Exploring the Healing Power of Celastrus paniculatus: Phytoconstituents and Their Pharmacological Actions

Raseena V, Gokulbal B.V, Dr.P.Srinivasan, Dr.D.Dhachinamoorthi
Sree Abirami college of pharmacy ,Affiliated to the The Tamil Nadu Dr.M.G.R.Medical University
raseenav88@gmail.com

Abstract

Celastrus paniculatus, also known as the "intellect tree" or Jyotishmati, is a plant that has been used in traditional Indian medicine for many years. Scientists are now studying it more closely to understand how it works and what makes it useful for healing.Researchers have found that the seeds and oil of this plant contain many natural chemicals such as alkaloids, triterpenes, fatty acids, flavonoids, and antioxidants. These substances help the body in different ways. For example, some of them protect brain cells, improve memory, and may even help prevent diseases like Alzheimer's.Others reduce pain, swelling, and inflammation by affecting certain chemicals in the body.One special chemical in the plant, called pristimerin, also shows promise in fighting malaria. In addition, the plant may help heal wounds, protect the stomach, lower cholesterol, and even affect fertility.So far, most of the research has been done on animals or in labs, and not many human studies have been done yet. Also, scientists often use the whole plant extract instead of focusing on specific compounds, which makes it harder to understand which part does what.In the future, scientists need to test this plant more carefully in humans, figure out the best parts of the plant to use, and make sure it's safe. If that happens, Celastrus paniculatus could become a valuable natural treatment for brain health and other medical problems.

Keywords: *Celastrus paniculatus, Phytoconstituents, Pharmacological activities, Neuroprotective effect, Traditional medicine, Herbal nootropics, Anti-inflammatory, Antioxidant.*

1.Introduction

Celastrus paniculatus Willd., commonly known as the "intellect tree," "Jyotishmati," or "Malkangani," is a woody climbing shrub belonging to the family Celastraceae. Native to the Indian subcontinent, it thrives in tropical and subtropical regions, particularly in hilly terrains up to 1800 meters in elevation. Traditionally, various parts of the plant, especially its seeds and oil, have been utilized in Ayurvedic, Unani, and Siddha medicine systems for their therapeutic properties, including cognitive enhancement, anti-inflammatory effects, and treatment of neurological disorders such as epilepsy and insomnia[1].

The significance of *C. paniculatus* in traditional medicine has spurred scientific interest in its phytochemical constituents and pharmacological activities. Phytochemical analyses have revealed a rich composition of bioactive compounds, including alkaloids, flavonoids, terpenoids, and fatty acids. These constituents are associated with a range of

pharmacological effects, such as neuroprotective, antioxidant, anti-inflammatory, analgesic, and anti-arthritic activities[1].

Recent studies have focused on the plant's potential as a nootropic agent, highlighting its ability to enhance memory and cognitive functions. The seed oil, in particular, has demonstrated significant neuropharmacological effects in various experimental models, suggesting its promise in managing neurodegenerative conditions[2].

Even though many studies have been done on *Celastrus paniculatus*, there is still a need to bring all the information together in one place. This review will collect and explain what scientists have discovered about the plant’s natural compounds and how they work in the body. The goal is to make it easier to understand how *C. paniculatus* can help in treating different health problems. This review will also point out what we still don’t know and suggest areas where more research is needed. Overall, it hopes to support future studies and the possible use of this plant in modern medicine[2].

2.Botanical Profile and Traditional Uses of *Celastrus paniculatus*

Figure 1. Celastrus paniculatus Fruit

Figure 2. Mature Fruit

Figure3. Celastrus paniculatus Seeds

Table 1.Taxonomy

Kingdom	Plantae
Order	Celastrales
Family	Celastraceae
Genus	Celastrus
Species	Celastrus paniculatus Willd

Table 2.Botanical profile

FEATURE	DESCRIPTION
Scientific Name	*Celastrus paniculatus Willd.*
Family	*C*elastraceae
Common Names	Jyotishmati, Malkangni, Intellect Tree, Climbing Staff Tree
Botanical Description	A large woody climbing shrub with yellowish bark and elliptical leaves. It produces small yellowish flowers and globose capsules containing seeds.
Part Used	Seeds (most commonly), oil, leaves, root, bark

