

Passiflora incarnata Linn: A Comprehensive Review of Botanical Characteristics, Phytochemistry, and Pharmacological Activities

Ciya Sangwan¹; Muskan²; Dr. Meenu^{3*}

^{1,2,3}Department of Pharmaceutical Sciences, Maharshi Dayanand University, Rohtak, Haryana, India

Corresponding Author: Dr. Meenu*

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Abstract: *Passiflora incarnata* Linn, commonly referred to as passionflower, is a traditional medicinal herb renowned for its soothing effects on the nervous system. It has long been utilized in the treatment of sleep disturbances, anxiety-related conditions, and inflammatory disorders. In recent years, growing scientific interest has positioned *P. incarnata* as a promising phytotherapeutic agent, particularly for neuropsychiatric and neuroprotective applications. The present review provides a comprehensive and integrative overview of *P. incarnata*, emphasizing its botanical characteristics, phytochemical composition, extraction methodologies, and pharmacological activities. Special attention is given to both conventional and advanced extraction techniques, highlighting how process parameters influence the recovery of flavonoids, alkaloids, and phenolic compounds responsible for the plant's biological activity. The review summarizes current evidence supporting the sedative, anxiolytic, anticonvulsant, antidepressant, antioxidant, anti-inflammatory, antidiabetic, antimicrobial, and anticancer properties of *P. incarnata*. Mechanistic insights, particularly those involving modulation of the GABAergic system and oxidative stress pathways, are discussed to explain its neuropharmacological effects. Furthermore, the sustainable utilization of *Passiflora* biomass and the need for standardized extracts, optimized extraction protocols, and well-designed clinical studies are critically addressed. Overall, this review highlights *P. incarnata* as a valuable natural resource with significant therapeutic potential and underscores future research directions required for its successful translation into evidence-based herbal formulations. This review critically evaluates existing literature, provides comparative analysis of extraction techniques, and highlights key research gaps for future investigations.

Keywords: *Passiflora incarnata* L.; Passionflower; Vitexin; Polyphenols; Neuropharmacology; Anxiolytic Activity; Antioxidant Activity.

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I. INTRODUCTION

Medicinal plants play a crucial role in both traditional and contemporary healthcare systems, as they represent a rich source of biologically active compounds with significant therapeutic value. Since ancient times, these plants have been utilized for the prevention and management of numerous diseases and remain an important basis for the discovery and development of new pharmaceutical agents. A significant proportion of modern pharmaceuticals are either directly derived from plant sources or developed based on phytochemicals identified from traditional medicinal knowledge. Thus, medicinal plants not only contribute to human health but also play an essential role in the advancement of civilizations across the globe [1,2].

In recent decades, global interest in plant-based therapeutics has increased markedly due to growing consumer preference for natural, safe, and sustainable remedies. This rising demand has significantly expanded the market for medicinal and aromatic plants, which was valued at approximately USD 300 billion in 2020 and increased to around USD 410 billion by 2024. Recent estimates indicate that the market exceeded USD 440 billion in 2025 and is projected to reach nearly USD 600 billion by 2030. This steady growth highlights the increasing reliance on medicinal plants as renewable sources of therapeutic compounds for pharmaceutical, nutraceutical, cosmetic, and wellness industries [3].

The genus *Passiflora* L. (family Passifloraceae) represents one of the most important medicinally and economically valuable genera of flowering plants. The name

of the genus originates from the Latin term “Passio,” meaning passion, which was assigned by Spanish explorers in the sixteenth century. They interpreted the unique floral structure as symbolic of the Passion of Christ, a perception that ultimately gave rise to the common name “passionflower”. It comprises approximately 520 species, predominantly distributed in tropical and subtropical regions of Central and South America, with some species extending to North America, Asia, and Australia. Several important species within this genus include *Passiflora incarnata* L., *Passiflora edulis* Sims, *Passiflora alata* Curtis, *Passiflora caerulea* L., *Passiflora foetida* L., *Passiflora quadrangularis* L., *Passiflora ligularis* Juss., and *Passiflora mollissima* (Kunth) L.H. Bailey [4].

