

Nyctanthes arbor-tristis – A Review

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Abstract

Nyctanthes arbor-tristis is small sacred ornamental tree known across the country for its beautiful fragrance and white orange flowers. It is widely cultivated in tropical and subtropical regions all over the world. Phenolic compounds, tannins, cardiac glycosides, terpenoids, saponins, steroids, carbohydrates, proteins and alkaloids are present in *N. arbor-tristis*. The crude extract of different parts of *N. arbor-tristis* i.e. leaf, bark, root and seed used as traditional medicine for the treatment of various diseases. Plant have analgesic, anti-inflammatory, anti-nociceptive, hepato-protective, antimicrobial, anti-fungal, anti-cancer, antidiabetic, anti-allergy, antioxidant, anticholinesterase, immunopotentiator, anti-filarial, anti-leishmanial, antiparasitic, CNS depressant, anti-anxiety, sedative, anti-anemic, anti-aggressive, antipyretic, ulcerogenic, anti-histaminic, anti-tryptaminergic, anti-malarial and immunostimulant activity.

Key Words – Nyctanthes, Harsinghar, ornamental, traditional and medicine.

Introduction

Nyctanthes arbor-tristis is small sacred ornamental tree known across the country for its beautiful fragrance and white flowers. *N. arbor-tristis* is 10 m tall, with flaky grey bark, stiff, whitish hair, young branches and rough leaves (Sasmal *et al.* 2007). It is one of the well known and most useful medicinal plant, belong to the family Nyctaginaceae (Oleaceae). It is popularly known as Night Jasmine or Harsinghar, due to the fact that it flowers emit very strong and pleasant fragrance during the whole night (Siddiqui *et al.* 2006 ; Rout *et al.* 2007, Rani *et al.* 2011, Pandey, 2013). The flowers start falling after midnight and by the day break, the plant appears dull. The generic name ‘Nyctanthes’ has been coined from two Greek words ‘Nykhta’ (Night) and ‘anthos’ (flower) (Vats *et al.* 2009 ; Meshram *et al.* 2012). The specific name ‘arbortristis’ meaning ‘the sad tree’ is derived from dull looks of the tree during daytime (Suresh *et al.* 2010 ; Bansal *et al.* 2015). It is a terrestrial woody perennial having life span of 5 - 20 years (Rani *et al.* 2011).

Different Names of Plant

The plant is known as Harsinghar, Harsingur, Seoli, Sheoli, Sihau (Hindi), Parijata, Parijatah, Parijataka, Sephalika (Sanskrit), Coral Jasmine, Night Jasmine (English), Harsinghar, Sephalika, Seoli, Sheoli (Bengali), Jayaparvati, Parijatak (Gujarati), Goli, Harsingaar, Parijata (Kannada), Pardic, Parizatak, Parzonto, Parzot (Konkani), Mannapu, Pavizhamalli, Parijatakom (Malayalam) Kharbadi, Kharassi, Khurasli, Parijatak (Marathi), Godokodiko, Gunjoseyoli, Singaraharo (Oriya) Harsinghar (Punjabi), Manjhapu, Pavala- Malligai, Pavazha-Malligai (Tamil) Kapilanagadustu, Pagadamalle, Parijat, Sepali (Telugu), Gulejafari, Harsingar (Urdu) Coral Jasmine (Filipino) Srigading (Indonesian) Salikaa (Lao), Seri Gading (Mlay), Karanikaa (Thai), Iai Tau (Vietnamese) (Kiew and Baas, 1984 ; Yadav, 2004 ; Shandhar and Kaur, 2011 ; Rani *et al.* 2011 ; Desai *et al.* 2016).

Distribution

Nyctanthes arbor-tristis is widely cultivated in tropical and subtropical regions all over the world. It is native to Southern Asia (Rani *et al.* 2011). It grows in Himalayan ranges from Chenab to Nepal, Bangladesh, Indo-Pak subcontinent and South-East Asia, Indo- Malayan region and distributed across Terai tracts as well as Burma, Thailand and Ceylon. In India, it grows in the outer Himalayas and found in tracts of Jammu and Kashmir, Nepal to East of Assam, Bengal, Tripura extended through the central region up to Godavari in the South (Nadkarani, 1982 ; Kirtikar and Basu, 2000 ; Rani *et al.* 2011 ; Agarwal and Pal, 2013 ; Bansal *et al.* 2015).

