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Medicinal Significance Of Celastrus Paniculatus: From Ayurveda To Modern Therapeutics

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Abstract

Celastrus paniculatus, also referred to as the "Intellect Tree," is a medicinal plant that has long been utilised in Ayurvedic medicine. Alkaloids, flavonoids, and sesquiterpenes found in its seeds and oil give it nootropic, anti-inflammatory, and antioxidant properties. Research indicates that it may enhance mental clarity, memory, and learning, which makes it a possible treatment option for neurodegenerative diseases like Alzheimer's. It also has antidepressant, anticonvulsant, and anxiolytic properties. C. paniculatus continues to get attention for its potential as a treatment for neurological and psychiatric disorders because of its wide pharmacological profile.

Key Points: Nootropic properties, Phytochemical Composition, Safety Profile, Traditional Uses

1. Introduction

The Celastraceae family includes Celastrus paniculatus Willd. Originally from India, this tiny to medium-sized woody plant is also found in many other countries, including Malaysia, Thailand, China, the Philippines, and the northeastern region of Australia. Several diseases and problems are treated with various parts of the Celastrus paniculatus plant, including the roots, bark, leaves, and seeds (1). Celastrus paniculatus, commonly referred to as the black oil plant, Malkangani, or Jyotishmati, is a member of the Celastraceae family. This climbing polygamoecious shrub, which is found nearly everywhere in India at elevations of 2000 m, requires assistance to climb its yellowish corky bark (2). For generations, Celastrus paniculatus (CP), a traditional Ayurvedic medicinal plant, has been utilised as a sedative, antiepileptic, analgesic, anti-inflammatory, and memory-enhancing herb. The neuropharmacological effects of the seed

extract have been thoroughly studied in a number of labs, and various papers attest to its nootropic action (3). Commonly referred to as "Malkangani," Celastrus paniculatus is found throughout the Pacific Islands, primarily in Maharashtra, Orissa, and the Andaman and Nicobar group of islands at an elevation of 1800 meters, as well as in the Maldives, Australia, China, Cambodia, Malaysia, Taiwan, Nepal, and Thailand. It ascends to more than 10 meters (4). Paniculatus Celastrus Wild is a climbing evergreen shrub. In the traditional Indian medical systems of Ayurveda, Unani, and Siddha, the plant holds immense importance. In addition to rheumatism, arthritis, sciatica, and leprosy, the seeds and their oil are widely used to treat neurological conditions like cognitive impairment, paralysis, epilepsy, and sleeplessness. In addition to examining the phytochemistry, traditional use, and other pharmacological properties of C. paniculatus, this research seeks to emphasise its nootropic activity (5).

1.1 Ethnopharmacological Significance

As a nootropic, nervine tonic, and rejuvenator, Celastrus paniculatus—known as Jyotishmati in Ayurveda—has ethnopharmacological significance. Its seed oil has long been used to treat rheumatism, neurological disorders, stress, and skin conditions, as well as to improve memory, intelligence, and mental alertness (6,7).

1.2 Morphological Description

Celastrus paniculatus is a big woody climbing shrub that is deciduous. It features serrated edges on large, oval or elliptic leaves. It has rough, pale brown bark with white lenticels all throughout it. Terminal, drooping panicles with tiny, yellowish-green flowers are called inflorescences. The fruit is a yellow, globose capsule with three to six seeds within, encased in a crimson aril (8).

1.3 Synonym

Celastrus leiocarpus, *C. oblanceifolius* and *C. rugosus* are confirmed as synonyms of *C. punctatus*, *C. aculeatus* and *C. glaucophyllus*, respectively (9).

1.4 Taxonomic Classification

- **Kingdom :** Plantae
- **Sub Kingdom :** Tracheobionta
- **Divison :** Magnoliophyta
- **Class :** Magnoliopsida
- **Subclass :** Rosidae
- **Order :** Celastrales
- **Family :** Celastraceae
- **Genus :** Celastrus
- **Species :** *Celastrus paniculatus* Willd. (10)

2. Biological Activity

2.1 Anti-oxidant Activity

By scavenging free radicals and preventing the production of reactive oxygen species, extracts from Celastrus paniculatus seeds demonstrate strong antioxidant activity. According to rat studies, extracts raise antioxidant enzymes like glutathione and catalase and decrease malondialdehyde in the brain, indicating a defence mechanism against oxidative stress (11).