Among the various species of the genus *Passiflora*, *Passiflora incarnata* L., commonly referred to as purple passionflower or maypop, is one of the most extensively investigated species due to its significant medicinal value. It is a perennial, fast-growing climbing vine distinguished by its deeply lobed leaves, coiling tendrils, and characteristic ornamental flowers with a complex corona, followed by oval-shaped fruits [6,8]. The plant is originally native to the southeastern regions of the United States, including states such as Florida, Texas, and Virginia; however, due to its adaptability to a wide range of climatic conditions, it has been successfully introduced and cultivated in many temperate and subtropical parts of the world. In Europe, it is commonly grown in countries such as Italy and the Netherlands, while in Asia it is cultivated in several regions of India, particularly in northern and northeastern states like Himachal Pradesh, Uttarakhand, Assam, and parts of West Bengal, as well as in some southern hill regions where moderate climatic conditions prevail [8]. Its widespread distribution has facilitated its integration into multiple traditional systems of medicine across different cultures,

including those of the West Indies, Mexico, South America, and Argentina, where it has been historically used to manage conditions such as anxiety, insomnia, nervous disorders, and gastrointestinal disturbances. Over time, its therapeutic applications have expanded to include the treatment of respiratory disorders like asthma, bronchitis, and whooping cough, along with conditions involving muscle spasms, pain, and inflammation [7]. Phytochemical investigations of *P. incarnata* have revealed the presence of diverse classes of bioactive compounds, including flavonoids (notably vitexin and isovitexin), alkaloids, glycosides, phenolic constituents, and volatile components, which are believed to act synergistically to produce therapeutic effects [4]. Pharmacological studies have further supported its traditional uses, demonstrating a wide range of biological activities such as sedative, anxiolytic, antispasmodic, analgesic, antioxidant, anticonvulsant, anti-inflammatory, antitussive, and antiasthmatic properties. Owing to this broad spectrum of pharmacological actions and its comparatively favorable safety profile, *P. incarnata* has gained considerable importance in modern herbal medicine as a natural therapeutic option, particularly for the management of neurological and respiratory conditions where long-term use of synthetic drugs may lead to undesirable side effects [8].

Taxonomical classification serves as a fundamental tool for organizing plant species into a structured hierarchy based on their evolutionary relationships and distinguishing characteristics. *Passiflora incarnata* L. is systematically placed within the family Passifloraceae under the order Malpighiales. A clear understanding of its taxonomic position is important for proper identification and supports further studies related to its morphology, phytochemistry, and pharmacological properties. The detailed classification of the species is summarized in Table 1 [5].

Table 1 Taxonomical Classification [5]

Taxonomic Rank	Classification
Botanical Kingdom	Plantae
Major Division	Streptophyta
Taxonomic Class	Equisetopsida
Subclass Group	Magnoliidae
Order Classification	Malpighiales
Plant Family	Passifloraceae
Genus Name	<i>Passiflora</i>
Identified Species	<i>P. incarnata</i> L.

II. MORPHOLOGY

P. incarnata is a perennial, herbaceous climbing vine that may extend up to approximately 2 meters (about 6.5 feet) in length. It is distinguished by its striking flowers and uniquely shaped, three-lobed leaves. The plant is commonly observed along woodland margins and field borders. In recent years, it has also been increasingly reported in agricultural landscapes across Virginia, particularly in fields managed under conservation tillage practices [4].

➤ Fruits:

Fruits are one-celled, indehiscent berries, green to yellowish-green in color and measuring about 1.5 to 3 inches in length, as shown in Figure 1. In some cases, fruits may also occur as capsules with three to five semi-placentiferous valves. The berries contain numerous dark brown, dimpled (reticulate) seeds embedded within the pulp [4].

Fig 1 *Passiflora incarnata* Fruit

➤ **Seeds:**

It contains numerous seeds, each attached by a funiculus that expands into a fleshy, cup-shaped or sac-like aril, as shown in Figure 1. The seed coat is hard and textured with small depressions and can be easily separated from the inner membranous layer (endopleura), which is characterized by a distinct longitudinal raphe. Pollination occurs mainly through insects, which are strongly attracted to the prominent and elaborate corona structures of the flower [4,9].

Fig 2 *Passiflora incarnata* Seeds

➤ **Leaves:**

Leaves are typically arranged alternately along the stem and are generally somewhat hairy, as shown in Figure 1. Each leaf is usually divided into three lobes (occasionally five) arising from a common central point (palmately lobed). The leaves measure approximately 2½ to 5½ inches in both length and width and are attached by petioles. At the junction of the leaf blade and petiole, two nectar-filled glands are present. Leaf morphology may vary, appearing simple and entire, distinctly lobed, or palmately shaped; in some cases, they may also be compound with an imparipinnate arrangement. Stipules are generally present at the base of the petiole, though they may sometimes be absent. Tendrils occur in the axils, arising from sterile pedicels [4].

