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CLITORIA TERNATEA: PHYTOCHEMICAL PROFILE, PHARMACOLOGICAL POTENTIAL, AND EMERGING NUTRACEUTICAL APPLICATIONS

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ABSTRACT

Clitoria ternatea, commonly known as butterfly pea, is a perennial legume rich in bioactive compounds with significant therapeutic promise. This review article explores its phytochemical composition, diverse pharmacological activities, and rising role in nutraceuticals, highlighting opportunities for functional food development.Clitoria ternatea contains key phytochemicals such as anthocyanins (e.g., ternatins), flavonoids, phenolic compounds, alkaloids, saponins, and tannins across its flowers, leaves, seeds, and roots. The plant exhibits antioxidant, antidiabetic, hepatoprotective, anticancer, anti-obesity, and neuroprotective activities, validated in preclinical models. Flower extracts show antiproliferative effects on cancer cells via apoptosis induction and inhibit enzymes like acetylcholinesterase for cognitive benefits. Clinical evidence supports its role in reducing oxidative stress in type 2 diabetes patient. Emerging uses include natural food colorants, functional beverages, and active packaging due to its color stability and antimicrobial properties. Its safety profile and clean-label appeal position it for supplements targeting metabolic and liver health. Further human trials are needed to optimize dosages and formulations.

KEYWORDS: Clitoria ternatea, Butterfly pea, Phytochemicals, Anthocyanins, Antioxidant activity, Antidiabetic, Nutraceuticals, Functional foods.

INTRODUCTION

Clitoria ternatea L., commonly known as butterfly pea or Asian pigeonwings, is a perennial herbaceous legume belonging to the Fabaceae family, native to tropical regions of Southeast Asia, India, and Australia. Traditionally

revered in Ayurvedic and Chinese medicine systems, its vibrant blue flowers, roots, leaves, and seeds have been used for centuries to treat ailments ranging from diabetes and inflammation to cognitive disorders and skin conditions. The plant's striking anthocyanin-rich petals, which exhibit pH-dependent color changes from deep blue to pink, have also found cultural significance in natural dyes and rituals.

In recent decades, scientific interest in C. ternatea has surged due to its rich phytochemical diversity and promising pharmacological profile, positioning it as a candidate for modern nutraceutical innovation. Bioactive constituents such as ternatins (delphinidin glucosides), flavonoids (quercetin, rutin), phenolic compounds, alkaloids, saponins, and triterpenoids confer potent antioxidant, anti-inflammatory, and enzyme-inhibitory properties. Preclinical studies highlight its antidiabetic, neuroprotective, anticancer, hepatoprotective, and anti-obesity effects, while emerging applications leverage its safety and sensory attributes in functional foods, beverages, and supplements.

This review article consolidates phytochemical analyses, pharmacological evidence from in vitro, in vivo, and limited clinical data, and nutraceutical developments up to 2025. It addresses gaps in bioavailability, standardization, and human trials, advocating C. ternatea's transition from folklore remedy to evidence-based functional ingredient.

Key aims include cataloging phytochemicals, evaluating therapeutic mechanisms, exploring food industry integrations, and proposing research directions for optimized nutraceutical formulations.

Fig. 1: Clitoria ternatea L.

Synonyms

English name-Butterfly Pea Hindi-Koyala

Sanskrit synonyms:-Asphota-It has dehiscent fruit

Vishnukranta-Considered as sacred plant, Shankhapushpi, shveta, Mahashveta Girikarni-Leaves resembles ear of rat.

Classical categorization

Charaka Samhita-Shiro virechanopaga-Group of herbs that are used in Nasaya panchakarma treatment.

Bh. Pr. Ni-Guduchyadi Varga.

Part Used-Root bark, root, seeds

Varieties

Bh. Pr. Ni-2 types- 1. Swetapushpa Aparajita, 2. Nila pushpa Aparajita

Ra. Ni.-2 types- 1. Aswaksūra, 2. Nila Aparajita

Medicinal qualities

Rasa-Katu (pungent), Tikta (Bitter), Kashaya (astringent), Guna (qualities)-Laghu (lightness), Rooksha (dry)
Vipaka-Katu (undergoes pungent taste conversion after digestion) Veerya-Sheeta-Cold potency treatment.

