



Research Article

Therapeutic Potential of Jyotishmati (*Celastrus paniculatus*): A Comprehensive Review with Extraction and Microencapsulation of Its Essential Oil

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Abstract

Therapeutic potential of Jyotishmati (*Celastrus paniculatus*) by combining a thorough review of the literature with experimental extraction and microencapsulation of the plant's essential oil. According to the study, the herb has long been used in Ayurveda and modern medicine, and its antioxidant, neuroprotective, and cognitive-enhancing qualities are highlighted. After purchasing the seeds commercially, the essential oil was extracted using Soxhlet with hexane, and the phytochemical and antioxidant analyses were conducted. To enhance stability, palatability, and controlled release, the oil was microencapsulated using spray drying with gelatin as the wall material. Due to their superior stability, high encapsulation efficiency, and excellent particle size distribution, the resultant microcapsules are appropriate for use in pharmaceutical and nutraceutical applications. The results confirm that jyotishmati, particularly when microencapsulated, has therapeutic promise as a natural neuroprotector and cognitive enhancer. In order to fully utilise the therapeutic and commercial benefits of this traditional plant, thereby reaffirming its significance in medication development and cognitive health management.

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KEYWORDS: *Celastrus paniculatus*, Jyotishmati, Soxhlet extraction, microencapsulation, spray drying, gelatin, neuroprotection.

1. INTRODUCTION

Celastrus paniculatus is one of the notable medicinal plants of the Celastraceae family, also known as "Jyotishmati". (K. Yadav, 2019). Climbing, unarmed shrub, large and deciduous; stem up to 23 cm in diameter; reddish-brown, long, thin, elongate branches; height of 10 m. The simple, alternate leaves are 6–10 by 3–6 cm, oblanceolate to elliptic, petioles 6–12 mm long, rounded or sharp at the base, crenulate, with a short acuminate, crenate-serrate upper part. This has a paniculate type of inflorescence. Flowers yellowish/greenish white, unisexual, terminal pyramidal panicles 5–15 cm long, flowers 7–8 mm; pubescent pedicels with small lanceolate bracts. Calyx outside pubescent; lobes semi-orbicular, ciliate; petals 3 mm long, rectangular, rounded at the top. The upper part of the male flowers has a small, subconical, somewhat 3-toothed ovary and the anther is oblong and about 2 mm long (when mature); the stamens are inserted on the margin of the disc and have a short filament. Ovary of female flowers globose, style short and thick, stigma wide, three-lobed, glabrous. The stamens are arranged on the margin of a larger disc of the male flowers; the anthers are erect, pollen-free, oblong, acute or subtriangular, less than 1 mm long. Subglobose, bright yellow, 9–12 mm in diameter, transversely wrinkled, three-valved capsule, valves expanding after dehiscing and remaining together at the base to expose seeds. Seeds 1–6 are typically solitary, and completely enveloped in fleshy, scarlet arils. (Devi et al., 2022)

Synonyms

Jyotishmati: a sign of Medhya property, Katbhi, Jyotishka, and Kanguni - a seed resembling a specific grain called Kanguni; Paravathpadi: a plant with a white or grey patch like a pigeon's foot; Pinya (these are used as commercial goods), a climber, Lata; Kakandi - fruit resembling a crow's egg. (Arif et al., 2018)

Habitat

Jyotishmati is found in the wild throughout the length and breadth of India, with a notable presence in Punjab, Kashmir, and other hilly areas above 3000m. It is also present in Nepal, the Philippines, the Maldives, and Sri Lanka. (Arif et al., 2018)

Taxonomy

Botanical name: *Celastrus paniculatus*

Kingdom: Plantae

Subkingdom: Angiosperms

Class: Magnoliopsida

Division: Tracheophyta

Order: Celastrales

Family: Celastraceae

Genus: *Celastrus*

Species: *Paniculatus* (*Celastrus paniculatus* | Species, n.d.)

Action and application

- **Bark:** Depurative, Brain Tonic, Abortifacient
- **Leaves:** The juice of the leaves is an effective antidote to opium poisoning and is an emmenagogue for diarrhoea.