Climate and Soil

The plant can grow on rocky ground in dry hill shades, dry deciduous forests or at sea-level up to 1500 m altitude with a wide range of rainfall patterns. It is often cultivated in gardens due to its most pleasant and peculiar fragrance (Lal, 1936 ; Khare, 2004 ; Das *et al.* 2010 ; Sandhar *et al.* 2011 ; Bansal *et al.* 2015). This tree grows well in a wide variety of loamy soils with pH 5.6–7.5. The plant requires conditions varying from full sunlight to partial shade and needs to be watered regularly but does not require over watering (Kirtikar and Basu, 1935 ; Kiew *et al.* 1984 ; Sasmal *et al.* 2007 ; Rani *et al.* 2011).

Morphological characters

Leaves

Leaves are opposite, simple, petiolate, exstipulate , 5 -10 cm long, 2.5 – 6.3 cm broad, ovate, acute or acuminate, entire or serrated, petiole 6 cm long, hairy (Bhosale *et al.* 2009 ; Sah and Verma, 2012). The upper surface dark green with dotted glands and the lower surface pale green and softly pubescent. *N. arbor-tristis* venation is unicostate and reticulate (Biswas1 and Mukherjee, 2011 ; Rani *et al.* 2011 ; Desai *et al.* 2016 ; Jain and Pandey, 2016).

Flowers

The flowers are arranged at the tips of branches terminally or in the axils of leaves and are small, often seen in clusters of 2-7 together (Jain *et al.* 2016), delightfully fragrant, sessile in pedunculate bracteate fascicles of 3–5, peduncles. Bracts broadly ovate or suborbicular, 6-10 mm long, apiculate, hairy on both sides. Calyx 6-8 mm long, narrowly campanulate, hairy outside, glabrous inside, truncate or obscurely toothed or lobed. Corolla glabrous rather more than 13 mm long, tube 6-8 mm long, orange colour, about equaling the limb, lobes white corolla with an orange-red center and sessile. Two stamens are inserted near the top of the corolla tube and stigma is obscurely divided by cleft into two part (Bhosale *et al.* 2009; Kirtikar and Basu, 2010 ; Desai *et al.* 2016 ; Jain and Pandey, 2016).

Fruits

The fruit is flat, brown and heart cordate-shaped to rounded-capsule, around 2 cm in diameter with two celled opening transversely from the apex, each containing a single seed. Microscopically, in the epicarp epidermal cells were compactly arranged, polygonal cells with slightly anticlinal walls covered by a thin cuticle followed by 1-3 layers of collenchyma, spongy parenchymatous tissue, sclerenchymatous fibres and oil gland (Bhosale *et al.* 2009 ; Kirtikar and Basu, 2010 ; Biswas1 and Mukherjee , 2011; Rani *et al.* 2011; Shinde *et al.* 2014 ; Desai *et al.* 2016).

Seed

The seed is compressed and is one per cell (Sah and Verma, 2012). Seeds are exalbuminous, testa thick, the outer layer of large transparent cells and heavily vascularised (Sasmal *et al.* 2007, Bhosale *et al.* 2009 ; Kirtikar and Basu, 2010; Rani *et al.* 2011, Desai *et al.* 2016 ; Jain and Pandey, 2016).

Stem and Bark

It is large shrub growing up to 10 m tall, with quadrangular branches. Bark of *N. arbor-tristis* plant is dark gray or brown in colour, rough and firm. Bark surface is dippled due to scaling off of circular barks and patchy due to gray brown colour regions. Inner bark is creamy white, soft and collapsed and non-collapsed phloem zone distinctly visible (Biswas1 and Mukherjee , 2011; Nirmal *et al.* 2012 ; Desai *et al.* 2016 ; Jain and Pandey, 2016).

Cultivation

It is often cultivated in gardens due to its most beautiful flowers and aroma. The shrub can be propagated by cutting as well as by seeds. The seeds have been found to exhibit a poor germination rate because of phenolic compounds leaching out of the imbibed seeds. These inhibitory phenolic compounds were stored in the pericarp assisted by the seed coat. The speed of germination is improved by either removing both. The treating seeds with a solution of antioxidants like polyvinylpyrrolidone and polyvinylpolypyrrolidone prior to germination (Shah and Verma, 2012).

Propagation

Plantlets of *N. arbor-tristis* can be raised *in vitro* from isolated immature embryos using excised cotyledons, hypocotyls, roots, leaves and bases of internodes of plantlets. Calli from cotyledons, hypocotyls and root show faster growth as compared with those from leaves and internodal bases when cultured in Murashige and Skoog's medium with 2, 4-dichlorophenoxyacetic acid, naphthalene acetic acid (NAA) and coconut milk. Plantlets are also regenerate in MS medium supplemented with thiaziduron (TDZ) and 6- benzyladenine (BA). Rooting is achieved *ex-vitro* by plunging the basal cut ends of regenerated shoots in indole-3-butyric acid (IBA) followed by transplantation in sterile soil contained in plastic pots. The plantlets with well developed shoots and roots can be successfully grown in garden soil in earthen pots with 85% survival rate. (Iyer *et al.* 1998; Rani *et al.* 2011 ; Desai *et al.* 2016).