Fig 3 *Passiflora incarnata* Leaves

➤ **Flowers:**

Flowers may be regular, bisexual, or occasionally unisexual, as shown in Figure 1. The corolla is well-developed, and the blossom typically measures about 6–7 cm in diameter [8], with a length ranging from 2 to 4 inches. The flower consists of five similar, alternating petals that are violet to pale in color, along with five greenish-white sepals bearing terminal appendages. Floral forms may vary, generally showing three stamens and characteristic structural differences. The flowers usually bloom around midday, during the warmest part of the day, and remain open until late afternoon. During this period, pollinators visit the flowers to collect nectar and assist in pollen transfer between flowers [4,8].

Fig 4 *Passiflora incarnata* Flower

➤ **Shoots:**

Shoots can grow indefinitely, reaching lengths of up to 10 meters, and may frequently branch out; plants commonly produce extra shoots unexpectedly from the hypocotyl, subsurface roots, and rhizomes. Shoots that develop from rhizomes and roots can emerge over 6 meters away from their original parent shoot. Perennating buds on rhizomes and roots give rise to new shoots every spring after shoots die in the fall [11].

➤ **Roots:**

P. incarnata possesses a well-developed taproot system that can extend more than one meter into the soil, as shown in Figure 1. Roots showing signs of shoot development are mainly found at depths of 10–20 cm but may extend up to 75 cm. The proportion of roots to rhizomes is approximately 9:1, and they are difficult to distinguish externally, differing mainly in internal structure, with roots having a central xylem core and rhizomes containing pith [13]. Initially, the root system develops as a primary taproot, which gradually transforms into a deep, perennial rootstock. This established root system allows the plant to generate new shoots during successive growing seasons [4].

Fig 5 *Passiflora incarnata* Roots

➤ *Seedlings:*

The cotyledons are thick, oval in shape, and possess a smooth, wax-like surface, as shown in Figure 1. The first true leaf that develops is cordate with a glossy appearance. As the plant matures, subsequent leaves typically become palmately lobed, usually forming three distinct lobes arising from a single point. Although seed germination occurs, the plant more commonly propagates through shoots emerging from its established perennial rootstock [4,6].



Fig 6 *Passiflora Incarnata* Seedlings

III. CHEMICAL CONSTITUENTS

The major chemical constituents of *Passiflora incarnata* primarily include flavonoids (approximately 0.25%), such as vitexin, isovitexin, orientin, isoorientin, apigenin, quercetin, and kaempferol. The plant also contains indole alkaloids (around 0.1%) belonging to the β -carboline group, including harman, harmine, harmaline, harmol, and harmalol. In addition to these compounds, several other phytochemicals have been identified, such as glycosides, amino acids, carbohydrates, benzopyrone derivatives, cyanogenic glycosides like gyanocardin, and pyrone compounds including maltol and its ethyl derivative [12].

➤ *Flavonoids*

Flavonoids are recognized as the primary phytoconstituents present in *P. incarnata*. These include compounds such as apigenin, luteolin, quercetin, and kaempferol, along with several C-glycosyl flavonoids like vitexin, isovitexin, orientin, isoorientin, schaftoside, isoschaftoside, isovitexin-2-O-glucopyranoside, isoorientin-2-O-glucopyranoside, 2-glucosylapigenin, isoscoparin-2-O-glucoside, 2-O-glucosyl-6-C-glucosylapigenin, 6-D-glucopyranosyl-8-D-ribopyranosyl apigenin, and swertisin (Dhawana et al., 2004). Flavonoids are polyphenolic compounds commonly found in plants and are characterized by a basic structural framework of 15 carbon atoms arranged in two aromatic rings connected by a three-carbon bridge, generally described as a C6–C3–C6 structure. These compounds are known to exhibit various biological activities in both in vitro and in vivo studies [8,14].

➤ *Alkaloids*

The passiflora family includes trace amounts of harmala alkaloids, such as harmane (passaflorine), and potentially harmine (telepathine), harmaline, harmol, and harmalol. The existence of the latter four compounds in *P. incarnata* is contested since they are found in very minimal quantities (0.01% or lower) [15].

The greenhouse-cultivated *P. incarnata* has vegetative components containing 0.012% harman and 0.007% harmine, whereas the alkaloid levels in field-grown plants have been reported as 0.005% for harman and none for harmine [14].

