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Review Paper

Pharmacognostical and Pharmacolological Account on Clitoria Ternatea: A Review

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ABSTRACT

Clitoriaternatea, commonly known as butterfly pea, is a perennial herbaceous plant belonging to the Fabaceae family. It is widely recognized for its vibrant blue flowers, which are rich in anthocyanins and have applications in food coloring, cosmetics, and herbal medicine. Traditionally, Clitoriaternatea has been used in Ayurvedic and traditional medicine for its cognitive-enhancing, anti-inflammatory, antimicrobial, and antioxidant properties.Scientific studies have demonstrated its potential in neuroprotection, memory enhancement, and anti-diabetic effects. Due to its diverse pharmacological and ecological benefits, Clitoriaternatea has gained interest in modern research for therapeutic and commercial applications. The chemical composition of the extracts of clitoriaternatea has been described and it includes alkaloids, flavonoids,saponin, phenol,tannins& steroids, This article summarizes the latest research on the phytochemical and pharmacological properties of this plant, along with its traditional uses and medical applications.

INTRODUCTION

Clitoriaternatea (CT) usually called as Asian pigeon wings or butterfly pea (Ashraf K; et:al.2024) or blue bell or blue pea or cordofan pea or Darwin's pea, IT is a species bellonging to Fabaceae family having Synonyms: Clitoris principissae. (Shinde N;et:al. 2024)Ayurveda has made extensive use of the *Clitoriaternatea* plant. Pharmacologically, it has analgesic, anxiolytic, antifungal, antioxidant, antimicrobial and anti-inflammatory properties. (Sarma D;et:al 2023**)**.*Clitoriaternatea* has been commonly used in Ayurvedic medicine for its potential to improve memory, act as an antidepressant, reduce stress,

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provide sedation, ease anxiety, and induce a calming effect. Clitoriaternatea, commonly known as butterfly pea, blue pea, or Asian pigeonwings, is a perennial climbing leguminous plant belonging to the Fabaceae family. It is native to tropical and subtropical regions, particularly in Asia and Africa, and has been widely cultivated for its medicinal, ornamental, and agricultural value (Kumar et al., 2021). The plant is well-known for its vibrant blue flowers, which contain anthocyanins responsible for their deep coloration.

Fig.No.01: - Flowers & leaves of Clitoria Ternatea

Traditionally, Clitoriaternatea has been used in Ayurvedic and traditional medicine for cognitive enhancement, stress relief, and antimicrobial purposes (Mukherjee et al., 2008). Recent scientific studies have also highlighted its potential as an antioxidant, anti-inflammatory, and memory-boosting agent (Srivastava & Singh, 2020). Besides medicinal applications, Clitoriaternatea is used as a natural food coloring, in herbal teas, and as a nitrogen-fixing cover crop in sustainable agriculture. The plant's ability to thrive in various soil conditions and its drought tolerance make it valuable in agroforestry and ecological restoration programs (Rai et al., 2019).

Synonyms: -

*C. philippensis*Perr., *C. pilosula*Benth., *C. ternatensium*Crantz, *Lathyrus spectabilis* Forssk.,*Ternateaternatea*(L.) Kuntze, *T. vulgaris* Kunth, *Clitoriaalbiflora*Mattei., *C. bracteata*Poir., *C. coelestris*Siebert & Voss, *C. parviflora* Raf..(suarna W;et.al;2021:,)

Vernacular Name: -

English: - Butterfly pea, blue pea
Indonesia: -kembangtelang
Indian: -Kajroti
Bali: -bungaceleng (suarna W;et.al;2021:)
Sudan: -kordofan pea,
Brazil: -cunha
Hindi: -Aparajita
Hin:-Khagin
Bengali: - Aparajita
Tamil: -Kokkattan
Sanskrit names: Aparajita, Girikarnu, Asphota and Vishnukranta
Gujrati: - Gorani
Marathi: -Gokarna
Arabic: -Buzrula(Zingare M; et.al;2013:)

Geographical Distribution: -

The Clitoria genus is a common garden climber found in tropical and subtropical regions worldwide. However, it is becoming rare in humid and semi-humid areas of Asia, America, Africa, and parts of Australia. This plant grows at altitudes from sea level up to 1,800 meters and is often used as an ornamental plant in warm climates. In Africa, Clitoria grows in grasslands, especially in seasonally wet black clay soils and abandoned farmlands. In Sudan, it is used for fodder and grazing, while in Kenya, it is mixed with *Chloris gayana* grass for cultivation. In America, this plant is found in regions from Florida to Texas and from New Jersey to Kentucky and Arkansas. It is also common in Jamaica, Puerto Rico, and the Turks and Caicos Islands.In India, Clitoria is widely spread, especially in southern regions up to 1,500 meters in altitude, including the Andaman Islands. (Chauhan S.N. et al.,2017).