Plant myths

The Parijata tree of the Matsya Purana list of articles secured from the churning of the milky ocean is considered as a Kalpa-vrksha, the heavenly tree which symbolizes mind. As the name implies, it remains with each one of us from birth and whatever one desires under its shade one gets.

The Parijata tree which arose from the milky ocean was taken by Indra and planted in his heavenly pleasure garden Vaikuntha. According to the Bhagavata Purana, Narad brought some flowers from the tree and gave them to Lord Krishna, Lord Krishna gifted the flowers to his wife Rukmani. Narad told Satyabhama (Krishna's other wife) about this and advised her to ask Krishna to get the Parijaat tree and from Indralok and plant it in her garden. Satybhama did exactly that and in the mean time Narad went back to Indralok and warned Indra that someone from the earth might attempt to steal the tree from Indralok. An angry Indra confronted Krishna while he was leaving with a branch of the tree. This led to a battle in which Indra lose. However, he put forth a curse on the branch that it will never bear fruit even though it may produce flowers, since then, the tree does not bear any fruit .The tree was then transported to Dwaraka where it was planted in Satyabhama's garden (Gupta, 1971). The Parijata is regarded in Hindu mythology as one of the five wish-granting trees of Devaloka (Shandhar and Kaur, 2011).

Phytochemicals

Phenolic compounds, tannins, cardiac glycosides, terpenoids, saponins, steroids, carbohydrates, proteins and alkaloids are present in *N. arbor-tristis* (Kapoor *et al.* 1971; Dhingra *et al.* 1976).

Phyto-constituents From Leaves

The benzoic esters of Loganin and 6- β -hydroxy loganin, namely Arborside-A, Arborside- B, and Arborside-C are present in the leaves. In leaves 10- Benzoyllyctanthoside named as Arborside-D was isolated. Other iridoid glycosides which are reported are 6, 7-Di-O-benzoyl nyctanthoside, 6-O-transcinnamoyl- 6- β -hydroxy loganin and 7- O-trans cinnamoyl-6- β -hydroxy loganin, a phenyl propanoid glucoside Desrhamnosylverbascoside. Leaves also contain the alkaloid nyctanthine along with mannitol, β -amyryn, β -sitosterol, hentriacontane, benzoic acid, astragaline, nicotiflorin, oleanolic acid, nyctanthic acid, friedelin, lupeol, astringent, resinous substances, ascorbic acid, coloring matters, sugar, tannic acid, methyl salicylate, carotene and traces of volatile oil. (Singh *et*

al. 1965 ; Anjaneyulu and Murthy, 1981; Singh and Jindal, 1985; Srivastava *et al.* 1990; Singh *et al.* 1995 ; Mathuram *et al.* 1997, Jain and Mittal, 2011; Shandar and Kour, 2011 ; Jain and Pandey, 2016).

Phyto-constituents From Stems

A glycoside Naringenin-4'-O- β -glucopyranosyl- α -xylopyranoside β -Amyrin, Arbortristoside-A, Oleanolic acid, Nyctoside-A, Nyctantacid and 6- β - hydroxyloganin are reported from the stem (Tondon *et al.* 1991; Jain and Mittal, 2011; Shandar and Kour, 2011; Jain and Pandey, 2016).

Phyto-constituents From Seeds

Seeds give a water soluble polysaccharide containing D-Glucose and D-Mannose, indicating that the polysaccharide is a glucomannan. Iridoidglucosides arbortristoside-A, arbortristoside B, arbortristoside-C and 6- β -hydroxyloganin are present. Further *N. arbor-tristis* also contains two minor iridoidglucosides, arbortristoside-D and arbortristoside-E. Other iridoidglucoside reported are Nyctanthoside, A phenyl propanoid glucoside, Nyctoside-A are also isolated from the methanolic extract of the seeds.(Jain and Mittal 2011; Shandar and Kour, 2011).Seed kernels yield 12-16% of the pale yellow brown fixed oil, which consists of glucosides of linoleic, oleic, lignoceric, stearic, palmitic acid and b-sitosterol (Singh and Jindal 1985; Mathuram *et al.* 1997). On keeping the oil for several weeks at 0°C, a tetracyclic triterpenoid acid named nyctanthic acid is deposited (Jain ,1991 ; Bhosale *et al.* 2009 ; Jain and Pandey, 2016)