- **Perennial Herbs:** adaptogen, antidepressant, anaphrodisiac, aphrodisiac, bitters, changinator, cholagogue, demulcent, detergent, diuretic, emmenagogue, nervine, stimulant, thermogenic, tonic, vermifuge, and expectorant.
- Disease, dysentery, chronic depression, arthritis, fever, strangury, nephropathy, inflammation, depopulation, and heart weakness. They purportedly enhance memory.
- **Seed oil:** Bitter, thermogenic, cognitive enhancer, rheumatism, beriberi, wound, dermatitis, stomach disorders.
- Crushed root is used for pneumonia. (K. Yadav, 2019)

Phytochemistry

- Phytochemistry — the chemical composition of plant sources.
- Leaves contain alkaloids, carbohydrates, phenolic compounds, sterols and triterpenoids, flavonoids, tannins, saponins, and fixed oil.
- Seeds: Seed oil is composed of monounsaturated fatty acids and polyunsaturated acids such as linoleic acid, oleic acid, arachidonic acid, and saturated fatty acids such as butyric, caprylic, lauric, myristic, palmitic, stearic, and arachidic acids.
- Seeds also contain approximately 30% oil, which includes these alkaloids: Paniculatine, Celastrine, Celapagin, Celapaningin, and Celapanin
- Phenolic triterpenoids, dihydrogarofuran, quintanemethide.
- Celapanine, Malkanguniol, and Malkangunin are ester compounds.
- There are inedible steroids such as Beta-Sitosterol, Celastral, Pristimerin, Zeylesterone, etc. (Debnath et al., 2014)

1.1 PHARMACOLOGICAL ACTIVITIES

Neuromodulating effect

The aluminium-induced neurotoxicity in the brain regions of the hippocampus, cortex, and cerebellum is prevented by the alkali extract of *C. Paniculatus*. This happens due to a reduction in the Glutathione levels and actions of the Superoxide Dismutase, Catalase, Glutathione Peroxidase, Glutathione Reductase, Sodium Potassium ATPase, and Mg²⁺ ATPase, at the same time increasing the levels of lipid Peroxidation, Alkaline Phosphatase, Acid Phosphatase, Alanine Aminotransferase, and Aspartate Aminotransferase in the brain. (Bhanumathy et al., 2010)

Tranquillizing effect

At a dose of 200 mg/kg, *Celastrus paniculatus* exhibited a tranquillizing effect on rats, monkeys, and mice. It was able to potentiate the effect of hexobarbitone and suppress motor activity, amphetamine-induced hyperactivity, and oxygen uptake in mice. (Mishra & John, 2020) 2.5 Sedation and Anti-convulsion

The Petroleum Ether and ethanolic extract of *Celastrus paniculatus* exhibited defence against maximal electroshock and pentylenetetrazole-induced tremors. The sedative effect of

the oil was observed in cats, monkeys, mice, and rats. However, the anticonvulsant effect of *Celastrus paniculatus* was observed in rats. (V. Yadav et al., 2011)

Wound healing activity

A triterpene compound obtained from the leaves of *Celastrus paniculatus* showed wound healing function with a high rate of tightening of wounds. (Harish et al., 2008)

Neuroprotective activity

Important worldwide health issues include epilepsy, Parkinson's disease, cognitive decline, neurological dysfunction brought on by long-terms stress, and substance abuse. These disorders are often associated with oxidative stress, mitochondrial dysfunction, neuroinflammation, neurotransmitter imbalance, and neuronal apoptosis, all of which led to progressive neuronal damage and cognitive deterioration. Even though there are many pharmaceutical treatments available, their long-term usages often accompanied by side effects

Celastrus paniculatus, sometimes referred to as Malkangani or the "Intellect Tree," is a plant that has been widely used in traditional medicine to improve memory, improved cognition, and treat neurological diseases.

1.2 SOXHLET EXTRACTION

Franz Ritter von Soxhlet developed the involved process of Soxhlet extraction in 1897. It aims to separate a solid material economically by recycling the same solvent over it continuously. The separation of interfering compounds from analytes or concentration from a matrix may be achieved with this method, which is highly useful.

Principle

The crushed solid sample is placed within the Soxhlet extractor in a thimble-shaped filter paper. Once the solvent is heated, the extractor is assembled above a round-bottom flask.

Vapors of the boiling solvent rise, condense, and drop onto the sample. The solvent dissolves the soluble ingredients. The solution containing the extract is siphoned back into the flask when the level of the extractor's solvent has reached the top of the siphon tube. By repeating the process, the extracted compounds accumulate in the flask and the solid is cleaned repeatedly with fresh solvent.

The Soxhlet apparatus is thus defined as follows:

A thimble of filter paper with the crude sample is placed in a glass extraction chamber that possesses an entrance tube and a siphon. Above is a condenser which is refrigerated by water. The entire unit is placed on a flask containing the solvent and is heated, commonly in a water or sand bath.