2.2 Anti-Inflammatory Activity

In animal experiments, a variety of solvent extracts from Celastrus paniculatus seeds have continuously demonstrated anti-inflammatory properties. Extracts considerably reduce inflammation in models such as carrageenan-induced paw oedema in rats, which is on par with conventional anti-inflammatory medications. It is believed that the mechanism entails blocking important inflammatory enzymes like soluble epoxide hydrolase (sEH) and cyclooxygenase (COX) as well as controlling inflammatory cytokines like TNF-α and IL-1β. The plant's potent antioxidant qualities, which aid in preventing oxidative stress, which fuels inflammation, are also connected to this anti-inflammatory effect (12,13).

2.3 Neuroprotective Activity

Celastrus paniculatus seed oil and extracts have strong neuroprotective properties that shield neurones from glutamate-induced toxicity and oxidative stress. According to research on rat models of neurological conditions like epilepsy, C. paniculatus can slow down the death of neurones in parts of the brain like the hippocampus. Its antioxidant qualities and regulation of the glutamate and cholinergic neurotransmitter systems are responsible for its neuroprotective benefits, which improve memory and learning (14).

2.4 Anti-microbial and Anti-Fungal Activity

Extracts of Celastrus paniculatus from the plant's leaves, seeds, and root bark show a range of antibacterial properties against different types of bacteria and fungi. The solvent employed and the particular microorganism targeted determine how effective these extracts are. Gram-positive bacteria like Staphylococcus aureus and gram-negative bacteria like Pseudomonas aeruginosa and Klebsiella pneumonia have both been shown to be inhibited by studies employing extracts and isolated chemicals, such as celapanin from leaves (15). Several Celastrus paniculatus extracts have shown antifungal qualities, successfully preventing the growth of harmful fungus. Methanolic extracts from the mother plant and in vitro-grown clones of C. paniculatus leaves, for example, totally suppressed the growth of Phytophthora capsici and considerably inhibited Rhizoctonia solani, according to a 2019 study. According to other studies, methanolic extracts with larger concentrations are more effective against fungi such as Helminthosporium and Alternaria solani (16,17).

2.5 Anti-Ulcer Activity

Modern pharmacological research supports the traditional usage of Celastrus paniculatus for gastrointestinal disorders. In rats, the seed oil has demonstrated strong gastroprotective and antiulcer properties, especially against ulcers brought on by ethanol and indomethacin. The plant's anti-inflammatory and antioxidant qualities, as well as a decrease in gastric acid output and an elevation in gastric pH, are thought to be responsible for the antiulcerogenic activity. In particular, the seed oil protects the stomach mucosa from oxidative damage by raising anti-inflammatory cytokine levels and decreasing pro-inflammatory ones (18).

2.6 Anxiolytic & Anti-depressant Activity

The anxiolytic (anti-anxiety) properties of Celastrus paniculatus seed oil and extracts are validated by preclinical research. The oil and several extracts have been shown to reduce anxiety-like behaviours in a dose-dependent manner in mouse models, including the elevated plus maze and the open-field test. The serotonergic neurotransmitter system in the brain is thought to be modulated in this action, producing a calming effect without sedation. Additionally, it has been demonstrated that long-term administration of C. paniculatus oil lowers anxiety in animal models of chronic stress (19). In mice models of depression, Celastrus paniculatus seed oil has demonstrated notable antidepressant-like effects. Similar to the common antidepressant fluoxetine, the oil, when given over a series of days, successfully decreased the immobility period in forced swim and tail suspension experiments. The suppression of monoamine oxidase-A (MAO-A) activity in the brain, which raises monoamine neurotransmitter levels, and a decrease in plasma corticosterone (stress hormone) levels are two of the processes associated with antidepressant effectiveness. This implies a multi-target effect on the stress response system and neurotransmitter balance (20).

2.7 Reproductive Activity

Celastrus paniculatus has been found in rat studies to have an anti-fertility effect, especially on the male reproductive system. The weight of the reproductive organs decreased significantly, as did the sperm count and motility, when seed oil and ethanolic extracts were administered orally and intraperitoneally. Damage including vacuolization and halted spermatogenesis were discovered by histological analyses. Nevertheless, it was discovered that some of these testicular alterations were reversible following the end of treatment. Although more research is necessary, its traditional usage in females include as an abortifacient (21).

2.8 Potential Gut-Brain Axis Modulation

More and more studies are examining how Celastrus paniculatus modulates the gut-brain axis, connecting its effects on the gut microbiota to its neuroprotective and psychotropic properties. According to studies, the plant's ingredients help lessen oxidative stress and neuroinflammation, two important aspects of the gut-brain communication system. C. paniculatus indirectly affects the intestinal environment and, in turn, brain function by regulating inflammation and the stress response, possibly via its antioxidant qualities. Nevertheless, there are currently few specific studies describing how C. paniculatus changes the production of short-chain fatty acids or the gut microbiota (22).