Phyto-constituents From Flowers

Flowers contain modified diterpenoid nyctanthin, flavonoids, anthocyanins and an essential oil (Khatune *et al.* 2003). It also contains an antiplasmodial cyclohexylethanoid, renyolone, a new iridoidglucoside 6-O -trans-cinnamoyl-7-O-acetyl-6- β -hydroxyloganin and three known iridoidglucosides, arborside-C, 6- β -hydroxyloganin and nyctanthoside. It was found that after several months the compound arborside-C has changed to the isomeric structure with the benzoate group shifted to C-6-OH. This structure is named as isoarborside-C (Jain and Mittal, 2011; Shandar and Kour, 2011, Kakoti *et al.* 2013).Some essential oil, colouring material nyctanthin, anthocyanin, mannitol, carotenoids, flavonoids, tannin and glucose is also present in the flower (Jain, 1991; Mathuram and Kundu, 1991; Girach *et al.* 1994 ; Kirtikar and Basu 2000).

Phyto-constituents From Roots

The root part of the plant composed of alkaloids, tannins and glucosides. From the chloroform extract of the root, β -Sitosterol and Oleanolic acid has been isolated (Stuppner *et al.* 1993 ;Jain and Mittal, 2011; Shandar and Kour, 2011; Jain and Pandey, 2016)

Traditional Uses

The crude extract of different part of *Nyctanthes arbor-tristis* i.e. leaf, bark, root and seed used as traditional medicine for the treatment of various diseases. Use of different part of *Nyctanthes arbor-tristis* in ayurveda, sindha and unani systems of medicine has been prescribed from time immemorial (Surange and Pendse, 1971 ; Sabir *et al.* 1974; Pant, 1983 ; Girach *et al.* 1994 ;Goyal *et al.* 1999).

Leaves

Leaves are used as cholagogue, laxative, diaphoretic and anti-helminthic, antimicrobial activity (Goyal *et al.* 1999 ; Shukla *et al.* 2011; Bansal *et al.* 2015). Juice of the leaves is used as digestives, antidote to reptile venoms, mild bitter tonic and diuretic (Nandkarani, 1954 ; Kirtikar and Basu, 2000). Leaves also used in treatment of the spleen disease, sciatica (Goyal *et al.* 1999), arthritis (Omkar *et al.* 2006), fungal skin infection and in dry cough (Hukkeri *et al.* 2006; Shukla *et al.* 2011; Bhadouria *et al.* 2012). The leaf juice is used to treat loss of appetite, piles, liver disorders, biliary disorders, diabetes and malarial fever. Fresh leaf juice has been suggested to be safe

purgative for infants when given with honey mixed with common salt. Crushed fresh leaves are externally used for ulcers and sore to reduce inflammation (Agrawal and Pal, 2009). The young leaves are used as female tonic and in alleviating gynaecological problems and also have wound healing activity (Deshmukh, 2007 ; Nawaz *et al.* 2009 ; Bharti *et al.* 2011 ; Shandhar and Kaur, 2011; Sah and Verma, 2012 ; Rani *et al.* 2012 ; Desai *et al.* 2016).

Flowers

The flowers of *N. arbor-tristis* are used to provoke menstruation. The hot infusion of flowers is used as a sedative. The flower helps in clearing out mouth ulcers (Sasmal *et al.* 2007), stimulate gastric secretions and improve expectoration from the lungs (Suresh *et al.* 2011). The decoction is also used in treatment of gout (Kirtikar and Basu, 1993). The flower juice is used as a hair tonic in preventing graying of hair and baldness (Tuntiwachwuttiku *et al.* 2003; Sah and Verma, 2012).The flowers are used as stomachic, carminative, astringent to bowel, antibilious, expectorant and in the treatment of ophthalmic purposes (Shandhar and Kaur, 2011 ; Rani *et al.* 2012 ; Bansal *et al.* 2015 and Desai *et al.* 2016).

Stem and Bark

Traditionally the powdered of stem bark is given in rheumatic joint pain and in also used as expectorant (Badam *et al.* 1988 ; Aminuddin *et al.* 1993 ; Gupta *et al.* 2005; Rani *et al.* 2012). Stem bark of *N. arbor-tristis* showed antimicrobial activity. Bark used for treatment of bronchitis and snakebite (Agrawal and Pal, 2009). The stem bark pounded with *Zingiber officinale* and *Piper longum* is boiled in water and the resultant liquid is taken for two days for the treatment of malaria (Shandar and Kour 2011; Rani *et al.* 2012 ; Nirmal *et al.* 2012 ; Desai *et al.* 2016).