FEATURE	DESCRIPTION
Geographical Distribution	Native to India and Southeast Asia. Found in tropical and subtropical forests, especially in the Indian subcontinent.
Habitat	Grows in hilly regions, deciduous forests, and along forest margins up to 1,200 m altitude.
Phytoconstituents	Celastrine, paniculatine, malkangunin, sesquiterpenes, alkaloids, flavonoids, polyalcohols

Table 3.Traditional Uses of *Celastrus paniculatus*

Part Used	System of Medicine	Traditional Use
Seeds	Ayurveda	Memory enhancement, cognitive function, brain tonic
Seed Oil	Ayurveda, Siddha	Treatment for joint pain, arthritis, and rheumatism
Leaves	Folk medicine	Used as a poultice for wounds and inflammation
Bark & Root	Traditional Indian Medicine	Used in treating epilepsy, paralysis, and gout
Whole Plant	Ayurvedic Formulation	Believed to improve mental clarity and intelligence

3.Phytochemistry of *Celastrus paniculatus*

3.1.Identified Bioactive Compounds

Celastrus paniculatus is rich in diverse bioactive compounds, contributing to its therapeutic potential.

Key constituents identified include:

Sesquiterpene Alkaloids: Paniculatine, malkangunin, celapanine, celapanigin, and celastrine.

Triterpenoids: Pristimerin and tingenone, known for anti-inflammatory and anticancer activities.

Steroids: β-sitosterol and stigmasterol.

Flavonoids: Quercetin and kaempferol.

Fatty Acids: Oleic acid, linoleic acid, palmitic acid, and stearic acid.

Phenolic Compounds: Benzenediol and cinnamic acid derivatives.

These compounds have been identified through various analytical techniques, including Gas Chromatography-Mass Spectrometry (GC-MS) and High-Performance Thin-Layer Chromatography (HPTLC)[3].

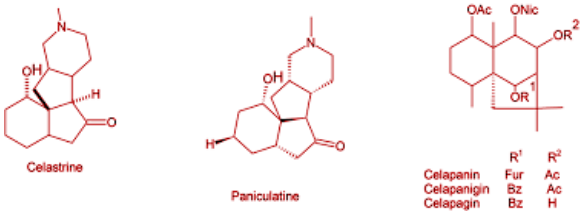

Table 4.Phytoconstituents and Pharmacological activity

Class of compounds	Key constituents	Pharmacological Action
Alkaloids: Sesquiterpene alkaloids	Paniculatine, malkangunin, celapanine, celapanigin, and celastrine.	Neuroprotective effect
Triterpenoids	Pristimerin , tingenone	Anti-inflammatory activity Anticancer activity

Steroids	β-sitosterol and stigmasterol	Cholesterol-lowering effects
Flavonoids	Quercetin and kaempferol	Antioxidant activity
Fatty Acids	Oleic acid, linoleic acid, palmitic acid, and stearic acid.	Contributing to cognitive health
Phenolic Compounds	Benzenediol and cinnamic acid derivatives	Antioxidant activity

3.2.Extraction Methods

Various extraction techniques have been employed to isolate these bioactive compounds:

Solvent Extraction: Utilizing solvents like methanol, ethanol, and petroleum ether to extract different phytochemicals. Methanol has been found effective in extracting alkaloids and flavonoids.

Traditional Methods: Involving mechanical crushing and steam distillation to obtain seed oil, as practiced in certain regions of India.

Advanced Techniques: GC-MS and HPTLC analyses have been employed for the identification and quantification of phytoconstituents[4].

4.Pharmacological Activities of *Celastrus paniculatus*

4.1. Neuroprotective and Nootropic Effects

C. paniculatus has been traditionally recognized for its cognitive-enhancing properties. Studies have demonstrated its efficacy in improving memory and intellect, attributed to its neuroprotective activity.

Celastrus paniculatus has long been used in traditional Ayurvedic medicine as a cognitive enhancer. Modern pharmacological studies attribute these effects to various phytochemicals, including alkaloids (celastrine, paniculatine), sesquiterpenes, and phenolic compounds.

These constituents exhibit several neuroprotective mechanisms:

Cholinergic Activity: Extracts inhibit acetylcholinesterase, resulting in elevated acetylcholine levels and enhanced memory function.