➤ *Miscellaneous Constituents*

In addition to flavonoids, several other constituents have been reported in *Passiflora incarnata*. These include the benzopyrone derivative maltol and various carbohydrates such as raffinose, D-glucose, D-fructose and sucrose. The plant also contains an essential oil composed of multiple volatile compounds, including hexanol (1.4%), benzyl alcohol (4.1%), 2-phenylethyl alcohol (1.2%), linalool (3.2%), methyl 2-hydroxybenzoate (1.3%), trans-anethole (2.6%), eugenol (1.8%), isoeugenol (1.6%), carvone (8.1%), ionone (2.6%), phytol (1.9%) and bergamotol (1.7%).

Several aromatic constituents such as limonene, cumene, α -pinene, presizaene, zizanene and zizaene, contribute to the plant's characteristic fragrance profile. Furthermore, the presence of approximately twenty-one amino acids and a cyanogenic glycoside, gyanocardin, has also been documented [14].

IV. EXTRACTION TECHNIQUES

Extraction is the process of separating bioactive compounds from plant materials using suitable solvents or techniques. It is an important step for isolating primary and secondary metabolites present in plants. The extracted compounds can then be used for chemical analysis, pharmacological studies, and therapeutic applications [17].

➤ *Conventional Extraction Methods*

• *Maceration*

Maceration is a traditional extraction technique in which powdered plant material is soaked in a suitable solvent at room temperature for a defined period to allow diffusion of soluble phytoconstituents into the solvent. The method is widely used for the extraction of thermolabile compounds because it avoids exposure to high temperatures. Various studies have reported the use of ethanol, methanol, and hydroalcoholic mixtures for maceration of *P. incarnata* leaves, with ethanol frequently considered a suitable solvent due to its ability to extract a broad range of polar phytochemicals such as flavonoids and phenolic compounds [18,23].

Table 2 Percentage Yield of Maceration Method Extract of *P. incarnata*

Study	Plant part	Solvent	Extraction conditions	Yield (% w/w)
Michael <i>et al.</i> , 2022	Leaves	Ethanol	48 h, room temperature	12.4%
Gupta <i>et al.</i> , 2012	Leaves	Methanol	72 h maceration	10.8%
Azwanida, 2015	Leaves	Hydroalcoholic (70% ethanol)	48 h	13.6%

The reported studies indicate that ethanol and hydroalcoholic solvents generally provide higher recovery of flavonoids and phenolic compounds from *P. incarnata*.

✓ Merits

- Simple and inexpensive technique
- Suitable for thermolabile compounds
- Requires minimal equipment

✓ Demerits

- Long extraction time
- Higher solvent consumption

- Lower extraction efficiency compared with hot extraction techniques

• Soxhlet Extraction

Soxhlet extraction is a continuous hot extraction technique in which solvent repeatedly refluxes through the plant material, enabling efficient recovery of phytoconstituents. In this method, dried and powdered *P. incarnata* leaves are placed in a thimble within the Soxhlet apparatus, and solvents such as petroleum ether, ethanol, or methanol are used for extraction according to compound polarity [19].

Table 3 Percentage Yield of Soxhlet Method Extract of *P. incarnata*

Study	Solvent	Extraction time	Major compounds extracted	Yield (% w/w)
Gupta <i>et al.</i> , 2012	Petroleum ether	6 h	Non-polar compounds	4.6%
Gupta <i>et al.</i> , 2012	Methanol	8 h	Flavonoids and phenolics	15.2%
Gadioli <i>et al.</i> , 2018	Ethanol	6–8 h	Phenolic compounds	14.1%

Soxhlet extraction generally produces higher extractive yields than cold extraction methods due to continuous solvent reflux and improved mass transfer.

• Aqueous Infusion and Decoction

Infusion and decoction are traditional water-based extraction techniques commonly used in herbal medicine. In

infusion, plant material is steeped in hot water for a short period, while decoction involves boiling the plant material in water for a longer duration. These techniques primarily extract water-soluble compounds such as phenolics, glycosides, and some flavonoids [22].

Table 4 Percentage Yield of Aqueous Infusion and Decoction Method Extract of *P. incarnata*

Study	Method	Extraction conditions	Yield (%w/w)
Yildirim <i>et al.</i> , 2022	Infusion	Hot water, 15–20 min	6.3%
Yildirim <i>et al.</i> , 2022	Decoction	Boiling water, 30 min	7.1%

Studies indicate that aqueous extraction generally results in lower concentrations of flavonoids compared to organic solvents but still exhibits mild antioxidant and sedative activity consistent with traditional medicinal use.