Seeds

The seed powder is used for scalp scurvy, in alopecia, in skin diseases and used as anthelmintic (Agrwal and Pal, 2009). It is antibilious and an expectorant and is used for the treatment of bilious fevers. The patients are suffering from piles are advised to apply fresh paste externally on piles, along with the internal use of the powdered seeds. The decoction of seeds is used as hair tonic and advised to wash the hair daily in order to get rid from dandruff and lice (Shandar and Kour, 2011 ; Nirmal *et al.* 2012 ; Desai *et al.* 2016).

Roots

Roots are traditionally used as anthelmintics (Narendhirakannan and Smeera, 2010 ; Rathod *et al.* 2010, Sah and Verma, 2012 ; Desai *et al.* 2016).

Pharmacological Activities

1. Analgesic activity

The analgesic activity of aqueous and ethanolic leaves extract of *N. arbor-tristis*, it was found from the percentage inhibition index that ethanolic extract shown better analgesic than aqueous extract when compared with standard drug aspirin (Nirmal *et al.* 2012). Petroleum ether extract and β -Sitosterol from *N. arbor-tristis* leaves might be responsible for analgesic activity (Saxena *et al.* 1987 ; Tripathi *et al.* 2011 and Bhdauria *et al.* 2012).

2. Anti-inflammatory activity

The aqueous extract of the whole plant and alcoholic extract of stem,sedd and leaves reported to have acute and subacute anti-inflammatory activity. The acute antiinflammntory activity is evaluated on inflammatory models using different phlogistic agents' viz. carrageenan, formalin, histamine, 5-hydroxytryptamine and hyaluronidase

in the hindpaw of rats. In the subacute models, *N. arbor-tristis* was found to check granulation tissue formation significantly in the granuloma pouch and cotton pellet test. *N. arbor-tristis* is also found to inhibit the inflammation produced by immunological methods that are Freund's adjuvant arthritis and purified tuberculin reaction (Saxena *et al.* 1984 ; Singh *et al.* 1984 ; Paul and Saxena, 1997; Tuntiwachwuttikul *et al.* 2003 ; Omkar *et al.* 2006 ; Das and Basu, 2008; Bhauria *et al.* 2012; Balasubramanian , 2012 and Bansal *et al.* 2015).

3. Anti-Nociceptive

The aqueous soluble fraction of ethanolic extract of the leaves exhibited significant aspirin-like antinociceptive activity which was evidenced by inhibition of acetic acid-induced writhing in albino mice (Tuntiwachwuttikul *et al.* 2003 ; Rani *et al.* 2012 and Desai *et al.* 2016).

4. Hepato-protective activity

The aqueous extracts of the leaves and seeds of *N. arbor-tristis* were found to have anti-hepatotoxic activity against carbon tetrachloride induced hepatotoxicity (Lucas and Sekhar 2000; Hukkeri *et al.* 2006). Further, it was established that the alcoholic and aqueous extracts showed significant hepatoprotective activity by reducing the levels of serum glutamic pyruvic transaminase (SGPT) , serum glutamic oxaloacetic transaminase (SGOT) and serum bilirubin. The results were supported by histopathological studies of liver samples which showed regeneration of hepatocytes by the extracts (Khatune and Mosadik 2001; Laghate *et al.* 2003; Wagh *et al.* 2010; Vishawnathan and Juvekar, 2010 ; Rani *et al.* 2012 and Singh *et al.* 2014).

5. Antimicrobial activity

Phenolic compounds and tannins in ethanolic extract of leaves are found to be active against *Staphylococcus aureus* and *Salmonella paratyphi*. Antibacterial evaluation of aqueous and alcoholic extract of leaves against numerous Gram positive and Gram negative strains revealed that *Salmonella typhimurium*, *Pseudomonas aeruginosa*, *Klebsiella pneumonia*, *E. coli*, *P. marginata* and *Staphylococcus epidermis* were found more susceptible to the aqueous extract where as *Micrococcus luteus*, *Staphylococcus aureus*, *Sterptococcus pyogenes* and *Bacillus subtilis* were more sensitive to methanolic extract. Chloroform and ethyl acetate extracts of fresh and dried leaf, flowers, fruits and seeds are also reported to have a dose dependent antibacterial activity against Gram negative bacteria. The activity has been found significant for fresh plant materials than the dried plant parts (Mahida and Mohan, 2007; Jain and Mittal , 2011; Kumari, 2012; Balasubramanian 2012; Aggarwal and Goyal 2013; Hirapure and Pote, 2014 ; Suparna *et al.* 2014 and Geetha *et al.* 2014).

6. Antifungal activity

The stem bark extracts (petroleum ether, chloroform and ethanol) are found to have potential antifungal activity against *Candida albicans* and *Aspergillus niger* (Balasubramanian, 2012; Aggarwal and Goyal, 2013; Hirapure and Pote, 2014 ; Suparna *et al.* 2014 and Geetha *et al.* 2014). Leaf extract of *N. arbor-tristis* are found effective in reducing radial growth of 3 fungal pathogens of rice viz. *Pyricularia oryzae*, *Cochliobolus miyabeanus* and *Rhizotonia solania* (Vats *et al.* 2007; Karnik *et al.* 2008, Prashad and Shekhar, 2014).