Antioxidant Effects: Flavonoids and phenolics reduce oxidative stress in neuronal tissue, preventing free radical-induced neuronal damage.

Neuroprotection: Compounds modulate neuroinflammatory pathways and inhibit neurotoxic enzymes such as GSK-3β, supporting neuronal survival.

Cognitive Support under Stress: Animal studies demonstrate cognitive improvement under chronic stress conditions following administration of seed extracts.

The seed oil and extracts have shown potential in treating neurological disorders such as cognitive dysfunction, paralysis, epilepsy, and insomnia[5].

4.2. Antioxidant Activity

Celastrus paniculatus has been extensively studied for its antioxidant properties, which are attributed to its rich phytochemical composition, including flavonoids, phenolic compounds, and alkaloids. These constituents contribute to the plant's ability to neutralize free radicals and protect against oxidative stress, which is implicated in various neurodegenerative and metabolic disorders.

Phytochemical analyses have identified several bioactive compounds in *C. paniculatus*, such as flavonoids (e.g., paniculatin), phenolic acids, and alkaloids (e.g., celastrine, paniculatine). These compounds are known for their antioxidant activities, including free radical scavenging and metal ion chelation.

The antioxidant activity of *C. paniculatus* is primarily due to its ability to scavenge reactive oxygen species (ROS) and enhance endogenous antioxidant defenses. Studies have demonstrated that extracts of the plant can increase levels of antioxidant enzymes such as catalase and glutathione, while reducing markers of oxidative stress like malondialdehyde (MDA)[6].

Experimental Evidence

In Vitro Studies: Ethanolic and aqueous extracts of *C. paniculatus* have shown significant antioxidant activity in assays measuring DPPH radical scavenging, nitric oxide scavenging, and reducing power.

In Vivo Studies: Animal models have demonstrated that administration of *C. paniculatus* extracts leads to improved antioxidant status in the brain, suggesting potential neuroprotective effects[6].

4.3.Anti-inflammatory and Analgesic Effects

Extracts of *C. paniculatus* have demonstrated significant anti-inflammatory and analgesic activities. These properties support its traditional use in treating conditions like rheumatism, arthritis, and sciatica.

The therapeutic effects are attributed to various bioactive compounds present in the plant, including:

Alkaloids: Such as celastrine and paniculatine.

Sesquiterpenes: Including malkanguniol and malkangunin.

Triterpenes: Like lupeol and paniculatadiol.

Flavonoids: Notably paniculatin.

These compounds are known to modulate inflammatory pathways and pain perception mechanisms[7].

Experimental Evidence

Anti-inflammatory Activity: Methanolic extracts of *C. paniculatus* have demonstrated significant anti-inflammatory effects in animal models. For instance, in carrageenan-induced paw edema models, the seed oil exhibited 66.60% and 78.78% inhibition of inflammation at doses of 5 ml/kg and 10 ml/kg, respectively, which is comparable to the 75.75% inhibition observed with a 100 mg/kg dose of ibuprofen[7].

Analgesic Activity: The plant's extracts have shown notable analgesic effects in various pain models. In hot plate and tail immersion tests, methanolic extracts of the seeds produced significant analgesic responses, indicating central analgesic activity[7].

Mechanisms of Action

The anti-inflammatory and analgesic effects of *C. paniculatus* are believed to be mediated through: Inhibition of Pro-inflammatory Mediators .The extracts suppress the production of prostaglandins and other inflammatory cytokines[7].

By scavenging free radicals, the plant reduces oxidative stress, which is a known contributor to inflammation and pain.These mechanisms collectively contribute to the plant's efficacy in managing inflammatory conditions and pain[7].

4.4. Antidepressant and Anxiolytic Properties

The seed oil has been reported to possess antidepressant and anxiolytic effects, contributing to its use in managing mental health disorders .

Antidepressant Activity Experimental studies have demonstrated that *C. paniculatus* seed oil exhibits significant antidepressant-like effects in animal models. In the forced swim

test (FST) and tail suspension test (TST), administration of the seed oil resulted in a notable decrease in immobility time, indicating antidepressant activity comparable to standard drugs like fluoxetine. The effective dose (ED_{50}) values were determined to be 17.38 mg/kg for FST and 31.62 mg/kg for TST. Importantly, these effects were achieved without significant alterations in locomotor activity, suggesting a specific antidepressant action rather than general stimulation.

