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Clitoria ternatea: Areview on its pharmacognosy and medicinal uses

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Abstract:

Clitoria ternatea**,** commonly known as butterfly pea, is a medicinal plant with significant pharmacological potential. This review provides a comprehensive analysis of its pharmacognostic characteristics, phytochemical constituents, and medicinal applications. The plant is rich in bioactive compounds such as flavonoids, alkaloids, saponins, and anthocyanins, which contribute to its diverse pharmacological activities. Traditionally**,** Clitoria ternatea has been used in Ayurvedic and folk medicine for cognitive enhancement, stress relief, and wound healing. Recent scientific studies have validated its neuroprotective, antioxidant, anti-inflammatory, antimicrobial, antidiabetic, and hepatoprotective properties. Moreover, its role in memory enhancement and neurodegenerative disorder management has gained increasing research interest. This review highlights the therapeutic significance of Clitoria ternatea, supporting its potential as a natural alternative for various ailments. Further investigations are necessary to explore its clinical efficacy, mechanism of action, and formulation advancements for optimized medicinal use.

Keywords: Clitoria ternatea, pharmacognosy, phytochemicals, medicinal uses, neuroprotection, antioxidant, antimicrobial

Introduction:

Clitoria ternatea, commonly known as Butterfly Pea, is a medicinal plant belonging to the Fabaceae family, widely recognized for its striking blue flowers and extensive therapeutic potential. Traditionally, it has been used in Ayurvedic, Chinese, and folk medicine for its cognitive-enhancing, anti-inflammatory, and anti-stress properties. The plant is a rich source of bioactive compounds, including flavonoids, anthocyanins (particularly ternatins), alkaloids, and triterpenoids, which contribute to its diverse pharmacological activities. Scientific studies have demonstrated its antioxidant, neuroprotective, antimicrobial, antidiabetic, anti-inflammatory, and hepatoprotective properties, making it a valuable candidate for modern drug development. In recent years, Butterfly Pea has gained attention in pharmaceuticals, nutraceuticals, cosmetics, and the food industry, particularly as a natural coloring agent and herbal supplement. With increasing scientific interest, further research on its bioavailability, mechanism of action, and potential clinical applications could enhance its role in evidence-based medicine. (1) (2)

Fig 1. Clitoria ternatea plant

Fig 2. Seeds of Clitoria ternatea

Scientific studies have demonstrated its antioxidant, neuroprotective, antimicrobial, antidiabetic, anti-inflammatory, and hepatoprotective properties, making it a valuable candidate for modern drug development. Additionally, its nootropic effects have been extensively studied for their potential in memory enhancement and neurodegenerative disorder management. The presence of natural anthocyanins also makes Butterfly Pea a promising natural food colorant, with applications in functional foods, cosmetics, and nutraceuticals. In recent years, its bioavailability, mechanism of action, and safety profile have gained significant research interest, further strengthening its role in evidence-based medicine. As the demand for plant-based therapeutics grows, Clitoria ternatea continues to emerge as a versatile medicinal plant with broad applications in health and wellness. (3,4)

Scientific Synonyms:

1. Clitoria bracteata Poir.
2. Clitoria ternatea var. albiflora (for white-flowered variety)
3. Clitoria ternatea var. pleniflora (for double-flowered variety)

Common Names:

- English: Butterfly Pea, Blue Pea, Asian Pigeonwings, Darwin Pea
- Hindi: Aparajita (अपराजिता), Koyal, Gokarni
- Sanskrit: Vishnukanta (विष्णुकांता), Girikarnika
- Tamil: Shankupushpam (சங்கு புஷ்பம்)
- Malayalam: Shankhupushpam (ശംഖുപുഷ്പം)
- Telugu: Sankhapushpam (శంఖపుష్పం)
- Kannada: Shankhapushpa (ಶಂಖಪುಷ್ಪ)
- Bengali: Aparajita (অপরাজিতা)
- Marathi: Gokarna (गोकर्ण)
- Gujarati: Koyala
- Malay/Indonesian: Bunga Telang
- Thai: Anchan (อัญชัน)

