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CLITORIA TERNATEA (APARAJITA) IN MODERN HERBAL MEDICINE: A STUDY OF ITS TRADITIONAL USES AND CONTEMPORARY APPLICATIONS

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ABSTRACT

Clitoria ternatea, commonly known as Butterfly pea, is a medicinal plant belonging to the family Fabaceae. It is a twining evergreen garden flowering plant which is commonly known as Aparajita (Hindi) or Butterfly pea (English).The plant is reported to be used in insect bites, skin diseases, asthma, burning sensation, ascites, inflammation, leucoderma, leprosy, hemicrania, amentia and pulmonary tuberculosis. It is commonly called "Shankpushpi"in the Sanskrit language, where it is reported to be a good "Medhya" (brain tonic). The major phytoconstituents found in *Clitoria ternatea* include pentacyclic triterpenoids such as taraxerol and taraxerone, ternatins, alkaloids, flavonoids, saponins, tannins, carbohydrates, proteins, resins, and starch. *Clitoria ternatea* has been evaluated for its medicinal properties and shows promising effects, including antioxidant, antidiabetic, antidepressant, anti-anxiety, anti-stress, anti-inflammatory, anti-hyperlipidemic, anti-diabetic, analgesic, cytotoxicity, platelet aggregation inhibitory, and hepatoprotective activities. However, commercially, it is valued as a natural dye and food colorant because of the acylated anthocyanins in it. This plant has marked antioxidant and antiaging properties, and hence it is gaining popularity in formulating cosmetics and cosmeceuticals. It is also used for protecting crops in agro-technology. This study highlights the numerous medicinal properties, ethnobotanical, ecological importance, and commercial uses, as well as its phytochemical investigation prove multifaceted potential of this plant.

No. of Pages: 10 **References: 53**

Keywords: Medicinal value, Ethnobotanical importance, Alkaloids, Food additive.

INTRODUCTION

The *Clitoria ternatea,* commonly known as Butterfly pea, belongs to the family Fabaceae and sub- family Papilionaceae, is a perennial leguminous twiner. *Clitoria* Linn., comprises 60 species distributed mostly within the tropical belt, with a few species found in temperate areas. The *Clitoria ternatea* (butterfly pea) has gained a lot of attention due to its role in traditional medicine, food coloring, cosmetics, fodder, and as a source of an environmentally friendly insecticide, among other agricultural and medical applications (Aggarwal et al. 2007). There are various names for this perennial leguminous plant in the Fabaceae family, including Blue Bell Vine, Asian Pigeon Wings, Cordofan Pea, Blue Pea, and Darwin Pea. It is also known as "Shankapushpi" (conch flower) in indigenous states, as well as "Aparajit" (Hindi), "Aparajita" (Bengali), and Kakkattan" (Tamil) (Anuradha et al. 2004 and Arise et al. 2009). The young shoots, leaves, flowers, and delicate pods are used as vegetables in South India and the Philippines, while in Malaysia, the leaves are used to color food

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green and the flowering to color rice cakes bright blue (Barik et al. 2007). While its origins are debatable, it is now native to parts of India, South America, Southern and Eastern Africa, Madagascar, and the Western Indian Ocean. It has also become a good feeding source for the hot and semi-arid North-Eastern Brazil due to its adaptability and persistence under drought circumstances, as well as its capacity for regrowth quickly after the rainy season begins, aside from its good palatability and nutritional content (Aggarwal et al. 2007).

The juice of flowers is reported to be used in insect bites and skin diseases (Aggarwal et al. 2007). The roots are useful in asthma, burning sensation, ascites, inflammation, leucoderma, leprosy, hemicrania, amentia, pulmonary tuberculosis, ophthalmology, and reported as bitter, refrigerant, ophthalmic, laxative, diuretic, cathartic, aphrodisiac, tonic (Parmiladevi et al. 2003). Consequently, they are used in the treatment of several ailments, including body aches, infections, urinogenital disorders, and as antihelmintics and antidotes to animal stings. Seeds are cathartic and useful in visceralgia. They are considered safe for colic, dropsy, and enlargement of abdominal viscera. The root, stem, and flower are recommended for the treatment of snake bite and scorpion sting in India (Mathada et al. 2012).