3. Phytochemical Screening

3.1 Aerial Parts

Alkaloids, flavonoids, tannins, and saponins are found in the leaves and stems. The leaves include terpenoids, and some extracts also contain proteins, amino acids, and glycosides. The plant's numerous medicinal benefits are a result of the variety and dispersion of these phytochemicals (23).

3.2 Roots

Several phytochemicals, including alkaloids like pristimerin and n-triacontanol, have been identified in petroleum ether and chloroform extracts of Celastrus paniculatus root bark. There have also been reports of benzoic acid and an unidentified quinine compound. Quinone, celastrol, zeylasterone, and other phenolic triterpenoids are found in particular in the outer root bark. The traditional medical use of the roots, such as remedies for scorpion bites, are primarily due to these chemicals (24).

3.3 Leaves

Numerous bioactive chemicals are found in Celastrus paniculatus leaves when they are screened phytochemically; however, the exact makeup of these compounds changes depending on the extraction solvent. Common components found in aqueous, ethanolic, and methanolic extracts include alkaloids, tannins, flavonoids, and saponins. Steroids and terpenoids are also commonly found, particularly in petroleum ether and ethyl acetate extracts. These several substances highlight the leaves' pharmacological potential and historical medical uses (25).

3.4 Seed

A rich and varied profile of bioactive chemicals is revealed by phytochemical screening of Celastrus paniculatus seeds; the extraction process has an impact on the content of these compounds. Notable components include terpenoids (including sesquiterpenoids like malkanguinol and malkangunin), sterols (such β-sitosterol and stigmasterol), and different alkaloids (including celapanin, celapagine, celastrine, and paniculatine). Fatty acids, mainly oleic, linoleic, palmitic, and stearic acids, and fixed oil are also present in the seed oil. Additionally, many seed extracts have been found to include phenolic chemicals, flavonoids, saponins, and glycosides (26).

3.5 Flower

Alkaloids, sterols, and the sugar alcohol dulcitol are among the active substances found in Celastrus paniculatus flowers, according to phytochemical screening. Additionally, preliminary studies show that the flowers' methanolic extracts have anti-inflammatory and analgesic properties, which may imply the presence of other unidentified active ingredients. These findings indicate that the flowers, though less studied than the seeds, contribute to the plant's overall medicinal properties (27).

3.6 Stem

Important alkaloids, including wifornine F and paniculatine A and B, have been found in Celastrus paniculatus stems according to phytochemical study. Ethanolic extracts show that the stem bark also contains tannins. Numerous chemicals, including alkaloids, terpenoids, flavonoids, and saponins, have been found by other research conducted on the entire plant, including the stem. According to these results, the stem has a number of bioactive substances that support the plant's conventional therapeutic uses (28).

4. Geographical Distribution

Originally from the Indian subcontinent, Celastrus paniculatus is a woody climbing shrub that is also found throughout Southeast Asia and other tropical areas. At elevations of 1,800–2,000 meters , it flourishes in tropical moist deciduous and semi-evergreen forests in its natural habitat (29).

The Indian Substituent :

The plant is found all over India, from the southernmost parts to the Himalayas.

• Himalayan region: Found in states like Punjab, Uttarakhand, Himachal Pradesh, and Jammu & Kashmir along the mountainside.

• Central India: Contains reserves such as Simlipal, Karlapat, and the Niyamgiri hills, and it spans Madhya Pradesh and Chhattisgarh.

The hills of Bihar, Odisha, Maharashtra, Karnataka, Kerala, and Tamil Nadu are home to the Eastern and Western Ghats.

The woods of Assam, Sikkim, Arunachal Pradesh, Nagaland, and Meghalaya are located in northeastern India.

• Islands: The Andaman and Nicobar Islands are also home to this species.

Southeast Asia and other regions

The plant's range goes well beyond India.

Sri Lanka, the Maldives, Nepal, Myanmar, Thailand, Vietnam, Cambodia, Malaysia, and the Philippines are among the nations of Southeast Asia.

• East Asia: Occurs in Southern China and Taiwan.

• Oceania: Extends to Australia and the Pacific Islands (30).

5. Mechanistic Insights

5.1 Neurotransmitter Modulation

Celastrus paniculatus modulates neurotransmitters through several mechanisms to enhance cognitive function and reduce anxiety.

• Acetylcholine (ACh): Acetylcholinesterase is an enzyme that breaks down acetylcholine, and the seed oil inhibits it. This improves learning and memory by increasing the amount of ACh available in the brain.

• Monoamines: The oil reduces the turnover of central monoamines that are important in mood regulation and learning, including serotonin, norepinephrine, and dopamine. This may have antidepressant and anxiolytic effects.