Taxonical classification: (5)

- Kingdom: Plantae (Plants)
- Subkingdom: Tracheobionta (Vascular plants)
- Superdivision: Spermatophyta (Seed plants)
- Division: Magnoliophyta (Flowering plants)
- Class: Magnoliopsida (Dicotyledons)

- Order: Fabales
- Family: Fabaceae (Leguminosae) – Pea family
- Subfamily: Faboideae (Papilionoideae)
- Genus: Clitoria
- Species: Clitoria ternatea

Botanical Distribution:

Clitoria ternatea, commonly known as Butterfly Pea, is widely distributed across tropical and subtropical regions of the world. It is native to South and Southeast Asia, particularly India, Sri Lanka, Thailand, and Malaysia, where it has been traditionally used in medicine and agriculture. Over time, it has been introduced and naturalized in various regions, including Africa, Australia, South America, and Central America, due to its adaptability and diverse applications. The plant thrives in warm, humid climates and is commonly found in grasslands, riverbanks, open forests, and roadsides, often growing as a wild creeper. It prefers well-drained sandy, loamy, or clay soils and flourishes in full sunlight, though it can tolerate partial shade. Due to its resilience, Butterfly Pea is widely cultivated in gardens, farms, and plantations for medicinal, ornamental, and agricultural purposes, such as soil improvement and livestock fodder. Its global presence and increasing scientific interest have led to its widespread cultivation for herbal, cosmetic, and nutraceutical applications.

Ethnopharmacology of Clitoria ternatea (Butterfly Pea)

Clitoria ternatea has been widely used in traditional medicine across various cultures due to its diverse therapeutic properties. In Ayurveda, Unani, and Siddha medicine, it is highly valued for its nootropic, anxiolytic, and anti-inflammatory effects. Known as Aparajita in Ayurveda, it is traditionally used to enhance memory, alleviate stress, and treat neurological disorders. The roots, leaves, seeds, and flowers are used in different formulations to treat fever, inflammation, and respiratory disorders.

In Traditional Chinese Medicine (TCM), Butterfly Pea is believed to have detoxifying and cooling properties and is often used to treat skin diseases, sore throats, and inflammation. The plant is also widely used in Thai, Indonesian, and Malaysian folk medicine, where its blue flower extract is consumed as a tea to promote relaxation, improve vision, and regulate blood sugar levels. In African traditional medicine, Clitoria ternatea has been used to treat infections, gastrointestinal disorders, and reproductive health issues.

Chemical Composition of Clitoria ternatea (Butterfly Pea) (6) (7) (8)

Clitoria ternatea is rich in bioactive compounds that contribute to its diverse pharmacological activities. The major phytochemical constituents include flavonoids, anthocyanins, alkaloids, saponins, and triterpenoids.

1. Flavonoids

- Kaempferol
- Quercetin
- Myricetin
- Rutin
- Apigenin

These flavonoids exhibit antioxidant, anti-inflammatory, and neuroprotective properties.

2. Anthocyanins (Responsible for the blue color of the flowers)

- Ternatins (Ternatin A1–A3, B1–B4, C1–C5)

These water-soluble pigments possess antioxidant, anti-diabetic, and anti-obesity effects and are used as natural food colorants.

3. Alkaloids

- Clitorine
- Vasicine
- Vasicinol

Alkaloids contribute to anti-inflammatory, bronchodilator, and antimicrobial properties.

4. Saponins

- Triterpenoid saponins
  Saponins are known for their immune-boosting, antimicrobial, and cholesterol-lowering effects.

5. Triterpenoids

- Taraxerol
- Lupeol
  Triterpenoids exhibit anti-inflammatory, hepatoprotective, and anticancer properties.

6. Coumarins

- Scopoletin
  Coumarins contribute to antioxidant and anticoagulant effects.

