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Review Paper

Review on Neuropharmacological Activities of *Pueraria tuberosa*: Focus on Antidepressant activity

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ABSTRACT

Due to their rising incidence and the drawbacks of current synthetic treatment medicines, such as side effects, delayed onset of action, and low patient compliance, depression and neurodegenerative diseases pose significant global health issues. Growing interest in plant-based therapeutics with neuropharmacological potential has been sparked by these difficulties. Due to its many pharmacological characteristics, Pueraria tuberosa (Roxb. ex Willd.), a well-known medicinal herb used in traditional Ayurvedic medicine, has been thoroughly investigated. Among these, its effects on the central nervous system have drawn a lot of attention latelyPueraria tuberosa's neuropharmacological activities are the main topic of this review, with a focus on its neuroprotective and depressive properties. The medicinal potential of P. tuberosa is enhanced by the tubers' abundance of bioactive phytoconstituents, which include glycosides, phenolic compounds, isoflavonoids (such as puerarin, daidzein, and genistein), and saponins. Significant antidepressant-like effect has been shown in experimental research utilizing a variety of animal models; this activity may be mediated through regulation of neuroinflammatory pathways, antioxidant processes, and monoamine neurotransmitter modulation. Furthermore, by lowering oxidative stress, preventing neuronal apoptosis, and enhancing neuronal survival and function, P. tuberosa has demonstrated encouraging neuroprotective properties.The phytochemistry, traditional use, experimental data, and potential processes behind Pueraria tuberosa's neuroprotective and depressive properties are all compiled and thoroughly examined in this paper. In addition, present constraints, safety issues, and potential for future research—such as the necessity of clinical validation and sophisticated drug delivery methods—are covered. All things considered, Pueraria tuberosa shows promise as a natural treatment option for the treatment of neurodegenerative diseases and depression.

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INTRODUCTION

Among the most common neurological problems in the world, depression and neurodegenerative disorders have a major negative impact on quality of life and place a heavy financial burden on society. While neurodegenerative illnesses include progressive neuronal malfunction and death, resulting in reduced cognitive and motor abilities, depression is defined by persistent low mood, anhedonia, cognitive impairment, and emotional instability. Despite advancements in contemporary medicine, the pharmaceutical treatments for these conditions that are now on the market frequently have drawbacks such poor long-term compliance, unpleasant effects, incomplete remission, and delayed therapeutic response. These drawbacks have prompted research into supplementary and alternative therapy modalities, especially those derived from natural sources. For centuries, traditional medical systems like Ayurveda have employed medicinal plants to treat problems of the central nervous system. In complicated neurological disorders involving oxidative stress, inflammation, neurotransmitter imbalance, and neuronal damage, herbal medicines are known to have multi-targeted activities and are typically regarded as safer. The validation of traditional medicinal plants' therapeutic potential through experimental and mechanistic research has become a major focus of neuropharmacology research in recent years. Pueraria tuberosa (Roxb. ex Willd.), a perennial climbing plant in the Fabaceae family, is sometimes referred to as Indian Kudzu or Vidarikand. In Ayurvedic medicine, P. tuberosa tubers are widely used as a rejuvenating tonic and to cure a variety of illnesses, such as weakness, inflammation, metabolic abnormalities, and issues related to the neurological system. According to phytochemical studies, P. tuberosa is abundant in bioactive substances such phenolic compounds, glycosides, saponins, and isoflavonoids (puerarin, daidzein, and genistein), which are known to have neuroactive, anti-inflammatory, and antioxidant qualities. Pueraria tuberosa may have important neuropharmacological actions, especially antidepressant and neuroprotective benefits, according to emerging preclinical data. Its capacity to regulate monoamine neurotransmitter levels, lower oxidative stress, inhibit neuroinflammatory mediators, and shield neurons from apoptotic damage has been shown in experiments conducted on animal models. These complex processes demonstrate P. tuberosa's potential as a viable option for the treatment of neurodegenerative diseases and depression. The goal of this study is to gather and critically assess the body of research on Pueraria tuberosa's neuropharmacological activities, with a focus on the plant's neuroprotective and depressive properties. In order to encourage the development of P. tuberosa as a natural therapeutic agent for neurological illnesses, the review also addresses potential mechanisms of action, safety considerations, present limitations, and future research possibilities.