The underlying mechanisms are believed to involve modulation of monoaminergic systems. The antidepressant-like effects were attenuated by pre-treatment with sulpiride (a dopamine D_2 receptor antagonist), p-chlorophenylalanine (a serotonin synthesis inhibitor), and baclofen (a GABA_B receptor agonist), indicating the involvement of dopaminergic, serotonergic, and GABAergic pathways. Additionally, the seed oil significantly inhibited monoamine oxidase-A (MAO-A) activity and reduced plasma corticosterone levels, further supporting its role in alleviating depressive symptoms[8].

Anxiolytic Activity The anxiolytic potential of *C. paniculatus* has been evaluated in various animal models. In studies utilizing elevated plus maze and open field tests, administration of seed oil at doses of 1 and 1.5 g/kg resulted in significant anxiolytic effects, evidenced by increased exploration of open arms and central areas, respectively. These effects were observed without the development of tolerance over repeated administrations[9].

Furthermore, in response-consequence learning, *C. paniculatus* seed oil demonstrated the ability to reduce punishment-induced suppression of behavior, suggesting its efficacy in mitigating anxiety-related responses.

Collectively, these findings substantiate the traditional use of *Celastrus paniculatus* as a therapeutic agent for mood disorders. Its multifaceted mechanisms, involving modulation of neurotransmitter systems and stress-related hormonal pathways, underscore its potential as a natural alternative for the management of depression and anxiety[9].

4.5. Anticonvulsant Activity

C. paniculatus has shown anticonvulsant properties, making it beneficial in the treatment of epilepsy and related neurological conditions . Recent pharmacological studies have provided scientific validation for its efficacy in managing seizure disorders[10].

Experimental Evidence

1. Methanolic Extract of Whole Plant: A study evaluated the antiepileptic activity of the methanolic extract of *C. paniculatus* whole plant (MECP) using in vivo models. In Isoniazid (INH)-induced seizure models, MECP at doses of 200, 400, and 600 mg/kg

significantly delayed the onset of seizures and reduced the duration of tonic hindlimb extension. Similarly, in Pentylenetetrazole (PTZ)-induced seizures, MECP demonstrated a dose-dependent increase in seizure latency and decrease in seizure duration. These effects suggest the involvement of GABAergic mechanisms in the anticonvulsant activity of MECP[10].

2. Petroleum Ether and Ethanolic Seed Extracts: Another investigation assessed the anticonvulsant potential of petroleum ether (PECP) and ethanolic (EECP) extracts of *C. paniculatus* seeds in Maximal Electroshock Seizure (MES) and PTZ-induced seizure models in mice. Both extracts, at doses of 200, 400, and 600 mg/kg, significantly increased seizure latency and reduced seizure duration. Phytochemical analysis revealed the presence of alkaloids, flavonoids, tannins, and phenolic compounds, which may contribute to the observed anticonvulsant effects[10].

Mechanisms of Action : The anticonvulsant activity of *C. paniculatus* is attributed to its modulation of neurotransmitter systems, particularly the enhancement of GABAergic transmission and inhibition of excitatory neurotransmitters. The presence of bioactive compounds such as alkaloids and flavonoids supports these mechanisms.

The findings from various studies substantiate the traditional use of *Celastrus paniculatus* as an anticonvulsant agent. Its efficacy in different seizure models and the involvement of GABAergic mechanisms highlight its potential as a natural therapeutic option for epilepsy management[10].

4.6. Antimicrobial and Antimalarial Activities

The plant exhibits antimicrobial properties against various bacterial strains. Additionally, the compound pristimerin, isolated from *C. paniculatus*, has demonstrated antimalarial activity, although it was found to be less potent than standard medications in vitro .Recent scientific investigations have validated its antimicrobial and antimalarial properties, attributing these effects to its rich phytochemical composition.

Antimicrobial Activity The antimicrobial efficacy of *C. paniculatus* is largely attributed to its diverse array of phytochemicals, including sesquiterpenes, triterpenoids, alkaloids, and flavonoids. Notably, compounds such as celapanin, celapanigin, malkangunin, and pristimerin have been identified as key contributors to its antimicrobial properties . In a study focusing on the synthesis of silver nanoparticles (AgNPs) using leaf and callus extracts of *C. paniculatus*, the resulting AgNPs exhibited significant antibacterial activity against various pathogenic strains. This enhanced activity is believed to be due to the synergistic effect of the plant's phytochemicals acting as capping and stabilizing agents during nanoparticle synthesis.