• Glutamate: By blocking NMDA receptors and lowering calcium influx, extracts have shown a neuroprotective benefit against glutamate toxicity. This guards against glutamate-induced damage to neuronal cells.

• GABA: Interaction with GABA receptors may possibly contribute to the antidepressant-like effects by lowering GABA levels (31).

5.2 Gut -Brain axis involvement

Though its therapeutic properties strongly imply such involvement, there is currently little evidence directly connecting Celastrus paniculatus to the gut-brain axis. Strong anti-inflammatory and antioxidant properties of the plant are known to impact the composition of the gut microbiota and lower systemic inflammation, which in turn affects the brain (32). The gut-brain connection also mediates its neuroprotective and antidepressant actions, which include modifying neurotransmitters like serotonin. Although there is a dearth of direct studies on C. paniculatus's effects on gut microbial balance, it is known to be a digestive stimulant that may have an indirect effect on the gut microbiota and the signals it sends to the brain (33).

5.3 Cellular And Molecular Pathways

Celastrus paniculatus has a variety of therapeutic effects because it alters a number of important cellular and molecular processes. Acetylcholine and glutamate are two examples of neurotransmitter systems that are influenced by neuroprotective and cognitive-enhancing effects. Acetylcholine levels rise as a result of its inhibition of acetylcholinesterase. By reversibly blocking NMDA receptors, aqueous extracts shield neuronal cells from glutamate-induced damage. One key mechanism is antioxidant activity, where extracts reduce lipid peroxidation while raising endogenous antioxidant enzymes like glutathione and catalase. Cytokine release is modulated in anti-inflammatory actions,

which may increase anti-inflammatory cytokines like IL-10 and suppress pro-inflammatory ones like TNF-α and IL-1β. A sesquiterpene from C. paniculatus inhibits the growth of breast cancer cells by killing Akt, NF-κB, p53, and MAP kinases, as well as by triggering apoptosis and autophagy, according to research that also shows participation in cell proliferation pathways (34).

6. Toxicological Profile & Safety Concerns

6.1 Acute and Chronic Toxicity

Celastrus paniculatus has a good safety profile, according to preclinical research.

AcuteToxicology

• Oral administration of C. paniculatus seed oil or extracts up to 2000 mg/kg did not result in animal death or notable negative effects in tests conducted in accordance with OECD recommendations.

• No fatal or harmful toxic effects were seen at doses up to 5000 mg/kg.

• Following therapy, the animals' body weight and health state remained normal (35).

Chronic Toxicology

Long-term research indicates safety at recommended dosages, with no discernible liver, renal, or cardiac damage.• Later studies demonstrate protective effects against induced organ damage, such as nephroprotective effects against lead-induced toxicity; one older study did report reversible focal necrosis in the liver of rats receiving high, sub-chronic doses of seed oil intraperitoneally, but these effects were absent after 45 days.Importantly, suitable dosages and administration techniques have been shown to be safe in laboratory animals, but long-term treatment is frequently required to obtain therapeutic effects, such as those on cognitive function. Although preclinical research indicates low toxicity, more clinical trials are required to fully validate safety in people, particularly for particular formulations and long-term usage (36).

6.2 Safe Dosage Ranges

Although the majority of the data is based on preclinical research and traditional use rather than clinical trials, safe dosage levels for Celastrus paniculatus vary depending on the form.

Ayurvedic practice:

• Seed powder: 500 mg to 2 grams daily for adults, often mixed with milk.

• Seed oil: 5 to 15 drops twice daily for adults, taken with milk or as directed by a practitioner.

Preclinical research:

• Animal studies using up to 2000 mg/kg of seed oil show no significant acute or subacute toxicity.

• Caution: Higher doses (over 2 grams of seeds) may cause side effects like vomiting and diarrhea.

Always consult a qualified healthcare provider for personalized dosage recommendations (37).

7. Conclusion

The 'intellect tree,' or Celastrus paniculatus, is a key herb in traditional Ayurvedic therapy. Its seeds are prized for their strong nootropic qualities, which improve memory, focus, and brain function in general. This is mostly because of its potent neuroprotective and antioxidant properties, which aid in fending off stress and age-related cognitive loss. The herb has anti-inflammatory, analgesic, and antidepressant

properties in addition to its cognitive advantages, making it helpful in the treatment of ailments including anxiety, rheumatism, and joint pain. To establish ideal dosages and completely comprehend long-term consequences, more clinical research and caution are required, as with any strong medicinal plant. All things considered, Malkangani provides encouraging natural treatments for mental and physical ailments.

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