• Heat Reflux Extraction

Heat reflux extraction involves heating plant material with a solvent under reflux conditions, allowing continuous boiling and condensation of the solvent. This method enhances the dissolution of phenolic compounds and flavonoids from *P. incarnata* leaves [20].

Table 5 Percentage Yield of Heat Reflux Method Extract of *P. incarnata*

Study	Solvent	Temperature	Extraction time	Yield (% w/w)
Gadioli <i>et al.</i> , 2018	Ethanol	70–80°C	2–3 h	13.9%
Gadioli <i>et al.</i> , 2018	Methanol	75°C	3 h	14.6%

Heat reflux extraction generally provides moderate to high recovery of phenolic compounds.

• Percolation

Percolation is a continuous extraction technique in which coarsely powdered plant material is placed in a

percolator, a conical extraction vessel designed to allow solvent to pass slowly through the plant matrix. The plant material is first moistened with solvent and allowed to stand for a short maceration period. Fresh solvent is then passed through the packed material at a controlled flow rate, and the percolate is collected continuously [23].

Table 6 Percentage Yield of Percolation Method Extract of *P. incarnata*

Study	Solvent	Percolator size	Extraction time	Yield (% w/w)
Azwanida, 2015	Ethanol	Laboratory percolator	24 h	11.8%
Azwanida, 2015	Hydroalcoholic solvent	Laboratory percolator	24 h	12.6%

Percolation provides more uniform extraction compared to maceration because fresh solvent continuously passes through the plant material.

➤ Modern Extraction Methods

• Ultrasound-Assisted Extraction (UAE):

It is an advanced extraction technique widely applied for the efficient recovery of phenolic and flavonoid compounds from medicinal plants, including *Passiflora incarnata*. In this method, dried and powdered plant material is mixed with a suitable solvent such as ethanol, methanol, or hydroalcoholic mixtures and exposed to ultrasonic waves using an ultrasonic bath or probe system. The ultrasonic waves generate cavitation bubbles in the solvent, which

collapse and cause mechanical disruption of plant cell walls. This phenomenon enhances solvent penetration into plant tissues and accelerates the diffusion of bioactive constituents into the extraction medium. As a result, UAE significantly improves extraction efficiency while reducing extraction time and solvent consumption compared to conventional extraction techniques.

Several studies have reported the use of UAE for the extraction of phenolic compounds from *Passiflora* species under different experimental parameters such as extraction time, temperature, ultrasonic power, and solvent composition. These parameters influence the recovery of bioactive compounds and overall extraction yield [20,21].

Table 7 Percentage Yield of Ultrasound-Assisted Method Extract of *P. incarnata*

Study	Solvent	Ultrasonic conditions	Temperature	Time	Major compounds extracted	Result/Yield
Gadioli et al., 2018	Ethanol–water (70%)	Ultrasonic bath (~40 kHz)	30–40°C	30 min	Phenolic acids and flavonoids	Higher phenolic recovery compared to maceration
Fierascu et al., 2020	Hydroalcoholic solvent	Ultrasonic bath (~35–40 kHz)	~35°C	20–40 min	Flavonoids (vitexin, isovitexin)	Increased flavonoid yield and reduced extraction time

The results reported in these studies indicate that UAE significantly enhances the extraction of phenolic and flavonoid compounds from *P. incarnata* leaves. The cavitation effect improves mass transfer between plant material and solvent, leading to higher extraction yields within a shorter time. Compared with conventional maceration methods, UAE provides improved extraction efficiency while operating at relatively mild temperatures, which helps preserve thermolabile phytochemicals present in *P. incarnata*.

✓ Merits

- Short extraction time
- Reduced solvent consumption
- Higher extraction efficiency
- Suitable for thermolabile compounds

✓ Demerits

- Requires specialized ultrasonic equipment
- Scale-up for industrial applications can be challenging

Table 8 Comparison of Different Extraction Methods

Method	Time	Yield	Advantages	Limitations
Maceration	Long	Moderate	Simple	Low efficiency
Soxhlet	Medium	High	Efficient	Heat degradation
UAE	Short	High	Fast	Costly

V. PHARMACOLOGICAL USES

➤ Sedative and Anxiolytic Activities

Clinical studies indicate that *P. incarnata* extracts help reduce tension, restlessness, and nervous irritability, supporting their use in managing anxiety and insomnia. In several studies, passionflower preparations have shown effects comparable to conventional anxiolytic drugs, suggesting their potential as an alternative or supportive therapy. These effects are believed to occur via interaction with the GABA–benzodiazepine receptor complex, making the leaves useful in anxiety-related disorders and stress-induced conditions. In recent years, the prevalence of anxiety

and depressive symptoms has increased, particularly following the COVID-19 pandemic, leading to greater use of antidepressant and anti-anxiety medications [16].