This comprehensive study provides basic information about this flower and its significance in several indigenous cultures, including the nature-based healing practices of Indian Ayurveda and those of South America, which were passed down from early civilizations. This paper compiles a list of functional attributes of the pea flower and the ethnomedicinal importance, which are the reasons behind it.

Botanical description

Clitoria ternatea has twining fine stems, 0.5-3 m long. The leaves are pinnate, with 5-7 elliptic to lanceolate leaflets, 3-5 cm long and shortly pubescent underneath (Fig. 1). Flowers are solitary, deep blue to blue mauve; very short pedicellate and 4-5cm long (Fig.2). Pods are flat, linear, beaked, 6-12 cm long, 0.7-1.2 mm wide and slightly pubescent with upto 10 seeds. The seeds are olive, brown or black in colour, often mottled, 4.5-7 mm long and 3-4 mm wide (Gollen et al. 2018).

Fig 1: A Close-up view of the *Clitoria ternatea* flower.

Fig 2: A general view of *Clitoria ternatea* twinner.

Background

From ancient times, "Shankhpushpi" has beenrecognized as a reputed medicinal herb in Ayurveda, and it is reported to be abrain tonic, nervine tonic, and laxative. It is considered a "Medhya-Rasayana" in Ayurvedic texts. It comprises the entire herb with the following botanicals, viz. *Convolvulus pluricaulis* (Convolvulaceae), *Evolvulus alsinoides* (Convolvulaceae), *Clitoria ternatea* (Papilionaceae), and *Conscora decusata* (Gentianaceae). It is an Ayurvedic drug used for its action on the Central Nervous System, especially for boosting memory and improving intellect (Sarwar et al. 2014). The flowers of the plant *Clitoria ternatea* resemble a conch shell; therefore, it is commonly called "Shankpushpi" in the Sanskrit language, where it is reported to be a good

"Medhya"(braintonic) drug and, therefore, used in the treatment of "Masasika Roga" (mental illness) (Huang et al. 2010). Extracts of this plant have been used as an ingredient in Medhya- Rasayana, are juvenating recipe used for the treatment of neurological disorders (Mukherjee et al. 2010).

Cultural and Mythological Importance

The Aparajita plant, also known as *Clitoria ternatea* or Butterfly Pea, is one of the most attractive flowering vines recognized for its stunning *shankh or conch shell-like* shape and blue or white blooms. In India, it is valued not only for its beauty but also for its deep spiritual and medicinal significance (Fig 3). The Aparajita plant is readily available at temples and is often found in herbal teas and Ayurvedic medicines. The plant is a superb addition to every Indian home garden, so much so that in some households, people place it next to Tulsi for Vastu purposes as well. In Indian mythology, it is believed that this flower was used by the goddess Durga to kill Asuras, and hence it is kept for divine purposes as it is perceived to kill the evil that surrounds one and their loved ones. The Aparajita flower holds significant importance in Indian tradition due to its connotations of purity, wisdom, and victory. In Sanskrit, Aparajita means "undefeated" or "invincible." In terms of religious significance, blue and white flowers are given to Goddess Durga and Lord Vishnu, particularly during the Hindu festival of Navratri and in special pujas. The health benefits of its roots and flowers have been acknowledged in Ayurveda to improve memory, reduce anxiety, and detoxify the body. The very well-known Butterfly Pea Tea is created from dried petals of the flower and is a natural stress reliever. Butterfly Pea Tea also contains many antioxidants. Because of this, Aparajita is not only decorative but also has spiritual and medicinal effects. In India, it is sacred, and you will find it in almost all Indian Gardens (Gollen et al. 2018).

Fig 3: A view of the spiritual importance of *Clitoria sp.* (Butterfly Pea).

Nomenclature

There are around 60 global species belonging to the genus *Clitoria*, which originated from tropical equatorial Asia, and later was distributed widely in Southand Central America, the East and West Indies, Africa, Australia. The vernacular name of *Clitoria ternatea* is also known as butterfly pea, blue pea, (English), aparajita (Bengali), cunha (Brazilian), lanhu die, lanhuadou (Chinese), aparajit (Hindi), kajroti (India), bungabiru, tembangtelang (Indonesian), bungabiru, kacangtelang (Khmer), ang san dam, bang san dam (Lao), bungatelang (Malaysian), cunhã, fulacriqua (Portuguese), aparajita (Sanskrit), clitoriaazul, azulejo, conchitis, bejuco de conchitas (Spanish), kakkattan, sangupushpam (Tamil), nallaghentana (Telugu), un-chan, uang-chan, dang-chan (Thai), mavikelebeksarmaşığı (Turkish), and chi daubiec (Vietnamese) (Shirodkar et al. 2023).