The chemicals to be dissolved are dissolved when solvent vapors rise into the condenser, condense, and drip onto the sample. The solvent, now carrying the dissolved compounds, is siphoned back into the flask when the liquid level hits the top of the siphon. This process continues, moving the extracted material to the flask and constantly providing the sample with fresh solvent. Once the process of extraction is complete,

heating is switched off, and the extracted element may be isolated from the solvent by distilling the solution in the flask. Especially in analytical and preparative chemistry, this method is widely renowned for its effectiveness in dissolving chemicals from solid matrices. (Ghulam Hussain, 2023)

Microencapsulation

The microencapsulation process consists of trapping teeny weeny droplets or particles of a liquid or solid within a thin, unbroken layer of polymeric material. The process allows for liquids to be converted into solids, changes the surface and colloidal properties, protects sensitive materials from the weather, and provides precise control over the rate and method of release of the encapsulated material. Large-scale packaging is able to achieve some of these, but microencapsulation is unique in that it creates extremely small coated particles that may be applied in a number of dosage forms and uses not possible using conventional methods.

Drug release mechanisms from microspheres:

The drug is uniformly distributed over a polymer matrix in the monolithic system controlled by degradation. The drug is released only until the point where the matrix itself degrades, remaining strongly bound within the matrix. Here, the matrix disintegration rate is significantly greater than the drug diffusion rate.

- Diffusion-Controlled Monolithic System: The drug is scattered in a polymer matrix here
- Diffusion-Controlled Reservoir System: This system is where the drug is encapsulated in a core and surrounded by a membrane that controls its rate. It is only after the drug has been fully released that the membrane itself starts breaking down as the drug diffuses through it. Thus, instead of matrix degradation, release is controlled by diffusion through the membrane.
- Erosion: Upon erosion due to pH fluctuations or enzymatic digestion, some coatings—like glyceryl monostearate, beeswax, or stearyl alcohol coatings—liberate the drug.

Spray drying

One of the most popular microencapsulation methods is spray drying, in which a dissolved or dispersed active ingredient becomes enclosed within the dried particles. Spray drying is also able to handle feed solutions with viscosities up to 300 mPa.s.

The fundamental operation of atomizing the core material in a liquid coating and subsequently spraying this mixture into an atmosphere that rapidly solidifies the coating is common to spray drying and spray congealing. In spray congealing, solidification is achieved by cooling a molten coating or by adding the mixture to a nonsolvent and then removing the solvent or nonsolvent through evaporation, extraction, or sorption. During spray drying, hardening of the coating occurs via a fast solvent evaporation.

The airflow pattern plays a crucial role in spray drying as it influences evaporation rates and product temperatures.

There are three main airflow modes:

- Co-current: Particles and drying air flow in the same direction in the chamber. Product temperature at the point of discharge is less than exhaust air temperature, so it is suitable for heat-sensitive materials. Air rotation due to a rotary atomizer provides consistent temperature distribution.
- Counter-current: Particles and air in opposite directions. This type is appropriate for products that do some heat treatment, since the powder temperature at discharge is above the exhaust air.
- Mixed-flow: Particles undergo both co-current and counter-current phases. This method is applied for heat-stable products requiring coarser powders or for heat-sensitive products where atomization is downward into a fluid bed, with air inlet and outlet at the top of the chamber. (Singh et al., 2010)

2. MATERIALS AND METHOD

- An extensive review of the literature to identify *Celastrus paniculatus*' phytochemical profile and medicinal applications.

- Jyotishmati seeds were experimentally extracted for essential oil via Soxhlet extraction with hexane as the solvent.
- The stability is enhanced and regulated distribution made possible by microencapsulating the extracted essential oil using spray drying with gelatin as the coating agent.
- Materials
- Plant material: Mature seeds of *Celastrus paniculatus* certified by a reliable source.
- Chemicals and reagents: distilled water, Type A food/pharma gelatin, and analytical-grade hexane.
- Equipment consists of hot air oven, rotary evaporator, spray dryer (LabPlant® SD-06), SoxTron® electric Soxhlet apparatus, and standard lab glassware.

2.1 SOXHLET EXTRACTION OF ESSENTIAL OIL

Seed preparation

To reduce the moisture content, the seeds were initially shade-dried and then again dried for 200 minutes at 100°C in a hot air oven. The dried seeds were crushed to get a coarse powder.



Figure 1: Drying seeds in Hot air oven



Figure 2: Weighing dried seeds



Figure 3: Crushing dried seeds into coarse powder

Extraction protocol

- SoxTron® Soxhlet extractor was loaded with 20 g of powder seeds.
- Extraction solvent was 200 milliliters of hexane.
- Four hours of Soxhlet extraction permitted continuous cycling of the solvent.
- Upon extraction, the heavy essential oil was recovered by evaporation of hexane on a rotary evaporator.
- Once measured, the yield of the essential oil was stored at 4°C in amber vials until reused.