It has long been used in traditional medicine as a mild sedative. Preclinical investigations have demonstrated that its ethanolic extract (FDS-PI) can significantly prolong sleep duration in male ICR mice without impairing motor coordination. Clinical observations further indicate that adolescents who consumed tea prepared from the flowers of *P. incarnata* experienced improvements in sleep quality. In addition, a controlled clinical study evaluating a standardized preparation (SIVI) of *P. incarnata* reported marked

reductions in stress levels and insomnia symptoms following 30 days of administration in adults aged 18–60 years. Collectively, these findings provide scientific support for its traditional use and align with contemporary pharmacological research [24].

It has been reported that preoperative oral administration of an aqueous leaf extract of *Passiflora incarnata* L. (700 mg/5 ml) significantly alleviated anxiety in patients undergoing spinal anesthesia. Importantly, this anxiolytic effect was achieved without producing noticeable changes in sedation levels, psychomotor function, or hemodynamic stability [27].

➤ Antiepileptic Activity

Leaves of *P. incarnata* have demonstrated pronounced antiepileptic effects in experimental models of epilepsy. Studies using pentylenetetrazol (PTZ)-induced seizure models have shown that hydroethanolic leaf extracts significantly reduce seizure onset, frequency, and severity. PTZ is known to induce seizures by inhibiting GABA-mediated neurotransmission; therefore, the protective effect of *P. incarnata* suggests its ability to enhance inhibitory signaling in the central nervous system [25].

The antiepileptic activity is mainly attributed to the presence of flavonoids such as chrysin, vitexin, and isovitexin, along with β -carboline alkaloids. These compounds are known to interact with the GABA–benzodiazepine receptor complex, leading to neuronal hyperpolarization and reduced excitability. Unlike many conventional antiepileptic drugs, *P. incarnata* leaf extracts produce anticonvulsant effects without causing marked sedation or motor impairment, indicating a favorable safety profile. This dual efficacy and tolerability highlight the therapeutic potential of *P. incarnata* leaves as an adjunct or alternative treatment for epilepsy [14].

The anticonvulsant activity of hydroethanolic and aqueous extracts of *Passiflora incarnata* may be explained by recent findings showing the presence of γ -aminobutyric acid (GABA), an inhibitory neurotransmitter, as a major amino acid in these extracts. Cold extraction using 44% ethanol was found to yield the highest GABA content, suggesting that GABA plays a key role in the anticonvulsant effects of *P. incarnata*. Based on these observations, chrysin alone may not be the primary phytoconstituent responsible for seizure protection. However, improved formulations of methanolic extracts with enhanced chrysin bioavailability could further increase the therapeutic and clinical potential of *P. incarnata* [14].

➤ Antidepressant and Neuroprotective Effects

In addition to seizure control, *P. incarnata* leaf extracts have shown significant antidepressant and neuroprotective effects, particularly in epilepsy-associated post-ictal depression. Experimental studies indicate that treatment with leaf extracts improves behavioral outcomes in forced swim and locomotor activity tests, reflecting reduced depressive-like behavior [25].

Depression is associated with disruptions in dopaminergic, serotonergic, and GABAergic neurotransmission, along with increased oxidative stress and neuroinflammatory processes. Bioactive compounds present in *P. incarnata*, including Vitexin, chrysin, apigenin and harmine, are known to act on these pathways, which may contribute to its antidepressant effects [14].

Biochemical analyses reveal that these effects are associated with increased levels of key monoamine neurotransmitters, including serotonin and noradrenaline, in brain tissue. By modulating these neurotransmitter systems, *P. incarnata* leaves help restore emotional balance and improve mood regulation. Furthermore, the antioxidant properties of leaf constituents protect neuronal cells from oxidative stress induced by recurrent seizures, thereby contributing to their neuroprotective action [26].

These results provide scientific validation for the traditional application of *P. incarnata* leaves in the management of nervous system disorders, emotional disturbances, and depressive conditions. The combined antidepressant and neuroprotective effects are particularly valuable in neurological disorders, where long-term neuronal damage and mood dysfunction frequently coexist [24].