Potential Role in the Indian Ayurvedic System

The Ayurvedic approach to disease prevention and health promotion takes into account the entire body, spirit, and mind when addressing health maintenance, development, and healing. It is a holistic strategy that is now becoming more popular throughout the Western world (Nayak et al. 2011). The root juice of the white-flowered *C. ternatea* is sprayed up the nose as a hemicrania therapy. An infusion or powder of the root is used to treat rheumatism and ear issues. It treats stomach, arthritis, fever, constipation, and eye issues. Additionally, it is used in cases of ascetics, abdominal visceral hypertrophy, sore throats, and skin problems. Ginger and finely ground seeds are employed as a laxative; however, the impact is accompanied by lower abdominal gritting. The seeds are also used to treat swollen joints, colic, dropsy, and abdominal visceral edema (Bhaskar et al. 2010). The distribution and diversity of all these plant species are influenced by pollution and human interference (Prakash and Verma, 2022; Singh et al., 2023).

The occlusive feature of the whole *C. ternatea* plant is ground to a paste and is mostly used on bleeding piles. Leaf juice is employed as a nasal drop for headaches. Because it stops the production of pus, *C. ternatea* decoction is useful for wound cleaning and stomatitis gargling. It is used to treat syncope, vertigo, and brain weakness since it also has a relaxing effect on the brain. Additionally, this type of medicine treats snakebite and scorpion stings by using the root, stem,

and flower. The Ayurvedic scripture refers to the juice from this flower as "medhya rasayana", which means "therapeutic procedure or preparation that, if consumed regularly, will boost memory, intellect, and immunity, although the roots, leaves, and stems also have medicinal qualities. Due to its well-known effects on the brain and central nervous system, it is used to treat neurological problems, improve memory, and hone intellect due to these effects. It is widely used in Ayurvedic medicine as a memory-improving, anxiolytic, antidepressant, tranquilizing, and sedative drug (Jayakar et al. 2010).

Traditional Uses: *Clitoria ternatea* is known as Aparajita in Bengali which is used as a well-known Ayurvedic medicine. All the part of the herb (leaf, root, shoot) is used as medicine. In traditional Ayurvedic medicine, it has been used for centuries as a memory enhancer, nootropic, anti-stress, anxiolytic, antidepressant, anticonvulsant, tranquilizing and sedative agent (Mukherjee et al. 2008; Fig. 4). It is also used in neurological disorders. Seeds and leaves were widely used as a brain tonic and to promote memory and intelligence (Gupta et al. 2010). Juice and flowers were used as an antidote for a snake bite. Seeds were used in swollen joints; crushed seeds are taken with cold or boiled water for urinary problems, and some other traditional uses (Table 1; Fig 5).

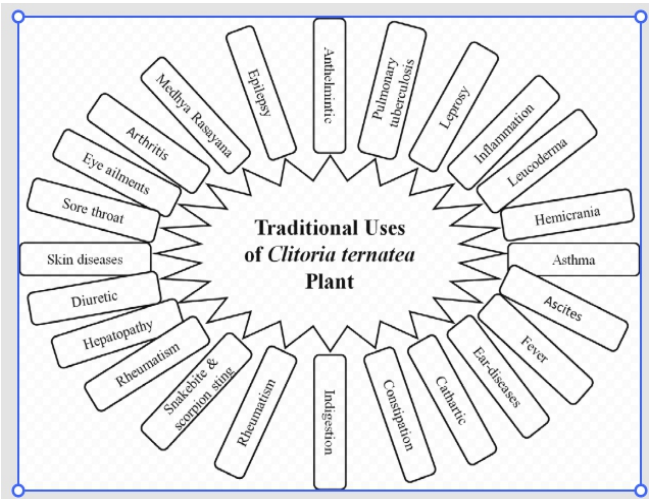

Fig 4: Traditional uses of the *Clitoria ternatea* plant.