Botanical Profile of *Pueraria tuberosa*

Scientific Name

Pueraria tuberosa (Roxb. ex Willd.)

Family

Fabaceae (Leguminosae)

Common / Vernacular Names

- English: Indian Kudzu
- Hindi: Vidarikand
- Marathi: Gajvel / Vidarikand
- Sanskrit: Vidari, Ikshugandha
- Tamil: Nilappanai

Telugu: Nelagummadi

Taxonomical Classification

- Kingdom: Plantae
- Division: Magnoliophyta
- Class: Magnoliopsida

- Order: Fabales
- Family: Fabaceae
- Genus: *Pueraria*
- Species: *Pueraria tuberosa*

Morphological Features

The big, perennial, twining climber Pueraria tuberosa is distinguished by its robust, tuberous roots.

• The plant's roots are a significant medicinal component; they are large, fleshy, tuberous, and starchy, with a hue ranging from cream to light brown.

• Stem: Pubescent, twining, woody, and ascending.

• Leaves: Ovate to rhomboid with complete or somewhat lobed edges; trifoliate, alternating.

• Flowers: Papilionaceous, with terminal or axillary racemes that range in color from bluish-purple to violet.

• Fruits: Oblong, flat pods with a few seeds.

• Seeds: Brownish in hue, hard, and compacted.

Geographical Distribution -

Pueraria tuberosa is found all across the Indian subcontinent, although it is most common in the following areas: Central and northern India; Western Ghats; and Sub-Himalayan regions.It grows well in tropical and subtropical climes and is frequently found in mountainous areas, woodlands, and hedges.

Part Used

• **Tubers** (primary medicinal part)

Conventional Medical Practices

Pueraria tuberosa is widely utilized in Ayurveda. Siddha and Unani systems

Traditionally, it is thought of as:

• Aphrodisiac; • Nervine tonic; • Strength-promoting agent; • Macroscopic and Organoleptic Characteristics (Tubers) Creamy white to pale brown in color; sweet and slightly mucilaginous in taste; characteristic in odor; and hard on the outside and starchy inside

Phytochemical Components *Pueraria tuberosa'*-

Numerous bioactive secondary metabolites found in Pueraria tuberosa tubers have been identified by phytochemical analyses as the cause of the plant's various pharmacological effects. Isoflavonoids, which are known to have important neuroactive, antioxidant, and anti-inflammatory qualities, are especially abundant in the plant. P. tuberosa's medicinal potential is enhanced by the presence of phenolic compounds, glycosides, saponins, alkaloids, and carbohydrates in addition to isoflavonoids. By affecting neurotransmitter levels, shielding neurons from oxidative damage, and lowering neuroinflammation, these phytoconstituents significantly contribute to the modulation of central nervous system activities. The historic usage of P. tuberosa as a nervine tonic is supported by the presence of several bioactive chemicals, which also highlight the plant's potential for treating depression and neurological disease

Table: Pueraria tuberosa's Principal Phytochemical Components and Their Pharmacological Significance

Phytochemical Class	Major Compounds Identified	Pharmacological/Neuropharmacological Relevance
Isoflavonoids	Puerarin, Daidzein, Genistein	Antidepressant, neuroprotective, antioxidant, estrogen-like activity

Phenolic compounds	Coumarins, flavonoids	Free radical scavenging, neuroprotection
Glycosides	Isoflavone glycosides	CNS modulation, antioxidant activity
Saponins	Steroidal and triterpenoid saponins	Adaptogenic, neuroprotective effects
Alkaloids	Trace alkaloids	Neuroactive properties
Carbohydrates	Starch, sugars	Nutritional and energy-providing role
Proteins and amino acids	Essential amino acids	Support neuronal function
Tannins	Condensed tannins	Antioxidant and anti-inflammatory activity
Sterols	β-sitosterol	Neuroprotective and anti-inflammatory effects

The Importance of Isoflavonoids

Isoflavonoids, including puerarin, daidzein, and genistein, are thought to be the most significant bioactive components of Pueraria tuberosa among all phytochemical classes. By lowering oxidative stress, controlling neurotransmitter levels, and blocking inflammatory pathways, these substances have been shown to pass through the blood–brain barrier and protect neuronal cells. The plant's neuroprotective and depressive properties are mostly explained by their existence.