Furthermore, the hydroethanolic extract of *C. paniculatus* demonstrated moderate antibacterial and antifungal activities. The presence of phenolic compounds and flavonoids in the extract is thought to contribute to these antimicrobial effects[11].

Antimalarial Activity The antimalarial potential of *C. paniculatus* has been explored through various studies, with particular emphasis on its root bark extracts. A chloroform fraction of the root bark exhibited significant schizontocidal activity against Plasmodium berghei, a rodent malaria parasite. The active compound responsible for this activity was identified as pristimerin, a quinonoid triterpene . Pristimerin's antimalarial effect is believed to stem from its ability to interfere with the parasite's metabolic processes, although the exact mechanism remains to be fully elucidated. This finding underscores the potential of *C. paniculatus* as a source of novel antimalarial agents, especially in the face of increasing drug resistance[12].

The antimicrobial and antimalarial activities of *Celastrus paniculatus* are well-supported by scientific research, highlighting the significance of its phytochemical constituents. Compounds such as celapanin, malkangunin, and pristimerin play pivotal roles in these pharmacological effects. Further studies focusing on the isolation and characterization of these bioactive compounds could pave the way for the development of new therapeutic agents derived from this medicinal plant[12].

4.7. Cardiovascular and Hypolipidemic Effects

Studies suggest that *C. paniculatus* may have beneficial effects on cardiovascular health, including hypolipidemic activity, which helps in lowering lipid levels in the blood.

Hypolipidemic Activity The hypolipidemic potential of *C. paniculatus* has been demonstrated in various experimental models. Methanolic seed extracts have shown significant reductions in total cholesterol, triglycerides, low-density lipoprotein (LDL), and very low-density lipoprotein (VLDL) levels, along with an increase in high-density lipoprotein (HDL) levels in high-fat diet-induced hyperlipidemic rats. These effects are attributed to the presence of phytochemicals such as lupeol, β-amyrin, and squalene, which are known to modulate lipid metabolism and exhibit antioxidant properties . Additionally, sesquiterpene esters like malkanguniol and malkangunin have been identified in *C. paniculatus*, which may contribute to its lipid-lowering effects by influencing lipid absorption and metabolism[13].

Cardiovascular Activity The cardiovascular benefits of *C. paniculatus* are closely linked to its hypolipidemic and antioxidant properties. By reducing lipid levels and preventing oxidative stress, the plant helps in maintaining vascular health and preventing atherosclerosis. The presence of flavonoids and phenolic compounds contributes to its

antioxidant capacity, which in turn supports endothelial function and reduces the risk of cardiovascular disease[14].

Furthermore, the anti-inflammatory properties of *C. paniculatus*, attributed to compounds like pristimerin and paniculatadiol, may also play a role in cardiovascular protection by mitigating inflammation-induced vascular damage[15].

The cardiovascular and hypolipidemic activities of *Celastrus paniculatus* are well-supported by scientific research, highlighting the significance of its phytochemical constituents. Compounds such as lupeol, β-amyrin, squalene, malkanguniol, and malkangunin play pivotal roles in these pharmacological effects. Further studies focusing on the isolation and characterization of these bioactive compounds could pave the way for the development of new therapeutic agents derived from this medicinal plant[16].

4.8. Anti-arthritic and Anti-fertility Activities

The plant has been reported to possess anti-arthritic properties, aiding in the management of arthritis. Moreover, it exhibits anti-fertility effects, which could be explored for contraceptive purposes.

Antiarthritic Activity *Celastrus paniculatus* has demonstrated significant antiarthritic properties, primarily attributed to its rich phytochemical profile. Experimental studies have shown that both alcoholic and petroleum ether extracts of *C. paniculatus* seeds exhibit notable anti-inflammatory effects in Wistar albino rats. These effects are believed to result from the inhibition of pro-inflammatory mediators and the modulation of immune responses[17].

Key phytoconstituents contributing to these effects include:

Lupeol: A triterpenoid known for its anti-inflammatory and analgesic properties.