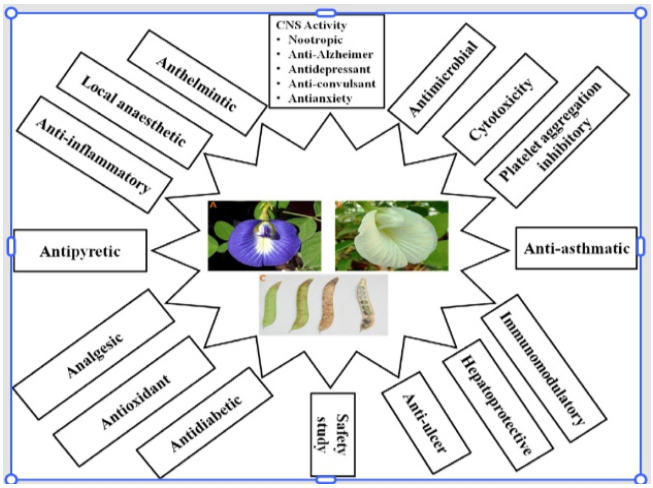

Fig 5. Various pharmacological activities of the *Clitoria ternatea* plant. A and B) Blue and white flowers of *Clitoria ternatea*) Fruit and seed of *Clitoria ternatea*.

Table 1: Various traditional uses of *Clitoria ternatea* plant (Source: Tamanna et al. 2024).

Plant Part	Uses	References
Flower	• The paste of flowers is used for the treatment of eye infection and headache • Flower are also used as an antidote for snakebites	Alok et al. 2015
Leaves	• When a headache or swelling of a nearby gland occurs, juice from the leaves is combined with salt and placed around the ears to reduce discomfort • Juice of leaves is used as an antidote against snakebite • To treat swelling joint and used as poultices	Alok et al. 2015
Seeds	• Used to treat colic, dropsy, swelling joints and enlargement of abdominal viscera • It also possesses laxative, mild emetic and vermifugal properties • Used as green manure and as related problems	Ashraf et al. 2024

Stem	• Used as antidote for snake bite and scorpion • It act as brain tonic because of the presence of some problem throat and eye related problems	Sama et al. 2023
Roots	• Ascetics epilepsy, enlargement of the abdominal viscera, skin disease and sore throat • Used as diuretic, laxative, mind tonic and purgative • Serve to treat different ailments such as an constipation, dyspepsia, eye conditions, enlarged abdominal organs, fever • Rheumatism and ear problems are also treated using roots in the form of powder or decoction • White variety flowered root juice is blown up the nose as a treatment for hemicrania.	Alok et al. 2015; Ashraf et al. 2024

Phytoconstituents

Roots, seeds, and leaves are the reported plant parts used from ancient times. The major phytoconstituents found in *Clitoria ternatea* are the pentacyclic triterpenoids such as taraxerol and taraxerone (Jain et al. 2003). Phytochemical screening of the roots shows the presence of terpenes, alkaloids, flavonoids, saponins, tannins, carbohydrates, proteins, resins, starch, taraxerol, and taraxerone (Fig 6). A new, simple, sensitive, selective, and precise High Performance Thin Layer Chromatography method has been developed for the determination of taraxerol in *Clitoria ternatea* Linn., which was performed on Thin Layer Chromatography aluminium plates (Mukherjee et al. 2010). A wide range of secondary metabolites, including triterpenoids, flavonol glycosides, anthocyanins, and steroids, has been isolated from *Clitoria ternatea* Linn.