Estimation

Clitoria ternatea L., commonly known as butterfly pea, is a perennial legume whose phytochemical estimation is essential for validating its therapeutic and nutraceutical potential in review articles. Estimation involves qualitative screening for primary and secondary metabolites, followed by quantitative assays and advanced profiling techniques to ensure reproducibility and standardization.

Qualitative Screening

Standard tests detect alkaloids (Dragendorff's, Wagner's), flavonoids (Shinoda), saponins (foam), tannins (FeCl3), steroids (Salkowski), and glycosides using color changes or precipitates on aqueous, ethanolic, or methanolic extracts from flowers, leaves, roots, and seeds. These confirm presence across plant parts, with flowers rich in anthocyanins and roots in triterpenoids.

Quantitative Methods

Total phenolic content uses Folin-Ciocalteu (gallic acid equivalents), total flavonoids via aluminum chloride, and total anthocyanins by pH-differential spectrophotometry. Antioxidant capacity is quantified by DPPH, ABTS, or FRAP assays, often expressing IC50 values.

Advanced Profiling

HPTLC fingerprints resolve constituents (Rf 0.04-0.83) at 254/366/620 nm, while HPLC quantifies ternatins and GC-MS identifies volatiles. Physicochemical parameters like ash (total 17.2%, acid-insoluble 5.7%), moisture (14.5%), and extractive yield (7.83%) support quality control. These methods bridge traditional use with evidence-based applications.

Dosage- Churna(powder)-1-3g

Chemical structure of Clitoria ternatea L.

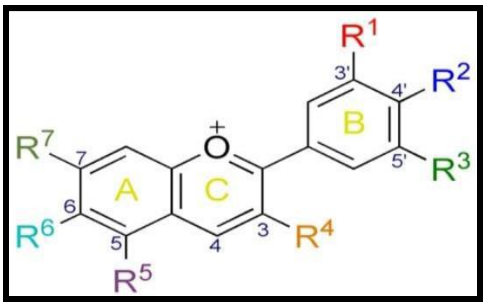

Fig. 2: Chemical structure of Clitoria ternatea L.

Botanical structure

Stems: Slender, climbing, up to 3-5 m long, with pubescent young parts. Leaves: Trifoliate, 3.8-6.8 cm long, elliptic-oblong leaflets.

Flowers: Solitary, vivid blue (ternatea varieties) or white, corolla 4-5 cm, keel bearded. Pods: Linear, 6-11 cm, 10-15

seeds, glabrous.

Roots: Tuberous, primary site for taraxerol.

Key Health Benefits

Brain Function & Mood: Acts as a memory enhancer (nootropic), reduces stress, anxiety, and supports better sleep quality.

Antioxidant Power: Rich in anthocyanins and flavonoids that fight free radicals, protecting cells from damage.

Anti-inflammatory: Helps reduce inflammation, potentially easing conditions like arthritis and body pain.

Skin & Hair: Boosts collagen, improves skin hydration, slows aging, nourishes hair, and promotes growth.

Eye Health: Antioxidants may improve vision, reduce eye fatigue, and protect against damage. Blood Sugar & Pressure: May help regulate blood sugar absorption and lower blood pressure. Digestive Health: Aids digestion and has anthelmintic properties (helps with gut worms).

Traditional & Other Uses

Ayurvedic Medicine: Used for indigestion, liver issues, skin diseases, and as a general tonic. Diuretic: Acts as a natural diuretic.

Food & Drink: Popular for its vibrant blue tea, used in various beverages and dishes.

Diet to follow

Ghee, coconut oil, sunflower seed, almond, taro root, flaxseed oil,soyabean, pistachio, broccoli, carrots, chard, nuts, papaya, pumpkin, red peppers.

Flax seeds, walnut, tofu, brussel sprout, cauliflower, winter squash, fish oil, egg oil, krill oil, chia seeds, camelia are fine to take. There are no diet restrictions.Please avoid all types of junk foods and sodas.Please prefer homemade food wherever possible.

