureban, R.R., Gopalkrishna, B., Byahatti, V.V., Rajendra, S.V., 2006. Hepatoprotective activity of the leaves of Nyctanthes arbor-tristis Linn. Indian Journal of Pharmaceutical Sciences 68, 542–543.

76) Talakal, T.S., Dwivedi, S.K., Sharma, S.R., 2000. In vitro and in vivo antitrypanosomalpotential of Nyctanthes arbor-tristis leaves. Pharmaceutical Biology 38, 326–329.

77) Tripathi, S., Tripathi, P.K., Singh, P.N., 2010. Antidepressant activity of Nyctanthes arbor-ristis leaf extract. Pharmacologyonline 3, 415–422.

78) Tripathi, S., Tripathi, P.K., Chitranshia, N Singh, P.N., 2011. Antiaggressive activity of Nyctanthes arbor-tristis leaves in rodents. Pharmacologyonline 1, 1290– 1300.

79) Tuntiwachwuttikul, P., Rayanil, K., Taylor, W.C., 2003. Chemical constituents fromthe flowers of Nyctanthes arbor-tristis. Science Asia 29, 21–30.

80) Turnbull, J.H., Vasistha, S.K., Wilson, W., Woodger, R., 1957. Nyctanthic acid, a constituent of Nyctanthes arbor-tristis. Journal of the Chemical Society, 569–573.

81) Vankar, P.S., 2008. Antioxidant activity of the flower of Nyctanthes arbor-tristis L. International Journal of Food Engineering, 4.

82) Vishwanathan, M., Juvekar, A.R., 2010. Hepatoregenerative effect of Nyctanthes arbor-tristiss. Linn on acetaminophen-induced oxidative damage in rats. International Journal of Pharmaceutical and Technical Research 2, 1291–1297.