Scientific / taxonomical: -

Table No 01: Taxonomic Classification (Shinde N, et.al. 2024; Suarna W, et.al; 2021).

Kindom	Plantae
Division	Tracheophyte
Subkingdom	Spermatophytina
Infrakingdom	angiosperms
Class	Magnoliopsida
Main order	Rosanae
Order	Fabale
Family	Fabiaceae
Sub family	Papilionoideae
Genus	Clitoria L.
Species	Clitoriaternatea

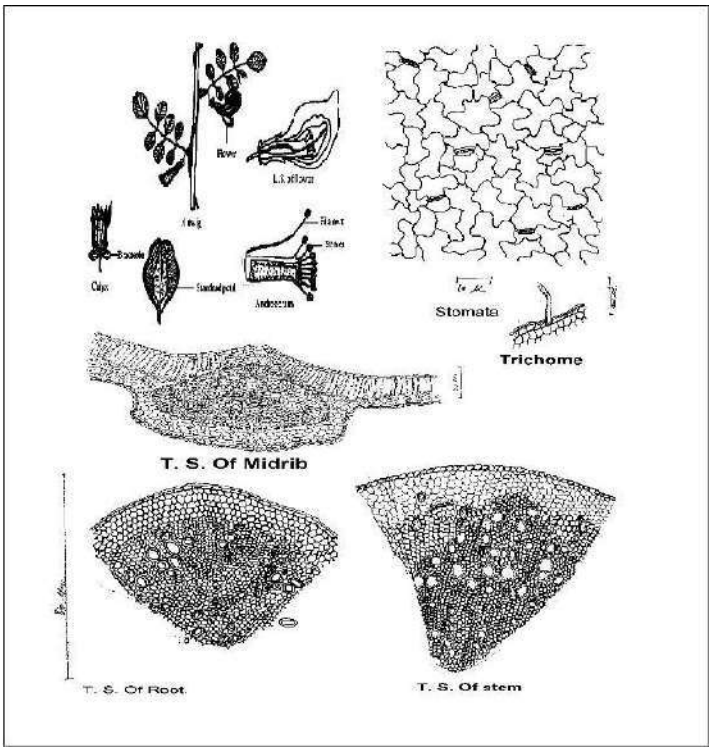
Morphological distribution: -

Colour: -deep blue with a white or yellowish (Rani, R., & Sharma, D. 2013)
Odour: -odorless (kazumaK.et:al 2003)
Shape: - elliptic - oblong (Sarma K.S.et: al.2023)
Size: -4 to 5 cm in length. (Rani, R., & Sharma, D. 2013)
Taste: -very mild, slightly earthy taste, similar to green tea.

Uses: -

1) It is used in Ayurvedic and traditional medicine for improving memory, reducing stress, and acting as an adaptogen. (Mukherjee P. K., et al. 2008)
2) Its root extracts have been used for their nootropic (cognitive-enhancing) and anxiolytic (anti-anxiety) properties. (Rai, K. S., et al. 2001)
3) It exhibits anti-inflammatory, antioxidant, and antimicrobial properties, making it useful for wound healing and infection prevention. (Avoseh O. N., et al. 2021).
4) In Cuba, a decoction of roots alone or combined with flowers is regarded as an emmenagogue. This preparation is made by placing a handful of cleaned and macerated roots in a bottle of water. Drinking a glass in the evening is believed to stimulate Menstruation and induce uterine contractins (Mukherjee K.P. et: al.2008).

Microscopical Distribution



T.S. of Stem:

The transverse section (T.S.) of the Clitoria ternatea stem shows that the outermost layer is the epidermis. The epidermis consists of barrel-shaped, thick-walled cells covered by a thin cuticle. The size of epidermal cells ranges from 1-2 µm in width and 3-4 µm in length.Below the epidermis is the cortex, made up of 4-5 layers of cells. The cortical cells vary in size, measuring 4-54 µm in width and 5-6 µm in length.At the center of the stem, there is a stele, which consists of phloem parenchyma and xylem elements. The phloem cells measure 3-4 µm in width and 4-5 µm in length, while the xylem elements are 1.2-1.3 µm in width and 1.3-1.4 µm in length.