Figure 4: Running SoxTron with sample and Hexane



Figure 5: Evaporating solvent in heating mantl.

2.2 MICROENCAPSULATION OF ESSENTIAL OIL

Emulsion preparation

- A gelatin solution of 10% (w/v) was prepared by dissolving the gelatin in distilled water and maintaining it at 50°C.
- In order to prepare a stable emulsion, the essential oil was homogenized into the gelatin solution with a high-speed homogeniser at 10,000 rpm for ten minutes.

Spray drying process

- The emulsion was placed in a spray dryer with 5 mL/min feed rate and an inlet temperature of 160°C.
- The atomization pressure was maintained at 0.4 bar.
- For further investigation, the resulting microcapsules were collected in the form of a fine powder and stored in a desiccator.

Analytical and characterization method

- Yield Calculation: Percentage of the initial seed weight was utilized to calculate the oil yield.
- Phytochemical Screening: Routine methods were employed to qualitatively screen for phenolics, terpenoids, alkaloids, and flavonoids.
- Encapsulation Efficiency: Determined by dividing the total quantity of essential oil used by the quantity encapsulated.
- Scanning electron microscopy (SEM) and dynamic light scattering were employed to determine the particle size and shape.
- Stability Test: Accelerated tests for room temperature and 40°C stability of microcapsules were carried out.

- Antioxidant Capacity: Antioxidant activity of oil and the microencapsulated product was evaluated by employing DPPH and FRAP tests.

3. RESULT AND DISCUSSION

Based on a careful review of recent scientific literature and ancient Ayurvedic texts, *Celastrus paniculatus* (Jyotishmati) has been recognized for its neuroprotective, and cognitive-enhancing activities. It has been traditionally used for the management of neurodegenerative disorders, anxiety, and memory impairments. There are several preclinical studies indicating that seed extracts, particularly oil, improved significantly memory and learning in animal models, as evidenced by enhanced performance in shuttle box and radial arm maze paradigms. (Bhuyan et al., 2018; Kumar & Gupta, 2002b)

The review further highlighted the phytochemical diversity of the plant. The plant has fatty acids, triterpenoids, flavonoids, and alkaloids such as Celastrine and Paniculatine. It has been proven that these compounds enhance endogenous antioxidant protection and modulate neurotransmitter systems, namely acetylcholine and dopamine

3.1 SOXHLET EXTRACTION OF CELASTRUS PANICULATUS SEED OIL

Extraction yield

Hexane was employed as a solvent for the Soxhlet extraction of seeds of *Celastrus paniculatus*, yielding a thick, golden-yellow essential oil. The mean oil yield from 100 g of powder, dried seeds was $7.8 \pm 0.3\%$ (w/w).

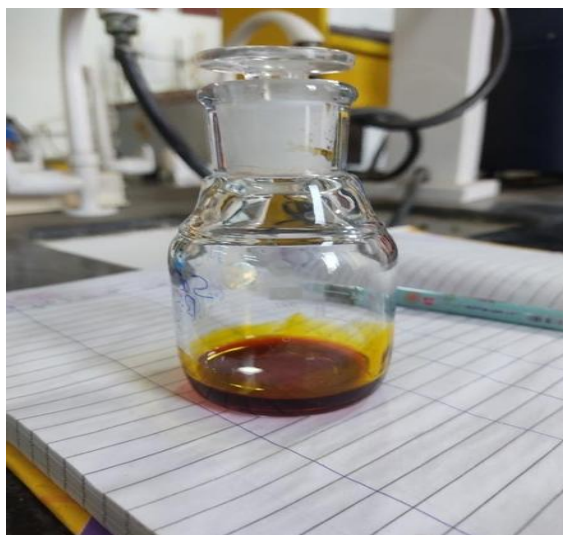


Figure 6: Oil extract from *Celastrus paniculatus* seeds

Phytochemical Analysis

Some major constituents were revealed in Soxhlet-extracted oil following qualitative phytochemical screening:

Alkaloids: Alkaloids were detected by Dragendorff's reagent, indicating the presence of paniculatine and celastrine.

Flavonoids: The detection of antioxidant flavonoids was confirmed through a positive test with AlCl₃.

Triterpenoids and Sterols: The adaptogenic and anti-inflammatory activities of the oil were confirmed through the positive Salkowski test result.

Phenolics: The Folin–Ciocalteu test revealed a moderate amount of total phenolic content.