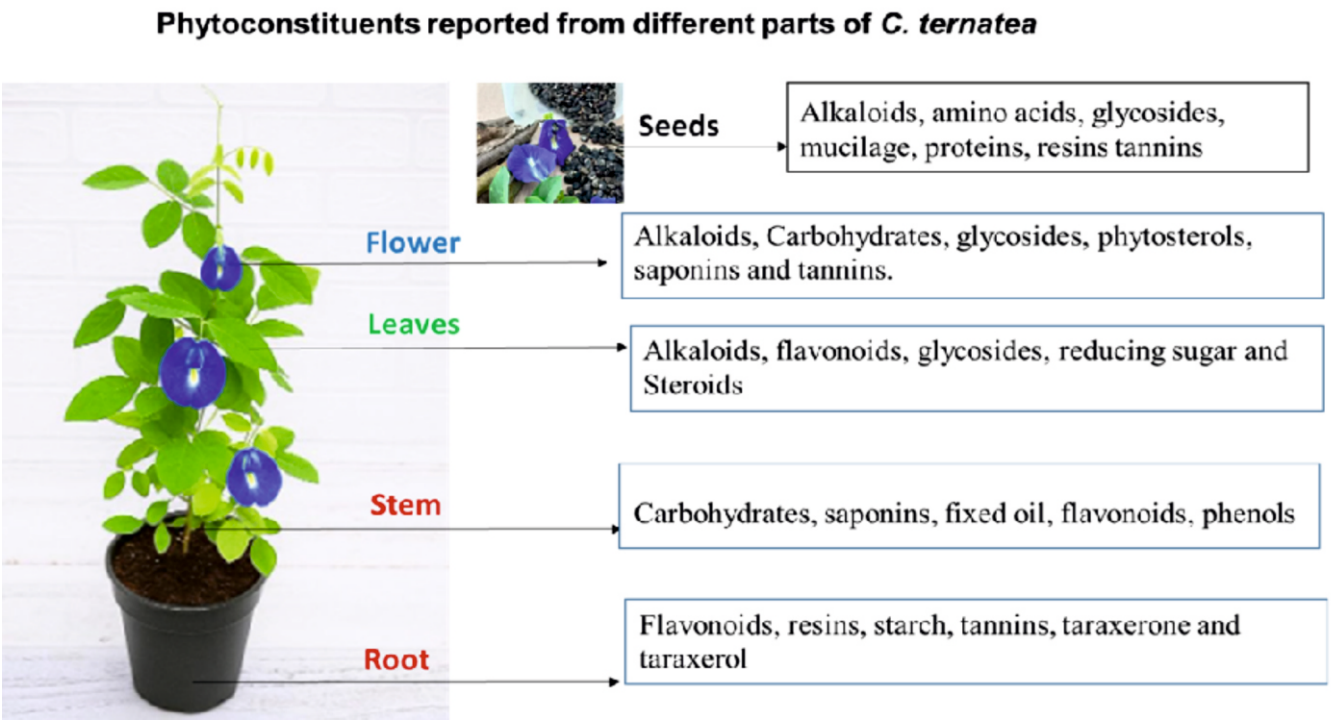

Fig 6: Phytoconstituents reported from different parts of *Clitoria ternatea*.

The seeds contain nucleoprotein with its amino- acid sequence similar to insulin, delphinidin- 3,3,5-triglucoside, essential amino-acids, pentosan, water soluble mucilage, adenosine, an anthoxanthin glucoside, greenish yellow fixed oil (Jaychitra et al. 2012), a phenol glycoside, 3,5,7,4-tetrahydroxy-flavone-3-rhamoglycoside, an alkaloid, ethyl D-galactopyranoside, p-hydroxycinnamic acid

polypeptide, a highly basic protein-finotin, a bitter acid resin, tannic acid, 6% ash and a toxic alkaloid (Rabeta et al. 2011) . A recent study showed that malonylated flavonol glycosides were isolated from the petals (flower part) of *Clitoria ternatea* with different petal colors (Khazuma et al. 2012).

Antioxidant Property of *Clitoria ternatea*

Antioxidants act as radical scavengers, inhibit lipid peroxidation and other free radical-mediated processes, and therefore, they protect the human body from several diseases attributed to the reactions of radicals. Various phenolic antioxidants such as flavonoids, tannins, cumarins, xanthenes, and, more recently, procyanidins have been shown to scavenge radicals in a dose-dependent manner and therefore are viewed as promising therapeutic drugs for free radical pathologies (Ramaswamy et al. 2017). Phenolic compounds are a large and diverse group of phytochemicals, which includes many different families of aromatic secondary metabolites in plants. They are known to exert various physiological effects in humans, such as inhibiting platelet aggregation (Morris et al. 1999), reducing the risk of coronary heart disease and cancer, and preventing oxidative damage of lipid and low- density lipoprotein (Shui et al. 2006; Bhatia et al. 2014). Flavonoids and other classes of phenolic compounds are important phytochemicals (Bhatia et al. 2014). Flavonoids are very effective antioxidants (Morrita et al. 1977) that constitute a large group of naturally occurring plant phenolic compounds, including flavones, flavonoles and chalcones. Many plant phenolics exhibiting antioxidant properties have been studied and proposed for protection against oxidation (Morton et al. 2000). Natural antioxidants occur in all parts of the plant (wood, bark, stems, pods, leaves, fruit, roots, flowers, pollen, and seeds) (Mukherjee et al. 2008). Flowers are an important part of plant which contains a great variety of natural antioxidants, such as phenolic acids, flavonoids, anthocyanin and many other phenolic compounds (Nadkarniet al.1976; Narayanswamy et al. 2005).