β-Amyrin: Another triterpenoid with demonstrated anti-inflammatory activity.

Malkanguniol and Malkangunin: Sesquiterpene esters that may modulate inflammatory pathways.

These compounds collectively contribute to the plant's ability to alleviate arthritic symptoms by reducing inflammation and joint swelling[17].

Antifertility Activity The antifertility effects of *C. paniculatus* have been observed in various studies, particularly concerning male reproductive health. Administration of ethanolic seed extracts in adult male rats resulted in significant reductions in reproductive organ weights,epididymal sperm count, and motility. Additionally, there was a notable decrease in sorbitol dehydrogenase activity, an enzyme critical for sperm maturation[18].

The antifertility effects are primarily attributed to the following phytochemicals:

Celapanin and Celapanigin: Alkaloids that may interfere with spermatogenesis.

β-Sitosterol: A phytosterol known to influence hormonal balance and reproductive functions.

These constituents are believed to disrupt normal spermatogenic processes, leading to reduced fertility.

The antiarthritic and antifertility activities of *Celastrus paniculatus* are well-supported by scientific research, highlighting the significance of its phytochemical constituents. Compounds such as lupeol, β-amyrin, malkanguniol, malkangunin, celapanin, celapanigin, and β-sitosterol play pivotal roles in these pharmacological effects. Further studies focusing on the isolation and characterization of these bioactive compounds could pave the way for the development of new therapeutic agents derived from this medicinal plant[18].

4.9. Wound Healing and Gastroprotective Effects

C. paniculatus has shown potential in promoting wound healing and providing gastroprotective effects, making it useful in treating ulcers and enhancing tissue repair.

Wound Healing Activity *Celastrus paniculatus* has been traditionally employed in Ayurvedic medicine for its wound healing properties. The plant's efficacy in promoting tissue repair is attributed to its rich phytochemical profile, which includes triterpenoids such as lupeol and β-amyrin, flavonoids like paniculatin, and sesquiterpene esters such as malkanguniol and malkangunin[19].

These compounds contribute to the wound healing process through multiple mechanisms:

Anti-inflammatory Action: Triterpenoids and flavonoids inhibit pro-inflammatory mediators, reducing inflammation at the wound site[20].

Antioxidant Activity: Flavonoids and phenolic compounds scavenge free radicals, minimizing oxidative stress and facilitating tissue regeneration[21].

Collagen Synthesis Enhancement:Certain phytochemicals stimulate fibroblast proliferation and collagen deposition, essential for wound closure and strength[21].

While direct studies on the wound healing activity of *C. paniculatus* are limited, its phytoconstituents' known pharmacological actions support its traditional use in wound management[22].

Gastroprotective Activity The gastroprotective potential of *C. paniculatus* has been substantiated through various experimental studies. Seed oil extracts have demonstrated

significant protective effects against gastric ulcers induced by ethanol, indomethacin, and pylorus ligation in rat models[23].

The underlying mechanisms involve:

Reduction of Gastric Acidity: The seed oil decreases total gastric juice volume and acidity while increasing pH, creating a less corrosive environment for the gastric mucosa.

Anti-inflammatory Effects: The extract inhibits pro-inflammatory cytokines like TNF-α and IL-6 and elevates anti-inflammatory cytokine IL-10 levels, mitigating inflammation-induced gastric damage[24].

Antioxidant Defense: Treatment with the seed oil reduces malondialdehyde (MDA) levels, a marker of lipid peroxidation, and enhances the activities of antioxidant enzymes such as superoxide dismutase (SOD) and catalase.

These gastroprotective effects are primarily attributed to the presence of bioactive compounds including lupeol, β-amyrin, and various flavonoids, which collectively contribute to mucosal defense and healing[25].

The wound healing and gastroprotective activities of *Celastrus paniculatus* are well-supported by its phytochemical constituents. Compounds such as lupeol, β-amyrin, malkanguniol, malkangunin, and paniculatin play pivotal roles in these pharmacological effects. Further studies focusing on the isolation and characterization of these bioactive compounds could pave the way for the development of new therapeutic agents derived from this medicinal plant[26].

5.Clinical studies on *C. paniculatus*

While traditional use and preclinical studies of *Celastrus paniculatus* suggest a range of therapeutic benefits, clinical research is still in its nascent stages. The ongoing and completed studies provide a foundation for understanding its potential, particularly in neuropsychiatric disorders. However, more extensive and rigorous clinical trials are necessary to fully establish its efficacy and safety profiles[27].