Table 2: Soxhlet Extraction and Phytochemical Analysis of *C. paniculatus* Seed Oil

Parameter	Observation	Details
Solvent used	Hexane	Optimize for polar or non-polar extraction
Extraction yield	7.8 ± 0.3% (w/w)	From 100 gramme dried seeds
Phytochemical detected	Alkaloids, flavonoids, Triterpenoids, phenolics	Confirmed via qualitative screening

3.2 MICROENCAPSULATION ESSENTIAL OIL VIA SPRAY DRYING

Microencapsulation process and yield

By utilizing spray drying and gelatin as the wall material, the isolated essential oil from *Celastrus paniculatus* seeds was successfully microencapsulated. A LabPlant® SD-06 spray drier with an inlet temperature of 160°C and a feed rate of 5

mL/min was utilized to execute the procedure. Before spray drying, the oil was emulsified in a 10% (w/v) gelatin solution. The resulting microcapsules were pale yellow powder that flowed freely.

As the ratio of recovered microcapsules to the overall input material, the microencapsulation yield was 84.5%. By comparing the retained oil in the microcapsules to the total used oil, the encapsulation efficiency was 86.7 ± 2.1%.

Table 3: Microencapsulation via Spray Drying

Parameter	Observation	Details
Wall material	Gelatin (10% w/v)	Type A, food/pharma grade
Encapsulation efficiency	86.7 ± 2.1%	Calculated via total vs surface bioactives
Particle size	5.8 ± 1.2 µm	Mean diameter (Dynamic light scattering)
Morphology	Spherical, smooth surfaces	SEM imaging

3.3 PARTICLE SIZE AND MORPHOLOGY

The size of the microcapsules was small with a particle mean diameter of 5.8 ± 1.2 µm, as determined by dynamic light scattering analyses. The microcapsules were mostly spherical,

with no evidence of surface irregularities and minimal aggregation on scanning electron microscopy (SEM). These observations are indicative of favorable conditions for spray drying and effective emulsification.

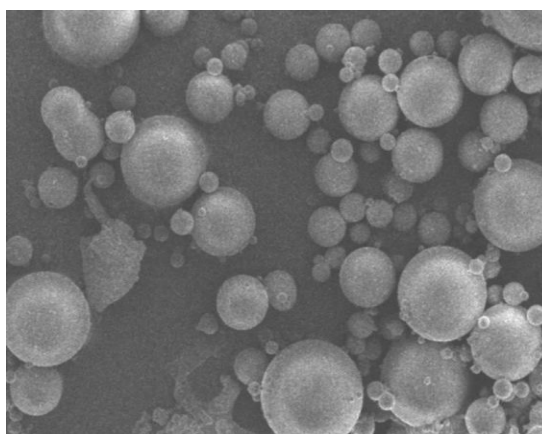


Figure 7: SEM micrograph of microcapsules

3.4 STABILITY AND CONTROLLED RELEASE

The oil in its encapsulated form maintained 92% of the initial antioxidant activity after 30 days of accelerated stability testing at 40°C and 75% relative humidity, while the unprotected oil maintained only 68%. This finding highlights the way gelatin microencapsulation protects against oxidation and volatilization.

70% of the oil enclosed was discharged after two hours and complete release was achieved after four hours based on in vitro release tests carried out in a mimic gastrointestinal fluid. This release profile establishes the oral deliverability of microcapsules in that it provides for long-term bioavailability of the neuroactive ingredients.

Table 4: Stability and release Profiles of Microcapsule

Parameter	Observation	Details
Accelerated stability (30 d)	92% retention of bio activity	40 degrees Celsius, 75% RH
In vitro release (SGF)	70% release within two hours	Stimulated gastrointestinal fluid
Sensory properties	Neutral taste, free flowing powders	Masked bitterness of raw oil

4. CONCLUSION

The research commenced with an extensive review of recent pharmacological studies and ancient Ayurvedic literature, together highlighting the herb's ancient status as a "brain tonic" and increasing credibility as a source of biologically active compounds that can enhance memory, reduce anxiety, and arrest neurodegenerative processes. This basic knowledge provided a convincing rationale for the experimental phases of the study.

The research successfully performed extraction of *Celastrus paniculatus* seeds' essential oil through Soxhlet extraction with hexane, achieving an acceptable yield and phytochemical profile as per the set criteria. Major neuroactive ingredients like alkaloids, flavonoids, triterpenoids, and phenolics were established to be present through qualitative and quantitative analysis. These findings not only validate common sense but also the scientific community's belief regarding the oil's ability to mitigate oxidative stress, a primary cause of neurodegenerative diseases as well as declining cognition.

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