T.S. of Leaf:

The transverse section (T.S.) of the Clitoria ternatea leaf shows two layers of epidermis—the upper epidermis and the lower epidermis.The upper epidermis consists of compactly arranged, barrel-shaped cells. These epidermal cells measure 3-4 µm in width and 4.5-5 µm in length.Below the upper epidermis is a single layer of palisade cells, which contain chlorophyll. These palisade cells measure 2.5 µm in width and 10-13 µm in length.Under the palisade layer is the spongy parenchyma, which is rich in chlorophyll. The spongy parenchyma cells measure 3.5-4 µm in width and 4.5-5 µm in length.

T.S. of Root:

The upper epidermis is made up of thick-walled cells.The cortex is small and consists of parenchymatous cells.In the vascular tissue, the xylem elements are interrupted by phloem parenchyma. The phloem parenchyma cells measure 2.5-3 µm in width and 3-3.5 µm in length, while the xylem elements measure 4-5 µm in width and 4.5-5.5 µm in length.

Trichomes:

Clitoria ternatea has unicellular, unicostate trichomes, which are 20-25 µm long.

Stomata:

The leaf has anisocytic (cruciferous) stomata, measuring 5-7 µm in width and 4-5 µm in length.

Traditional Uses: -

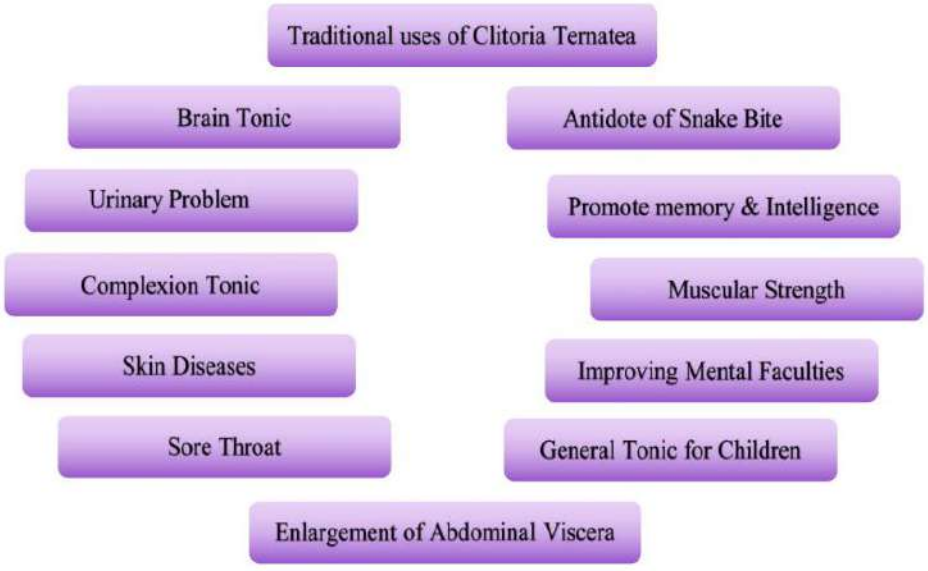


Fig.No. 02: - Traditional uses of clitoriaternatea(Sahu D.et:al. 2023)

Culinary and Industrial Uses

The edible flowers of *Clitoriaternatea* are widely used in culinary applications, particularly in Southeast Asian cuisine. The petals release a deep blue pigment when soaked in water, which changes to purple when mixed with acidic substances like lemon juice, making it a popular natural food dye (Lim, 2012). The extract is also used in herbal teas, smoothies, cocktails, and desserts. Industrially, the plant's bioactive compounds have potential applications in cosmetics, pharmaceuticals, and textile dyeing industries, further increasing its economic value (Golez & Golez, 2020).