7. Anti-Cancer activity

Fruit, leaf and stem methanol extracts of *N. arbor-tristis* were tested for *in vitro* anticancer activities. Moderate activity was observed at 30mg/ml conc. with 71% inhibition of dried *N. arbor-tristis* leaf methanol extract and least inhibitory activity was observed at 10mg/ml conc. with 86% inhibition of breast cancer cell lines free of pathogens. The phyto-chemicals isolated from *N. arbor-tristis* dried fruit methanol are glycosides, tannins, phenols and steroids and are predicted to be responsible for this anticancer activity (Khatune *et al.* 2003 and Desai *et al.* 2016).

8. Antidiabetic activity

Ethanol extract of the stem bark possess significant anti-diabetic activity when treated in streptozotocin-nicotinamide induced diabetic rats. The extract lowers the blood glucose level in a dose-dependent manner (Sah and Verma, 2012). Methanol extract of root of *N. arbor-tristis* is poses safe and strong anti-diabetic activity. The extract was prepared by extracting 50g root powders with 400 ml of methanol for 18 hours by hot continuous extraction method. The methanolic extract was filtered and partitioned by using petroleum ether to remove impurities. The solvent was evaporated under pressure and dried in vacuum. The dried extract *N. arbor-tristis* thus obtained was used for the assessment of hypoglycaemic activity. It reduces blood glucose level after seven days at the 500 mg/Kg in rats compare with standard drug. It was found that methanolic extract of *N. arbor-tristis* roots were more effective in reducing the blood glucose level compare to the standard drug (Bharti and saxena, 2011; Sharma *et al.* 2011; Pattanayak *et al.* 2012).

9. Anti-Allergy Activity

The pretreatment of guinea pigs exposed to histamine aerosol with a water soluble portion of the alcoholic extract of *N. arbor-tristis* leaves offered significant protection against the development of asphyxia. Arbortristoxide A and arbortristoxide C are present in *N. arbor-tristis* were reported to be anti-allergic (Rathee *et al.* 2007).

10. Antioxidant activity

The leaves and stem of *N. arbor-tristis* are potential source of natural antioxidants (Thangavelu and Thomas, 2010). Phytochemical screening of the ethanolic extract of the leaves and stem of *N. arbor-tristis* revealed the presence of flavonoids, tannins, saponins, glycosides, alkaloids, steroids and phenolic compounds Phenolic compounds have been recognized as antioxidant agents, which act as free radical terminator (Singh *et al.* 1984 ; Paul and Saxena, 1997) and have been known to show medicinal activity and exhibit physiological functions (Sofowora, 1993).The encouraging results of *N. arbor-tristis* with the various *in vitro* antioxidant tests proved the plant as a reducing agent and effective as scavenger of hydrogen peroxide and free radicals.The overall antioxidant activity of *N. arbor-tristis* might be attributed to its polyphenolic content and other phytochemical constituents (Dasgupta and De, 2006 ; Rathee *et al.* 2007, Kusum 2009, Rani *et al.* 2012; Michael *et al.* 2013 and Khanapur *et al.* 2014).

11. Anticholinesterase activity

The aqueous extract of *N. arbor-tristis* stimulated the activity of acetylcholinesterase in mice and antagonize the inhibition of this enzyme by malathion. The higher effects were seen in the serum than in the brain. The low antimuscarinic activity against acetylcholine induced contractions of isolated rabbit ileum was already reported (Tandon *et al.* 1991; Bhdauria *et al.* 2012 ; Desai *et al.* 2016).

12. Immunopotentiator activity

The anti-immunosuppressive effect of an aqueous extract of *N. arbor-tristis* was determined in three to four week old swiss albino mice (20-25 g) which were exposed to the extract, malathion. An aqueous extract of *N. arbor-tristis* reverted non specific, humeral and cell - mediated immunological parameters to normalcy as the values of antibody titres of the non specific immune parameters and of cell mediated immune parameters were raised by extract. The Fc receptor bearing cell counts, complement receptor, T-cell number, bearing Blymphocytes and IgG bearing B-cells of the extract-treated malathion mice were also increased towards normalcy while the phagocytic index was greater than in malathion mice not treated with the extract. The results showed that aqueous extract of leaf of *N. arbor-tristis* showed immunopotentiator activity with the effective capacity for potentiating both humoral as well as cell mediated immune responses (Hukkeri *et al.* 2006 ; Bhdauria *et al.* 2012 ; Desai *et al.* 2016).