7. Other Compounds

- Proteins and peptides (Clitorea peptide)
- Carbohydrates and polysaccharides
- Essential oils (trace amounts)

Pharmacological Uses of Clitoria ternatea

Anthelmintic Activity (9)

The ethanolic and aqueous extracts of Clitoria ternatea leaves demonstrated anthelmintic activity at a concentration of 100 mg/mL. The study was conducted using Eisenia foetida worms at three different concentrations (100, 50, and 25 mg/mL) of the ethanol-based extract to compare its efficacy with the aqueous extract. The time required for paralysis (P) and death (D) of the worms was recorded. For the aqueous extract, the paralysis and death times were 18 ± 1.57 minutes and 53.33 ± 0.33 minutes, respectively. In the case of the ethanolic extract, these values were significantly lower at 12.33 ± 0.80 minutes and 32.33 ± 0.71 minutes. The results indicated that the ethanol-based extract exhibited stronger anthelmintic activity compared to the aqueous extract.

Anti-diabetic Activity (10)

The anti-diabetic potential of the ethanolic extract of Clitoria ternatea flowers was evaluated in rats. After three weeks of administration, a significant reduction in serum glucose levels was observed in experimentally induced diabetic rats. This effect was attributed to the inhibition of galactosidase and glucosidase activities, although fructosidase activity remained unaffected.

The hypoglycemic effects of methanolic, aqueous, petroleum ether, and chloroform extracts of C. ternatea leaves were tested in streptozotocin-induced diabetic rats for both acute and subacute responses. The extracts, at doses of 200–400 mg/kg, significantly reduced hyperglycemia. The 400 mg/kg dose showed a more pronounced effect, whereas the 200 mg/kg dose also lowered glucose levels but to a lesser extent.

Subacute studies revealed that prolonged use of the 200 mg/kg dose provided better glucose control compared to the 400 mg/kg dose. Additionally, extracts from both leaves and flowers exhibited anti-hyperglycemic and anti-hyperlipidemic properties, which may protect against liver and kidney damage associated with diabetes. The anti-hyperlipidemic effects of C. ternatea and Vigna mungo were examined in poloxamer 407-induced and diet-induced hyperlipidemic rats. The combination of water-alcohol extracts from C. ternatea roots and seeds and hydroalcoholic extracts from V. mungo seeds significantly reduced triglyceride, very-low-density lipoprotein (VLDL), and low-density lipoprotein (LDL) cholesterol levels. The atherogenic index (AI) and HDL/LDL ratio were also normalized after treatment.

Anti-inflammatory, Antipyretic, and Analgesic Activities (11)

Both the leaf and flower extracts of C. ternatea have demonstrated anti-inflammatory effects. The petroleum ether and ethanolic extracts exhibited analgesic activity, with the ethanol-treated extract showing prolonged pain relief lasting up

to 1.5–2 hours. Flavonoids present in C. ternatea are believed to contribute to its anti-inflammatory, analgesic, and antipyretic properties.

Methanolic extracts of C. ternatea roots at doses of 200, 300, and 400 mg/kg body weight significantly reduced yeast-induced pyrexia in a dose-dependent manner, restoring body temperature to normal. Since conventional analgesic and anti-inflammatory drugs are often expensive and have side effects, C. ternatea offers a cost-effective and natural alternative.

In another study, methanolic root extract of C. ternatea was found to significantly reduce carrageenan-induced rat paw edema and acetic acid-induced vascular permeability in rats. The extract's antipyretic effect was comparable to that of paracetamol. Recently, C. ternatea leaf extracts have also been linked to analgesic activity.

Antidepressant Activity (12)

Methanolic extracts of C. ternatea at doses of 100 and 400 mg/kg, administered orally, demonstrated antidepressant effects in mice in a tail suspension test. The duration of immobility was significantly reduced, with the 400 mg/kg dose showing superior efficacy compared to fluoxetine (10 mg/kg, intraperitoneally).

Additionally, an ethanolic extract of C. ternatea roots at doses of 150 and 300 mg/kg exhibited antidepressant activity. Previous research identified two compounds, (Z)-9,17-octadecadienal and n-hexadecanoic acid, in the roots, which have the potential to serve as selective monoamine oxidase-A (MAO-A) inhibitors. These compounds could be useful in developing herbal treatments for psychiatric disorders such as depression and anxiety.