The antioxidant activities of the ethanol extract of *Clitoria ternatea* on acetaminophen (APAP) induced toxicity in rats suggest that the ethanol extract of *Clitoria ternatea* can prevent renal damage from APAP (Acetaminophen) induced nephrotoxicity in rats, and it is likely to be mediated through active phytoconstituents and its antioxidant activities (Nickavar et al. 2017). Acetaminophen (APAP) is a widely used analgesic and antipyretic drug that is safely employed for a wide range of treatments (Oktay et al. 2005). The blue-flowered leaves had higher content of all the enzyme antioxidants analyzed than the blue flower (Nithianantham et al. 2018). The enzymatic antioxidant activity of *Clitoria ternatea* was analyzed by using goat liver slices, in both blue flowered leaf and white flowered leaf of *Clitoria ternatea*, and H_2O_2 was used as oxidant. The scavenging activity in the flowers and leaves of *Clitoria ternatea* has been analyzed, and the presence of antioxidant activity in both leaves and flowers showed that *Clitoria ternatea* has the potential to be an alternative source of natural antioxidants. It is concluded that the scavenging activity expressed by *Clitoria ternatea* flower is affected by the amount of total phenolic compounds.

Plant Metabolites

Phytochemical analysis has revealed that the stem contains phytosterols, phenolic compounds, flavonoids, and carbohydrates (Pratt et al. 1992; Patil et al. 2011). Various *in vitro* models were applied to evaluate anti-oxidant property of these extracts. *In vitro* studies included Free Radical Scavenging Capacity (RSC) on DPPH Radicals, Scavenging capacity for hydroxyl radicals, scavenging capacity for superoxide radicals (NBT reduction assay, Nitro blue Tetrazolium assay), and Antioxidant using – Carotene linoleate model system *(* -CLAMS). The phytoconstituents responsible for antioxidant activity were isolated using the preparative TLC method. The methanolic extract showed the maximum free radical scavenging capacity as compared to the acetone extract. Comparative evaluation of *in vitro* antioxidant activity of the root of blue and white flowered varieties of *Clitoria ternatea* (Osbornet al. 1955) showed that methanol extracts of blue and white flowered varieties of *Clitoria ternatea* showed a very powerful antioxidant activity in DPPH radical- scavenging assay. Methanol extracts of *Clitoria ternatea* also showed significant reductive ability as well as hydroxyl radical scavenging activity. Methanol extract of the white-flowered variety of *Clitoria ternatea* showed more significant antioxidant activity as compared to blueflowered variety of *Clitoria ternatea*.

Antidiabetic Potential of *Clitoria ternatea*

Diabetes mellitus is a syndrome characterized by chronic hyperglycemia and disturbances of carbohydrate, fat, and protein metabolism, associated with an absolute or relative deficiency in insulin

secretion or insulin action (Rabeta et al., 2013; Verma, 2017). Diabetes mellitus is also associated with an increased risk of developing premature atherosclerosis due to independent risk factors such as hypertriglyceridemia and hypertension (Madhavrao et al., 2011). Insulin therapy and oral hypoglycemic agents offer effective glycemic control; however, their shortcomings limit their long-term usage. The World Health Organization has recommended the evaluation of the effectiveness of plants in conditions where safe modern drugs are lacking (Marvles et al., 1995). Phytochemicals isolated from plant sources are widely used for the prevention and treatment of cancer, heart disease, diabetes mellitus, and high blood pressure (Kavitha et al., 2012; Sharma and Pareek, 2021). Plants and sometimes animals are highly reputed in indigenous systems of medicine for the treatment of various diseases (Kumar et al., 2008; Prakash and Verma, 2021; Rao, 2021). The leaf and flower extracts of *Clitoria ternatea* exhibit anti-hyperglycemic effects in rats with alloxan-induced diabetes mellitus (Kaisoon et al., 2011). The aqueous extracts of *Clitoria ternatea* leaves and flowers significantly reduced serum glucose and glycosylated hemoglobin levels, as well as the activity of the gluconeogenic enzyme glucose-6-phosphatase. At the same time, these extracts increased serum insulin levels, liver and skeletal muscle glycogen content, and the activity of the glycolytic enzyme glucokinase. For all biochemical parameters studied, rats treated with leaf extracts showed profiles comparable to those treated with flower extracts. Additionally, *Clitoria ternatea* leaf extract exhibited a synergistic effect when combined with *Trichosanthes dioica* leaf extract in streptozotocin-induced diabetic rats (Kaur et al., 2006). Ethanolic extracts of *Trichosanthes dioica* leaf and *Clitoria ternatea* leaf demonstrated a higher degree of antihyperglycaemic activity. A significantly greater anti-hyperglycemic effect was observed with the combined dose (200 mg/kg of *Trichosanthes dioica* leaf + 200 mg/kg of *Clitoria ternatea* leaf) compared to a 400 mg/kg dose of the individual plant extracts.