13. Antifilarial activity

The chloroform extract of the flowers and a pure compound isolated from *N. arbor-tristis* plant exhibit larvicidal activity against *Culex quinquefasciatus* say, a common filarial vector (Khatu na, 2001; Ratnasooriya *et al.* 2005 ; Bhdauria *et al.* 2012 and Desai *et al.* 2016).

14. Anti-Leishmanial Activity

The anti-leishmanial activity of *N. arbortristis* has been attributed to iridoid glucosides, arbortristosides A, B, and C and 6-b-hydroxyloganin (Rathee *et al.* 2007). The arbortristosides A, B, C, and 6-beta-hydroxy-loganin exhibited both *in vitro* and *in vivo* anti-leishmanial activity against amastigotes in macrophage cultures and hamsters test systems, respectively (Tondon *et al.* 1991 ; Singh *et al.* 1992; Puri *et al.* 1994 ; Khan *et al.* 1995 ; Banerjee *et al.* 2007 and Rani *et al.* 2012).

15. CNS depressant activity

It was reported that the leaves, flowers, seeds and barks of *N. arbor-tristis* exhibited significant and dose-dependent prolongation of onset and duration of sleep and found to cause decrease in dopamine and increase serotonin level from which it can be resolved that the CNS depressant activity of the ethanol extracts of seeds, leaves and flowers may be due to the decrease in dopamine and increase in serotonin level (Das and Basu, 2008 and Suresh *et al.* 2010).

16. Anti Anxiety

Hydroalcoholic extracts of *N. arbor-tristis* have anxiolytic potential. Using hydro-alcoholic mixture, dried plant parts of *N. arbor-tristis* was extracted, concentrated by distilling off the solvent and then evaporated to dryness on the water bath and then stored in an air tight container in a refrigerator till used (Abraham, 2010).

17. Anti-Trypanosomal Potential

Antitrypanosomal potential of a crude 50% ethanolic extract of *N. arbor-tristis* leaves was evaluated *in vitro* and *in vivo*. The extract exhibited trypanocidal activity at the highest concentration (1000 µg/ml) tested (Talakal *et al.* 2000 ; Jain and Pandey, 2016).

18. Sedative Effects

Hot infusion of *N. arbo-tristis* flowers have potential sedative effect. Different concentrations of hot flower infusion was made and orally administered. Sedative potential was assessed 2 h post-treatment. The infusion had a moderate dose-dependent conscious sedative activity in male but, surprisingly, not in female rats. The infusion was well tolerated, in terms of overt toxic signs, liver or kidney functions even following subchronic treatments and also did not show any overt signs of dependence (Ratnasooriya and Jayakodi, 2005).

19. Antibacterial Activity

The antibacterial potential of *N. arbor-tritis* was evaluated for gram positive (*Staphylococcus aureus*) and gram negative (*Escherichia coli*, *Klebsiella pneumonia*, *Pseudomonas aeruginosa*) bacteria. The dried leaf, flower, fruit and seed extracts prepared in ethyl acetate and chloroform were used to assess their antibacterial potential in terms of zone of inhibition of bacterial growth. These activities of plant parts were due to the presence of various plants secondary metabolites viz. glycosides and phenolics. The ethanolic and hydro-alcoholic extracts of the leaves were also investigated for its antibacterial performance against both antibiotic resistant and nonresistant strains of *Staphylococcus aureus*. A benzofuranone, 3, 3a, 7, 7a-tetrahydro-3ahydroxy- 6 (2H)

benzo-furanone, was isolated from the flowers. The compound showed significant antibacterial activity against both gram positive and gram negative bacteria (Mahida and Mohan, 2007; Jain and Mittal, 2011 and Kumari, 2012).

20. Anti-Viral activity

The ethanolic extract, n-butanol fractions and two pure compounds, arbortristoside A and arbortristoside C, isolated from the *N. arbor-tristis* possess pronounced inhibitory activity against encephalo myocarditis virus (EMCV) and Semliki Forest Virus (SFV). The *in-vivo* ethanolic extract and the n-butanol fraction at daily doses of 125 mg/kg weight protected EMCV infected mice against SFV by 40 and 60% respectively (Brain and Turner, 1975; Rathore *et al.* 1990 ; Paul and Saxena 1997; Saxena *et al.* 2002; Gupta *et al.* 2005 ; Jain and Mittal, 2011; Rani *et al.* 2012 and Desai *et al.* 2016)

21. Tranquilizing, Antistaminic And Purgative Activity

An intensive research was done with water soluble portion of the alcoholic extract of the leaves of this plant for some CNS activities (*viz.* hypnotic, tranquilizing, local anaesthetic, hypothermic, anticonvulsant), antihistaminic and purgative activities. The results were found in accordance with major standard tranquilizers and thus supported the usage of the plant by Ayurvedic physicians in aforementioned conditions (Jain and Mittal, 2011 and Jain and Pandey, 2016).