Neuropharmacological Activity (13)

C. ternatea is reported to have neuroprotective effects, potentially due to its antioxidant and anti-inflammatory properties. It has shown promise in preventing neurodegenerative disorders and enhancing cognitive function. The plant is traditionally considered a brain tonic, particularly for improving mental health.

Studies have shown that intraperitoneal administration of alcohol extracts from the stem, flower, leaves, and fruit of C. ternatea in rats and mice induces sedation and reduces alertness. The root extracts, at doses of 300–500 mg/kg, improved memory by preventing electroshock-induced amnesia and increasing acetylcholine levels and acetylcholinesterase activity in different brain regions, including the cerebral cortex, midbrain, medulla oblongata, and cerebellum.

Anticonvulsant Activity (14)

Seizures result from an imbalance between excitatory and inhibitory neurotransmitters. Drugs that enhance gamma-aminobutyric acid (GABA) levels in the brain often exhibit anticonvulsant activity. The maximal electroshock (MES) test is a well-established model for evaluating antiepileptic drugs in generalized tonic-clonic seizures.

Methanolic extracts of the aerial parts of C. ternatea, at a dose of 100 mg/kg orally, displayed anticonvulsant activity in mice, delaying the onset of seizures and reducing tonic hind limb extension in MES- and pentylenetetrazol (PTZ)-induced seizure models. However, the extract was ineffective against PTZ- and MES-induced seizures in rats.

Antioxidant Activity (15)

Antioxidants function as radical scavengers, inhibit lipid peroxidation, and counteract free radical-mediated processes, thereby protecting against various diseases. C. ternatea contains numerous phenolic antioxidants, such as tannins, coumarins, xanthones, and procyanidins, which exhibit dose-dependent free radical scavenging activity. These compounds are associated with cardiovascular benefits, cancer prevention, and reduced oxidative damage to lipids and LDL cholesterol.

Nootropic Activity (16)

Studies have investigated the nootropic effects of C. pluricaulis, an ethyl acetate and aqueous fraction of which exhibited memory-enhancing effects in rats at doses of 100–200 mg/kg orally. Learning and memory enhancement were assessed using Cook and Weidley's pole climbing apparatus and the elevated plus-maze test.

Another study examined the nootropic properties of C. ternatea, C. pluricaulis, and Evolvulus alsinoides using various behavioral models. All three plants displayed anxiolytic, CNS depressant, and nootropic activities, but C. pluricaulis was identified as the most effective for memory enhancement.

Oral administration of ethanol extracts from C. ternatea roots and aerial parts improved electric shock-induced amnesia in rats. Additionally, neonatal rats treated with an aqueous root extract for 30 days exhibited improved spatial learning and memory retention.

Antimicrobial Activity (17)

Antimicrobial activity of C. ternatea was evaluated against various pathogens, including Escherichia coli, Salmonella typhimurium, Klebsiella pneumoniae, and Pseudomonas aeruginosa, using the disc diffusion method. The methanolic extract demonstrated the highest activity, producing inhibition zones of 16–26 mm, while aqueous and chloroform extracts produced zones of 12 mm and 14–18 mm, respectively. In contrast, hexane and petroleum ether extracts showed no antimicrobial activity.

Conclusion:

Clitoria ternatea is a medicinally significant plant with a rich phytochemical profile and diverse pharmacological activities. Its traditional uses have been scientifically validated, particularly in neuroprotection, antioxidant, antimicrobial, and anti-inflammatory applications. The presence of bioactive compounds such as flavonoids, alkaloids, and anthocyanins supports its therapeutic potential. Despite extensive research, further studies are required to elucidate its exact mechanisms of action, optimize its formulations, and establish its clinical efficacy. With continued exploration**,** Clitoria ternatea holds promise as a natural and sustainable source for novel drug development in modern medicine.

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