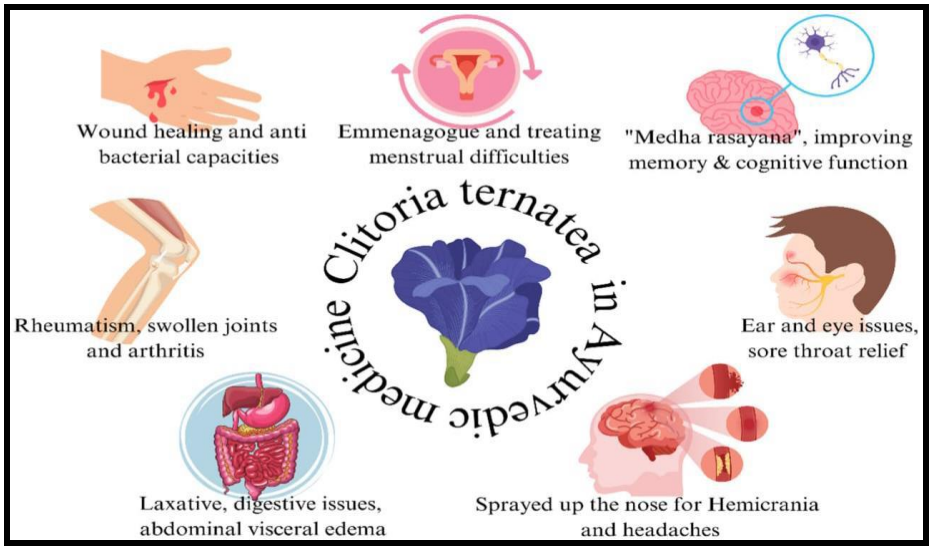

Fig. 3: Ayurvedic benefits of Clitoria ternatea.

Therapeutic benefits

1. Medhya-improves intelligence.
2. Kanthya-improves voice,good for throat

3. Sudrushtida-improves vision,good for eyes.
4. Kushta-useful in skin diseases.
5. Mutra-Cleanses Bladder.
6. Tridosha-Balances tridosha.
7. Ama-relieves indigestion,malabsorption.
8. Shothavrana-Acts as natural anti inflammatory herb.
9. Vishaapaha-Detoxifying,effective in cases of poisoning.
10. Smruti-buddhida-improves memory and concentration.
11. Rakta atisara-diarrhoea with bleeding.
12. Daha-burning sensation.
13. Jyara-natrual antipyretic.
14. Chardihara-anti-emetic.
15. Unmada, madabhrama hara-useful in psychiatric conditions like maniaand schizophrenia.
16. Shwasakasahara-useful in cough, asthma and related respiratory conditions.

Effect on Tridosha

Tridoshahara-It balances all the three Doshas Special effect-Medhya-improves intelligence.

Pharmacological Action-Intellect promoter, Laxative, Diuretic, Anthelmintic, Aphrodisiac.

Dosage forms and preparation methods for Butterfly pea

Common Teas

Steep 1 teaspoon (4 grams) of dried flowers in 1 cup (240 mL) hot water for 10-15 minutes, straining before drinking hot or iced; add lemon or honey for flavor and color change. Traditional decoctions boil flowers with water and sugar to form syrups for beverages or preservatives.

Powder Forms

Dry flowers or leaves via air-drying (7-10 days shaded), oven, or freeze-drying, then grind and sieve (e.g., 60-mesh) for uniform powder stored airtight; used in juices at 0.01-0.03 g/mL or supplements.

Extracts and Granules

Prepare ethanol extracts (e.g., 70% for 200 mg doses) via wet granulation with citric acid, sodium bicarbonate, and binders like PEG for effervescent granules dissolved in water. Aqueous extracts from petals suit dyes or colorants mixed with polymers and glidants.

Topical Forms

Form creams by emulsifying oil/water phases with extracts, incorporating via trituration for homogeneity; includes bases like beeswax, paraffin, and borax for skin applications.

Medicinal uses

1. Brain Health

The tea acts as a nootropic, enhancing memory, focus, and acetylcholine levels while reducing stress, anxiety, and risks of Alzheimer's or Parkinson's through anti-inflammatory polyphenols.

2. Metabolic Support

It helps regulate blood sugar by inhibiting α-amylase, supports antidiabetic effects via β-cell protection, lowers lipid levels, and aids anti-obesity by boosting antioxidant capacity and glutathione peroxidase.

3. Other Benefits

The tea offers hepatoprotective action against toxins or dyslipidemia, anticancer properties by inhibiting cell growth, and anti-inflammatory effects for overall wellness, with clinical studies showing reduced oxidative stress markers.

Fig. 4: Marcketed products of Clitoria ternatea.

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