Pharmacological Activities: -

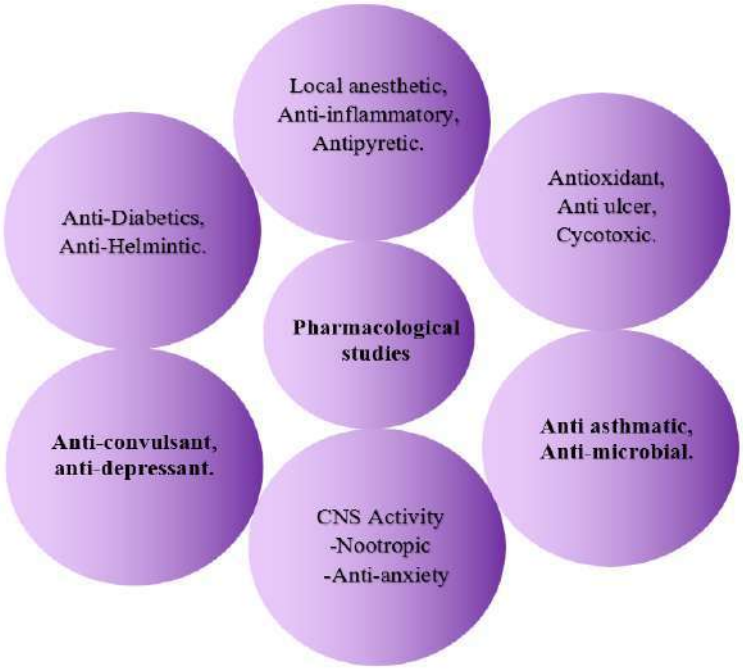


Fig No.2. Pharmacological Activities of Clitoria ternatea.

Antimicrobial Activity

A study tested the antimicrobial activity of Clitoria ternatea flower extracts using the disc diffusion method. Different solvents—water, methanol, petroleum ether, hexane, and chloroform—were used to extract compounds from the flower and tested against bacteria like E. coli, K. pneumoniae, and P. aeruginosa. Amikacin was used as a positive control. The results showed that the methanol extract had the strongest antibacterial effect, with inhibition zones ranging from 16 mm to 26 mm. The chloroform extract was also effective, with zones between 14 mm and 18 mm. The water extract showed some antibacterial activity with a 12 mm inhibition zone, while petroleum ether and hexane extracts had no effect. This suggests that the methanol extract is the most effective at killing bacteria compared to the others.

Antifungal Activity

A plant from this family showed strong antifungal effects against important fungi like Aspergillus niger and Candida albicans (Bishnupada et al., 2011). The leaf extract of Clitoria ternatea was very effective against A. niger, with a minimum amount of 0.8 mg/mL needed to stop its growth (Kamilla et al., 2009). Another study found that the seed extract of C. ternatea also worked well

against A. niger and A. ochraceous. (Mhaskar et al.,2010).

Antioxidants Activity

Clitoria ternatea is rich in bioactive compounds, including antioxidants. The first step in obtaining these antioxidants from the plant is extraction. The efficiency of this process depends on several factors, such as particle size, the type of solvent used, extraction conditions, methods, and the plant's chemical composition (Do Q.D et al., 2014). Ethanol is often used as a solvent for extraction because it is considered safe (GRAS) for use in food and medicine. (Zhang L. et al.,2019).

Anti-inflammatory Activity

The antidiabetic effect of Clitoria ternatea was tested by measuring how much it prevents hemoglobin from binding to sugar (glycosylation). This was done using a color measurement at 520 nm. Solutions of glucose (2%), hemoglobin (0.06%), and sodium azide (0.02%) were prepared in a phosphate buffer (0.01 M, pH 7.4). 1 ml of each solution was mixed together. Different concentrations of the plant extract were added to the mixture. The mixture was kept in the dark at room temperature for 72 hours.After incubation, the level of hemoglobin glycosylation was measured at 520 nm. Alpha-Tocopherol (Trolax) was used as a standard drug for comparison. The percentage of glycosylation inhibition was calculated using a standard method. All tests were performed three times to ensure accuracy.

Antidiabetic Activity

The effects of different extracts (methanol, water, petroleum ether, and chloroform) from *Clitoria ternatea* leaves on blood sugar levels were tested in diabetic rats induced by Streptozotocin. Both 200 mg/kg and 400 mg/kg doses of the extract significantly lowered blood sugar levels, with the higher dose (400 mg/kg) showing a stronger effect. However, the 200 mg/kg dose also helped reduce blood sugar, just not as much as 400 mg/kg. (Abhishek S, et al.,2015) For the short-term (acute) effect, both doses (200 mg/kg and 400 mg/kg) showed similar blood sugar reduction, but at the 30-minute mark, the 200 mg/kg dose caused a slightly better drop. For long-term (subacute) effects, using 200 mg/kg over time was found to be more effective in controlling blood sugar than the 400 mg/kg dose. The methanol extract of *Clitoria ternatea* (200 mg/kg and 400 mg/kg) was also tested in another type of diabetic rats induced by Alloxan. The extract significantly ($P<0.001$) lowered blood sugar levels in these rats within 12 hours of administration. (Abhishek S, et al.,2013)