6.Gaps, Challenges, and Future Prospects

Research Gaps

Despite the extensive traditional use and promising pharmacological properties of *Celastrus paniculatus*, several research gaps persist:

1. Limited Clinical Studies: Most studies on *C. paniculatus* are preclinical, involving in vitro or animal models. There is a lack of well-designed clinical trials to validate its efficacy and safety in humans.

2. Incomplete Phytochemical Profiling: While some bioactive compounds like malkangunin and paniculatin have been identified, a comprehensive phytochemical profile is lacking, delaying the understanding of its full therapeutic potential.
3. Understanding of the underlying mechanism: The exact molecular mechanisms underlying its pharmacological effects remain underexplored, limiting the ability to develop targeted therapies.
4. Standardization Issues: Variability in extraction methods and lack of standardized dosages give rise to challenges in ensuring consistent therapeutic outcomes.

Challenges

The study and application of *C. paniculatus* face several challenges:
1. Conservation Concerns: Overharvesting and habitat loss have led to the plant being categorized as threatened in some regions, requiring conservation efforts.
2. Bioavailability Issues: Some phytoconstituents exhibit poor bioavailability, limiting their therapeutic efficacy.
3. Regulatory Hurdles: The lack of standardized formulations and clinical data complicates regulatory approval processes for medicinal use.
4. Ethnobotanical Knowledge Erosion: Traditional knowledge about the plant's uses is at risk of being lost, highlighting the need for documentation and preservation.

Future Prospects

Despite the broad spectrum of pharmacological activities attributed to *Celastrus paniculatus*, several potential therapeutic applications remain underexplored. Notably, the plant holds promising prospects for future research in thrombolytic and hypolipidemic therapies.

Recent preliminary studies and phytochemical screenings have revealed the presence of flavonoids, sterols, and triterpenoids—bioactive compounds known for their antioxidant, anti-inflammatory, and lipid-regulating properties. These constituents may influence lipid metabolism and platelet aggregation, indicating a potential role in preventing or managing atherosclerosis, hyperlipidemia, and thrombotic disorders.

Given the global burden of cardiovascular diseases and the limitations of current synthetic lipid-lowering and clot-dissolving agents (e.g., side effects, cost), the exploration of *C. paniculatus* as a natural alternative or adjunct therapy is both relevant and necessary. Therefore, future studies should focus on validating the thrombolytic and hypolipidemic actions of this plant through:

*In vitro assays (e.g., fibrinolytic activity),

*In vivo animal models for lipid profile modulation,

*Clinical trials for efficacy and safety in human populations.

7.Conclusion

Celastrus paniculatus, traditionally revered in Ayurvedic medicine as “Jyotishmati,” has garnered significant scientific interest due to its rich phytochemical composition and a wide range of pharmacological activities. The plant contains diverse bioactive compounds such as alkaloids, flavonoids, terpenoids, and saponins, which contribute to its therapeutic properties.[28]

Extensive preclinical studies have validated its neuroprotective, nootropic, antioxidant, anti-inflammatory, analgesic, antidepressant, anxiolytic, anticonvulsant, antimicrobial, and antimalarial activities, among others. Emerging evidence also supports its wound healing, gastroprotective, antiarthritic, antifertility, cardiovascular, and hypolipidemic potential. Several phytoconstituents such as malkangunin, paniculatin, and lupeol have shown to be particularly important in these bioactivities. While a few clinical studies have been initiated—especially in the domain of mental health—most of the evidence remains confined to in vitro and animal models[29].

Despite these promising findings, several research gaps remain. There is a pressing need for comprehensive clinical trials, standardized formulations, detailed mechanistic studies, and conservation efforts to ensure sustainable utilization of the plant. Furthermore, the unexplored thrombolytic and hypolipidemic potential of *C. paniculatu*s opens new directions for future research, especially in the context of rising cardiovascular health challenges[29].

In conclusion, *Celastrus paniculatus* stands out as a valuable medicinal plant with vast therapeutic potential. Its integration into modern medicine—supported by robust scientific validation—may lead to the development of effective, plant-based alternatives for managing a wide range of diseases[30].

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