Hepatoprotective Potential of *Clitoria ternatea*

Hepatic disease is a worldwide health problem, and the search for new medicines is still ongoing. Hepatic cells participate in a variety of metabolic activities; therefore, the development of liver-protective agents is of paramount importance in protecting the liver from damage. The literature consistently shows that hepatoprotective effects are associated with plant extracts rich in antioxidants (Gunjan et al., 2009). Many compounds and plant extracts have been evaluated for hepatoprotective and antioxidant effects against chemically induced liver damage. Several studies have reported the hepatoprotective activity of *Clitoria ternatea*. The ethanolic extract of *Clitoria ternatea* leaves (EECT) at doses of 200 and 400 mg/kg was evaluated for both prophylactic and therapeutic hepatoprotective activity against carbon tetrachloride-induced hepatic damage (Daisy et al., 2009). Silymarin (100 mg/kg) was used as the standard drug. The hepatoprotective effect of EECT was evident in both prophylactic and therapeutic groups at doses of 200 and 400 mg/kg. Histopathological examination of the liver confirmed the effects of EECT and carbon tetrachloride on the cyto-architecture of the liver.

Future Aspects and Challenges

To ensure a regular supply of the plant, proper documentation of Good Agricultural Practices (GAP) is required. One limitation of *C. ternatea* is the instability of its color pigments, which readily degrade when exposed to environmental factors such as light, pH, and temperature. To develop stable formulations of plant pigments, novel drug-delivery systems should be explored. Microencapsulation or nanoparticle-based formulations may be effective approaches to protect and stabilize these natural pigments. Furthermore, to advance the development of *C. ternatea* and its products, stronger evidence through detailed pharmacological studies and human clinical trials is essential. Comprehensive investigations may ultimately lead to the development of a medicine, nutraceutical, or cosmeceutical derived from this delicate yet powerful plant (Choi et al., 2009).

Conclusion

The present review highlights the versatile role of this beautiful plant. *Clitoria ternatea* is not only an ornamental plant but also offers diverse benefits in the fields, cosmetics, food industry, and agro-technology. *Clitoria ternatea* is an abundant source of different Phytoconstituents, which offer health benefits to humans. It acts as an additive when supplemented with functional food anda pharmaceutical drug, and results in an increase in treatment efficiency. The scientific research on *Clitoria ternatea* suggests a huge antioxidant, antidiabetic, and hepatoprotective potential of this plant. The plant is a rich source of phytochemicals, withhigh levels of phenolic compounds and antioxidant activities. The study also indicates that the leaf and flower extracts of *Clitoria ternatea* have a hypoglycemic effect. The extracts were

effective in regulating the biochemical indices associated with diabetes mellitus. *Clitoria ternatea* possesses strong hepatoprotective potential. The plant demonstrates a variety of actions, and it exhibits a low toxicity profile. From the above-mentioned data, we conclude that *Clitoria ternatea* is versatile, safe, and effective. Further studies are in progress to better understand the mechanism of action of organicand aqueous extracts of *Clitoria ternatea,* which could be further exploited in the future as a source of useful phytochemical compounds for the pharmaceutical industry. The antioxidant mechanisms and the anti-Proliferativeproperties of the extracts should be further studied to gain more applications for use as natural antioxidants

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