Central Nervous System Activity

The seeds and leaves of *Clitoria ternatea* have long been used as a brain tonic, believed to enhance memory and intelligence. Researchers studied its effects on Alzheimer's disease to evaluate its benefits and identify the main active compounds responsible for its effects. The results showed that the aqueous extract of *Clitoria ternatea* helped in Alzheimer's disease through various mechanisms. The isolated compounds could serve as a basis for developing new drugs to improve memory. (Shahnas N et al., 2014) Giving 100 mg/kg of *Clitoria ternatea* aqueous root extract (CTR) to newborn and young adult rats for 30 days significantly increased acetylcholine (ACh) levels in their hippocampus compared to untreated rats of the same age. This increase in ACh may be the reason for their improved learning and memory. (Rai KS et al., 2002).

Nootropic Activity

Studies show that Clitoria ternatea (commonly known as butterfly pea) has been traditionally used

as a brain tonic to enhance memory and intelligence. Researchers investigated its effects on Alzheimer's disease and found that its aqueous extract helps improve memory through multiple mechanisms. The active compounds in the plant could serve as a foundation for developing new memory-boosting drugs. (Jiji K N, P. Muralidharan2020). In one study, rats treated with 100 mg/kg of Clitoria ternatea root extract for 30 days showed a significant increase in acetylcholine (ACh) levels in the hippocampus, compared to untreated rats of the same age. This increase in ACh may explain their improved learning and memory abilities. (Rai KS. 2010).

Anticonvulsant activity:

An imbalance between excitatory and inhibitory neurotransmitters can cause seizures. Drugs that increase GABA levels in the brain may help prevent seizures. The maximal electroshock (MES) test is a reliable method for evaluating antiepileptic drugs used for generalized tonic-clonic seizures. A methanolic extract from the aerial parts of CT showed anticonvulsant effects in mice at a dose of 100 mg/kg when given orally. It delayed the start of seizures in PTZ-induced seizures and reduced the duration of tonic hind limb extension in MES-induced seizures. These findings suggest that CT may have potential as an antiepileptic drug. However, in another study, the ethanolic extract

Phytochemical Constituents: -

Table No. 02: Phytochemical composition and functions of different parts of Clitoriaternatea. (Chakraborthy GS 2018).

Parts of Plants	Phytochemical Constituents	Functions
Flower	Saponin, Tannins, Alkaloids, Glycosides, Phytosterols, Carbohydrates	It is help to increased weight loss, improvement in skin and hair health also in better blood sugar control.
Leaf	Alkaloids, reducing sugars, flavonoids, steroids, glycosides	Prevention of neurodegenerative Diseases, diabetes mellitus and Effectively controls on excessive sweating.
Bark	1,1-diphenyl-2-picrylhydrazyl (DPPH)	bark is diuretic and laxative
root	1,1-diphenyl-2-picrylhydrazyl (DPPH)	It is used as an antioxidant also the root is diuretic and laxative; the extract is given as a demulcent in the irritation of the bladder as well as in urethra.
Seed	The seeds contain nucleoprotein with an amino acid sequence. Additionally, they include ethyl D-galactopyranoside, p-hydroxycinnamic acid polypeptide, a highly basic protein called finotin, a bitter acid resin, tannic acid, 6% ash, and a toxic alkaloid.	The seeds possess cathartic, purgative, and aperient properties. They usually used in enlargement of abdominal viscera, swollen joints, and dropsy.

CONCLUSION:

The traditional plant Clitoria ternatea has been used for many years to improve memory and reduce anxiety. Different parts of the plant, including its flowers, seeds, roots, and leaves, have been used in traditional medicine. Studies have found that this plant contains many beneficial natural compounds, such as flavonoids, anthocyanins, triterpenoids, and phytosterols.

These compounds may help boost memory and could be useful in developing new medicines for brain-related disorders. However, despite the many natural compounds in Clitoria ternatea, the flower has not yet been studied in detail in clinical trials. Therefore, it is highly recommended that future research focuses on studying the effects of the flower in clinical settings. The paper reviewed Clitoria ternatea as a promising medicinal plant with many health benefits. It can be used in different medical treatments because it works well and is safe to use.

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