Pueraria tuberosa's Antidepressant Properties

Changes in monoamine neurotransmitter levels, elevated oxidative stress, neuroinflammation, and compromised neuroplasticity are all linked to depression. Pueraria tuberosa shows strong antidepressant-like effects in preclinical models, according to several experimental investigations. P. tuberosa's antidepressant potential has mostly been assessed using rodent behavioral paradigms, which are commonly used to screen for antidepressant drugs.

In behavioral despair models, extracts from Pueraria tuberosa tubers, especially hydroalcoholic and ethanolic extracts, have been demonstrated to reduce immobility time, suggesting antidepressant-like effects. These effects are similar to those of conventional antidepressants and are thought to be mediated by neuroprotective, antioxidant, and monoaminergic neurotransmission regulation.

Models of Experimental Animals Used

1. The Forced Swim Test (FST)

One of the most used models for assessing antidepressant activity is the Forced Swim Test. In this experiment, rodents are immobilized for a predetermined amount of time in an unavoidable container filled with water. Immobility time has been demonstrated to be considerably reduced by P. tuberosa extract treatment, indicating improved coping behavior and antidepressant-like action.

2. Test for Tail Suspension (TST)

Mice are suspended by their tails in the Tail Suspension Test, and the amount of time they remain immobile is recorded. Treatment with P. tuberosa significantly reduces the length of immobility, supporting its potential as an antidepressant.

3. Test of Locomotor Activity

The purpose of this test is to eliminate false-positive findings brought on by stimulant effects. Research has demonstrated that P. tuberosa extracts do not significantly change locomotor activity, suggesting that psychostimulant action is not the cause of the observed antidepressant benefits.

Table: Antidepressant Activity of *Pueraria tuberosa* in Experimental Animal Models

Animal Model	Test Animals	Extract Used	Observed Effect	Inference
Forced Swim Test (FST)	Rats / Mice	Hydroalcoholic tuber extract	Decreased immobility time	Antidepressant-like activity
Tail Suspension Test (TST)	Mice	Ethanolic tuber extract	Reduced immobility duration	Behavioral despair reduction
Locomotor Activity Test	Rats / Mice	Hydroalcoholic extract	No significant change in locomotion	Effect not due to CNS stimulation
Chronic stress models (reported)	Rats	Plant extract	Improvement in behavioral parameters	Stress-adaptive potential

CONCLUSION

The substantial neuropharmacological potential of Pueraria tuberosa is highlighted in this review, with a focus on its neuroprotective and depressive properties. According to available experimental data, P. tuberosa tuberosa tuber extracts show significant antidepressant-like efficacy without causing nonspecific stimulant effects in well-established animal models like the forced swim test and tail suspension test. Its traditional usage as a nervine tonic is supported by these findings, which also point to its possible utility in the treatment of mood disorders. P. tuberosa's rich phytochemical composition, particularly isoflavonoids like puerarin, daidzein, and genistein, is responsible for its antidepressant and neuroprotective properties. These bioactive substances are thought to work in a variety of ways, such as regulating monoamine neurotransmitters, reducing oxidative stress, inhibiting neuroinflammatory pathways, and shielding neuronal cells from apoptosis. In complicated neurological illnesses like depression and neurodegenerative disorders, such multi-targeted treatments are very beneficial. The absence of well-designed human research, extract standardization, and thorough pharmacokinetic data limits Pueraria tuberosa's therapeutic usefulness despite promising preclinical findings. To improve bioavailability and therapeutic efficacy, future research should concentrate on clinical validation, active ingredient identification, dose optimization, and the creation of sophisticated drug delivery systems. In summary, Pueraria tuberosa shows great promise as a natural treatment option with significant neuropharmacological potential. Its incorporation into evidence-based treatment plans for depression and other neurological conditions may be made easier by more scientific research, leading to safer and more successful herbal therapies.

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