22. Antianemic Activity

A research was performed as hematological study on the ethanolic extracts of the flowers, barks, seeds and leaves of the plant and noticed the dose dependent rise in hemoglobin content and red blood cells count in rats. The extracts also protect the decline of hemogram profile in anemic rats (Jain and Mittal, 2011 ; Jain and Pandey, 2016).

23. Antipyretic and Ulcerogenic Activity

The extract exhibited antipyretic effect against brewer's yeast-induced pyrexias in rats. When administered orally for six successive days in rats. The water soluble portion of an ethanol extract of the leaves was screened for antipyretic and ulcerogenic activities (Tripathi *et al.* 2011).

24. Anti-Histaminic and Anti-Tryptaminergic activity

The aqueous soluble of the alcoholic extract of *N. arbor-tristis* leaves (4.0 and 8.0g/kg oral) significantly protect against histamine aerosol - induced asphyxia (2% at 300 mm Hg) in guinea pigs. Arbortristosid A and arbortristosid C present in *N. arbor-tristis* was reported to be anti allergic (Chatterjee and Bhattacharjee, 2007; Bhadauria, 2012).

25. Anti-Malarial activity

Clinical study on 120 patients of malaria. Administration of fresh paste of medium sized 5 leaves of *N. arbor-tristis* thrice a day for 7-10 days has cured the disease in 92 (76.7%) patients within 7 days. Other 20 patients were cured by 10 days while the remaining 8 patients did not respond to the treatment. The paste was well tolerated and no severe side effects were reported. Screening of methanol and chloroform extract of leaves for mosquito larvicidal activity against 3 major mosquito vectors-*Aedes aegypti*, *Culex quinquefasciatus* and *Anopheles stephensi* found the two extracts to kill larvae of *A. stephensi* with LC50 values of 244.4 and 747.7

ppm, respectively (Deshmukh, 2007 ; Balasubramanium 2012; Sah and Verma, 2012; Kumari *et al.* 2012; Raychaudhury, 2013 and Jain and Pandey, 2016)

26. Immunostimulent activity

Plant extracts have been widely investigated for their possible immunomodulatory properties (Alamgir and Uddin 2010). Aqueous leaf extract of *N. arbor-tristis* has been found as a immunomodulator (Chatterjee *et al.* 2007) as evidenced by both humoral and cell mediated responses (Puri *et al.* 1994 ; Bhatia and Kaur, 2001 and Rani *et al.* 2012)

Commercial Use

The orange heart is used for dyeing silk and cotton, this practice was started with Buddhist monks whose orange robes were given their colour by this flower. Traditionally the flowers are gathered for religious offerings and to make garlands. The essential oil in the fragrant flowers, which is similar to the oil in *N. arbor-tristis*, is used as perfume. The bright orange corolla tubes of the flowers contain a coloring substance nyctanthin, which is identical with α -Crocein from Saffron. The corolla tubes were formerly used for dyeing silk, sometimes together with Safflower, turmeric and Indigo (Shandhar and Kaur, 2011). The bark may be used as a tanning material and the leaves are sometimes used for polishing wood and ivory (Rani *et al.* 2012)

Toxicity

Nyctanthes arbor-tristis shown toxic effect of ethanolic extract of leaves in rats. The median lethal dose 16 gm/kg was observed in rats. No mortality was at 2.0 gm/kg while 75% mortality was seen at a 32 gm/kg dose. An administration of ethanol extract of the leaves (1, 2 and 4 gm/kg/day) orally for 6 consecutive days is produced gastric ulcers in rats. This extract also showed irritant effects as it, dose-dependently, the formation of unformed semi-fluid collagenous pasty stools in albino mice because of a purgative effect .when extract instilled into the rabbit's eye produced conjunctival congestion with oedema, while the person who grounded the dried leaves developed vesicles on both palms (Rani *et al.* 2012 ; Desai *et al.* 2016).

Conclusion

Nyctanthes arbor-tristis is easily available plant and no special conditions are required for its collection and cultivation. It is a rich source of biologically active compounds, which would attract the attention of drug discovery groups to discover bioactive molecules for the treatment of various diseases. This review article revealed the importance of herbal and ayurvedic pathway for effective treatment of various diseases considering tremendous potential pharmacological activities of the *N. arbor-tristis*. The wide spread use of the plant in traditional system of medicine for varied ailments is supported by various authors.

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