➤ Antidiabetic Effect

The leaves of *Passiflora incarnata* Linn. have demonstrated significant antidiabetic potential in experimental models of diabetes. In streptozotocin (STZ)-induced diabetic mice, methanolic leaf extracts of *P. incarnata* produced a marked reduction in fasting blood glucose levels when administered orally at doses of 100 and 200 mg/kg for 15 days. Treatment with the extract also significantly improved oral glucose tolerance, indicating enhanced glucose utilization and insulin sensitivity. In addition to glycemic control, the extract favorably modulated lipid metabolism by reducing elevated serum cholesterol, triglycerides, and low-density lipoprotein (LDL) levels, while improving overall lipid profile. Diabetic mice treated with *P. incarnata* extract showed prevention of body weight loss, a common complication associated with diabetes. Histopathological examination further revealed protective effects on pancreatic tissue, suggesting preservation of β -cell integrity. The overall antidiabetic efficacy of the extract was comparable to standard antidiabetic drugs, supporting the pharmacological use of *P. incarnata* leaves in the management of diabetes mellitus [19].

➤ Neuropsychiatric Disorder

P. incarnata has been widely studied for its beneficial effects on neuropsychiatric disorders, especially anxiety, stress, and sleep-related problems. Clinical evidence summarized in the systematic review by Janda et al. (2020) indicates that preparations of *P. incarnata* can significantly reduce anxiety symptoms in adults without causing major side effects. Unlike many conventional anxiolytic drugs, passionflower does not appear to adversely affect cognitive abilities or psychomotor performance. This favorable profile suggests that it may serve as a comparatively safer alternative

for prolonged or adjunctive use in individuals experiencing mild to moderate neuropsychiatric conditions.

The therapeutic effects of *P. incarnata* are mainly associated with its actions on the central nervous system, particularly through modulation of γ -aminobutyric acid (GABA) system. The plant contains bioactive compounds that enhance inhibitory neurotransmission, leading to a calming effect and reduced neuronal excitability. This mechanism helps explain its anxiolytic, sedative, and anticonvulsant properties. In addition, flavonoids such as chrysin may support these effects by interacting with benzodiazepine receptors, although the overall activity is believed to result from the combined action of multiple phytoconstituents rather than a single compound [29].

➤ Anti-Oxidant Activity

P. incarnata has exhibited notable antioxidant activity, primarily due to its diverse and abundant phytochemical constituents. Investigations have identified various bioactive compounds in the aerial parts of the plant, including phenolic compounds, flavonoids, alkaloids, and glycosides. Using in vitro antioxidant assays such as DPPH and hydrogen peroxide scavenging methods, the extracts showed strong free-radical-quenching activity. These findings indicate that *P. incarnata* can effectively neutralize reactive oxygen species (ROS), thereby protecting cells from oxidative damage [18].

The antioxidant properties of *P. incarnata* are largely attributed to its flavonoid constituents, particularly chrysin, vitexin, and isovitexin. These compounds exert their protective effects by donating electrons or hydrogen atoms to reactive free radicals, thereby neutralizing them and reducing oxidative damage to cellular components. In addition, phenolic compounds present in the plant enhance endogenous antioxidant defense mechanisms, which may contribute to its protective role against oxidative stress-related disorders. This antioxidant capacity supports the traditional use of *P. incarnata* in managing conditions linked to inflammation, neurodegeneration, and stress [18].

Further evidence from earlier pharmacological studies suggests that the antioxidant properties of *P. incarnata* may also enhance its neuroprotective and anxiolytic effects. Oxidative stress is known to play a crucial role in the pathophysiology of neuropsychiatric and neurodegenerative disorders, and the ability of *P. incarnata* extracts to reduce lipid peroxidation and scavenge free radicals may contribute to its overall therapeutic potential. Thus, the antioxidant activity of *P. incarnata* represents an important complementary mechanism underlying its pharmacological effects [14].

➤ Antimicrobial Activity

P. incarnata has demonstrated noteworthy antimicrobial activity against a range of pathogenic microorganisms. The extracts of *P. incarnata*, particularly methanolic and ethanolic extracts, exhibit inhibitory effects against both Gram-positive and Gram-negative bacteria, as well as certain fungal strains. The observed antimicrobial activity is largely

associated with various bioactive phytochemicals, including flavonoids, alkaloids, phenolic acids, and glycosides. These compounds are believed to exert their effects by compromising microbial cell wall integrity, disrupting protein synthesis, and inhibiting critical enzymatic processes necessary for microbial survival [24].

Additional experimental studies have reported that extracts of *P. incarnata* have demonstrated moderate to pronounced antibacterial effects against pathogens including *Staphylococcus aureus*, *Escherichia coli*, and *Pseudomonas aeruginosa*. This antimicrobial activity lends scientific support to its traditional application in the management of infectious conditions. Moreover, it highlights the plant's potential as a natural therapeutic option or adjunct to conventional antimicrobial agents, particularly in light of the growing challenge of antimicrobial resistance [30].

➤ Anticancer Activity

Emerging evidence suggests that *P. incarnata* possesses promising anticancer properties, largely due to its antioxidant and apoptosis-inducing potential. Phytochemicals such as flavonoids, polyphenols, and alkaloids present in *P. incarnata* have been reported to influence critical molecular mechanisms implicated in cancer development and progression. These constituents may exhibit anticancer activity by attenuating oxidative stress, limiting lipid peroxidation, and modulating signaling pathways that govern cellular proliferation and apoptosis [24].

Experimental studies have further demonstrated that *P. incarnata* extracts can induce cytotoxic effects in various cancer cell lines by increasing reactive oxygen species (ROS)-mediated apoptosis and altering mitochondrial membrane potential. The activation of antioxidant defense systems and modulation of transcription factors such as Nrf2 may also contribute to its chemopreventive effects. Although current findings are mainly preclinical, they indicate that *P. incarnata* could serve as a valuable source of bioactive constituents for future anticancer drug development [31].

➤ Aphrodisiac

P. incarnata, traditionally described in ancient Ayurvedic literature as a valuable remedy for conditions such as male sexual dysfunction, reduced libido in post-menopausal women, menstrual irregularities, morphine dependence, alcoholism, and tobacco addiction, significant progress has been achieved. The presence of a tri-substituted benzoflavone (BZF) moiety as a key bioactive phytoconstituent represents an important advancement in explaining its broad therapeutic effects and supports the traditional claims of its medicinal value [32].

➤ Anti-Inflammatory Activity

Experimental studies using animal models have revealed the anti-inflammatory potential of *P. incarnata*. Administration of an ethanolic extract of the herb at doses ranging from 75 to 500 mg/kg body weight resulted in a significant reduction in inflammatory responses within one hour of intragastric dosing. The extract was found to suppress inflammation by limiting leukocyte migration to the site of

injury, indicating its effectiveness in modulating inflammatory processes.

At a higher dose of 500 mg/kg body weight, the ethanolic extract produced approximately a 40% reduction in total leukocyte infiltration into the pleural cavity. This effect was associated with a marked decrease in the migration of both polymorphonuclear and mononuclear leukocytes. The anti-inflammatory response observed was comparable to that of acetylsalicylic acid administered at 250 mg/kg, suggesting that *P. incarnata* possesses clinically relevant anti-inflammatory activity along with antioxidant properties that may help in the prevention and management of inflammation-related disorders [33].

➤ Anti-Nauseating Effect

Clinical evidence suggests that *P. incarnata* may occasionally produce adverse effects such as nausea in sensitive individuals. These reactions are mainly attributed to β -carboline alkaloids present in the plant, which affect the central nervous system by altering neurotransmitter metabolism. As a result, symptoms like nausea, vomiting, dizziness, and sensory disturbances may occur. However, when used in appropriate doses, passionflower has also been reported to improve nervous restlessness and stress tolerance, indicating that its benefits depend on careful and controlled use [33].

VI. CONCLUSION

Passiflora incarnata L. is a well-recognized medicinal plant with significant pharmacological and therapeutic potential, supported by its long-standing traditional use and increasing scientific validation. Its diverse phytochemical composition, particularly the presence of flavonoids and alkaloids, contributes to a broad range of biological activities, especially those affecting the central nervous system. Experimental and clinical studies indicate that the plant exhibits notable anxiolytic, sedative, anticonvulsant, antidepressant, antioxidant, and anti-inflammatory effects, highlighting its potential role in the management of neuropsychiatric and stress-related disorders.

Modern extraction techniques like UAE have improved the recovery and characterization of bioactive compounds, allowing a more accurate assessment of its pharmacological properties. Despite these promising findings, several limitations remain, including the lack of standardized extracts, insufficient data on optimal dosing, and limited long-term safety and large-scale clinical studies. Addressing these gaps is essential to ensure its safe and effective use.

Future research should focus on refining extraction methods, understanding the underlying mechanisms of action, and conducting well-structured clinical trials to establish strong clinical evidence. With continued scientific exploration, *Passiflora incarnata* holds a promising, safe and effective phytotherapeutic agent, with the potential to be integrated into modern healthcare systems.

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